UT to Crab Creek Restoration Site

Alleghany County, North Carolina

Restoration Plan

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Ecosystem Enhancement PROGRAM

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EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (NCEEP) has selected the Crab Creek Site for a stream and wetland restoration project. The project will involve the restoration of approximately 2,405 linear feet and the preservation of 2,172 linear feet of an Unnamed Tributary to Crab Creek (UTCC). An Unnamed Tributary (UT1) will also include approximately 1,621 linear feet of restoration along with 583 linear feet of enhancement. In addition, the project will also involve approximately 4.7 acres of wetland preservation, 3.7 acres of wetland enhancement, 0.2 acre of wetland creation, and 7.9 acres of wetland restoration.

The site is located approximately 16 miles east of the Town of Sparta on NC-18 and approximately 6 miles west of the intersection of NC-89 and NC-18 in Alleghany County, North Carolina. It is situated within the 05050001 Little River Watershed Cataloging Unit (8-digit HUC) and the 05050001030020 Local Watershed Unit (14-digit HUC), which drains approximately 51,200 acres within Alleghany County. The NCEEP has identified this 14-digit HUC as a Targeted Local Watershed due to the large number of mitigation opportunities, the ability to conserve High Quality Waters, and the presence of rare bog habitat (W.K. Dickson & Co., Inc. 2004).

The Local Watershed Plan for the Little River Watershed (Phase 1) indicates the two most significant problems adversely affecting water quality in the watershed are degradation of riparian habitat and sedimentation (W.K. Dickson & Co., Inc. 2004). The majority of streams in the Little River watershed contain open pasture with cattle grazing. This restoration project would address both issues by establishing a riparian buffer and stabilizing the stream.

Located on the property directly adjacent to UT1, are agricultural fields consisting of pumpkins, Christmas trees, and no till corn. The agricultural fields are located on a hilly slope that drains directly into UT1 and UTCC-US. The agricultural production has led to increased surface runoff, erosion, and sedimentation in the UT1 and UTCC reaches.

UT1 originates from hillside seepage several hundred feet north of the project's northern boundary. This upstream section of stream located off the project site is heavily impacted by cattle and has active bank erosion, torturous meanders, heavy sedimentation, undercutting banks, and a widening channel. As a result, this section of the project portion of UT1 has eroding and undercut banks and reaches with vertical banks. Several log and leaf debris jams exist along the stream with past litter of old, rusty cars and appliances. Portions of UT1 have defined riffles and pools. However, the further upstream section contains heavy sedimentation. A corrugated metal pipe is located in UT1 and serves as an existing crossing. Upstream and downstream of the culvert, the stream is heavily incised and the channel is actively widening.

The UTCC upstream (UTCC-US) reach lacks a meandering pattern, natural features, and riparian vegetation. As a result of channelization, the stream has vertical banks with a straight pattern that contains only one artificial meander bend. The lack of a natural pattern has caused long riffles/runs with a minimal amount of pools. Grass and shrubby vegetation exists sporadically along the stream banks but the stream is lacking a mature forested buffer.

UTCC-US and the downstream portion of UT1 were historically channelized at some point between 1950 and 1964 to maximize the amount of cultivated land (W.K. Dickson & Co., Inc, 2004). Channelization involves straightening and occasional widening of the stream to increase water flow downstream to drain the land more quickly. This process allows the fields to be more farmable. The channelization of UT1 and UTCC-US has increased sedimentation from bank erosion and led to down cutting and widening of the streams. The project streams also have decreased habitat quality and diversity as demonstrated by the

The UTCC downstream (UTCC-DS) reach begins at the tree line when the stream enters a more forested area. This section of stream begins with an overwidened riffle feature where the channelized reach ends

and enters a forested section. The downstream section of UTCC has an established pattern with an extensive forested buffer. Overall, this reach is stable.
Existing wetlands at the site were delineated in December 2006 using the methods outlined by the US Army Corps of Engineers (USACE, 1987). There are currently eight separate wetlands at the project site, totaling approximately 13.7 acres. Wetlands 1 and 5 have Swamp Forest-Bog Complex Communities. Wetlands 2, 3, and 4 are all vegetated drainage features in cropland. Wetland 6 is classified as a Hillside Seepage Bog Community, Wetland 7 is a Montane Alluvial Forest Community, and Wetland 8 is classified as a Southern Appalachian Bog Community. The wetlands were classified in accordance with a "Classification of the Natural Communities of North Carolina, Third Approximation" (Schafale and Weakley, 1990).

The restoration goals for this project are as follows:
- Improve water quality for Crab Creek, which is categorized by NCDWQ as Class C, Trout Waters (Tr).
- Enhance and preserve riparian buffers to a headwater trout stream.
- Enhance aquatic and terrestrial habitat along an intact stream corridor.
- Improve wetland functions by connecting and expanding the following wetland communities: Swamp Forest-Bog Complex, Southern Appalachian Bog, and Montane Alluvial Forest.
- Improve and expand Southern Appalachian Bog wetland habitat for the Bog Turtle.

The objectives that must be accomplished to reach these goals are:
- Restore 4,026 linear feet of stable stream channel with the appropriate pattern, profile, and dimension to support a gravel transport system.
- Re-establish the natural stream features (bed heterogeneity) to restore diverse aquatic habitat.
- Improve aquatic organism passage and habitat corridor continuity by replacing an existing culvert.
- The conversion of existing croplands into Swamp Forest Bog-Complex Community and Southern Appalachian Bog Community.

The North Carolina Division of Water Quality (NCDWQ), Watershed Assessment Team (WAT) has developed a monitoring plan for the project site in efforts to provide further baseline details prior to restoration to implement post-restoration monitoring and data analyses (NCDWQ-WAT, 2007). The monitoring objective is to "provide evidence of a change or improvement in water quality, hydrology and habitat functions as a result of the restoration project" (NCDWQ-WAT, 2007). The monitoring plan is included in Appendix B.

Table 1. Project Restoration Structure and Objectives

Streams						
Reach	**Proposed Station Range**	**Restoration Type**	**Priority Approach**	**Stream Classification**	**Existing Linear Footage**	**Designed Linear Footage**
UT1	(100+00-101+70) (102+82-104+28) (105+22-110+62) (113+12-116+30) (119+60-123+93)	Restoration	P-1	B4c/C4	2,313*	2,204*
UT1	(101+70-102+82) (104+28-105+22) (110+62-113+12) (116+30-119+60)	Enhancement	E-II	B4c/C4		
UTCC - US	(10+00- 34+05)	Restoration	P-2	C4	2,086	2,405
UTCC - DS	-	Preservation	-	E4	2,172	-

Proposed Wetlands	**Acreage**		**Soil Type**	**Existing Community Type**	**Designed Community Type**
Wetland 1	0.5	Preservation	Nikwasi	Swamp Forest-Bog Complex	Swamp Forest-Bog Complex
Wetland 2	1.0	Restoration	Overfill/Nikwasi	Cropland	Swamp Forest-Bog Complex
Wetland 3	3.0	Restoration	Nikwasi	Cropland	Southern Appalachian Bog
Wetland 4	2.7	Restoration	Overfill/Nikwasi	Cropland	Southern Appalachian Bog
	0.1	Enhancement			
Wetland 5	0.1	Restoration	Nikwasi	Swamp Forest-Bog Complex	Swamp Forest-Bog Complex
	0.6	Enhancement			
Wetland 6	2.0	Preservation	Nikwasi	Swamp Forest-Bog Complex	Swamp Forest-Bog Complex
Wetland 7	0.9	Restoration	Nikwasi	Hillside Seepage Bog	Montane Alluvial Forest
	3.0	Enhancement		Montane Alluvial Forest	
Wetland 8	0.3	Restoration	Nikwasi	Cropland	Southern Appalachian Bog
	0.2	Creation			
Wetland 9	2.2	Preservation	Nikwasi	Southern Appalachian Bog	Southern Appalachian Bog

Stream Totals	
Restoration	4,026 lf
Enhancement	583 lf
Preservation	2,172 lf

Wetland Totals	
Restoration	7.9 acres
Enhancement	3.7 acres
Creation	0.2 acre
Preservation	4.7 acres

Note: The wetland soil types were determined in a field investigation by a certified soil scientist from KCI.

*There are some discrepancies when comparing the existing and proposed thalweg alignments using stationing lengths. This difference is due to the lateral movement of the existing stream thalweg within the bottom of its banks, which exaggerates the actual amount of existing stream length. When comparing stream lengths using existing and proposed stationing, the data shows a difference in linear footage, however after compensating for the lateral movements mentioned above, the difference decreases. This is due to the straightening of a few sections in order to reduce near bank stress.

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1.0 PROJECT SITE IDENTIFICATION AND LOCATION

The North Carolina Ecosystem Enhancement Program (NCEEP) has selected the Crab Creek Site for a stream and wetland restoration project. The project will involve the restoration of approximately 2,405 linear feet and the preservation of 2,172 linear feet of an Unnamed Tributary to Crab Creek (UTCC). An Unnamed Tributary (UT1) will also include approximately 1,621 linear feet of restoration along with 583 linear feet of enhancement. In addition, the project will also involve approximately 4.7 acres of wetland preservation, 3.7 acres of wetland enhancement, 0.2 acre of wetland creation, and 7.9 acres of wetland restoration opportunities (Figure 1). This restoration plan presents information describing the existing site and watershed conditions, the restoration design criteria, the design summary, and the proposed monitoring protocol.

1.1 Directions to Project Site

The Crab Creek Site is located on a parcel owned by Mr. Keith Andrews. The project site is located approximately 6 miles west of the intersection of NC-89 and NC-18 in Alleghany County, North Carolina.

From Raleigh:
Proceed west on Interstate 40 (I-40). Continue on I-40 West toward Winston-Salem. Take Exit 193B (NC-8N/US-52N) to Mount Airy. Proceed on US-52N and take the I-74W ramp toward Wytheville I-77. Take Exit 5 (I-77 South), proceed to Exit 100 (NC-89) to Mount Airy/Galax, turn left and proceed west on NC-89. Turn left at NC-18 and proceed approximately 6 miles to the project site. The UTCC project site is located on the north side of NC-18 (Figure 2).

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

UTCC is a second order stream that enters the property at the northeast boundary and flows south and then west for a total of approximately 4,259 linear feet. UT1 is a first order tributary to UTCC and enters the project site at the northern boundary and flows south for approximately 2,318 linear feet.

The project site is within the Little River cataloging unit (8-digit HUC 05050001) and the 05050001030020 Local Watershed Unit (14-digit HUC). The site resides in the NCDWQ Subbasin 05-07-03. The NCEEP directed a Local Watershed Plan (LWP) be developed for the Little Rvier Watershed, which was to identify "factors contributing to water quality degradation within a watershed and provide strategies to address non-point sources of pollution" (W.K. Dickson & Co., Inc. 2004**)**. The objective of the Local Watershed Plan was to identify stream, wetland and riparian buffer restoration projects (W.K. Dickson & Co., Inc. 2004). As an objective of the LWP, the Crab Creek restoration project will benefit water quality, aquatic habitat and riparian buffers.

2.0 WATERSHED CHARACTERIZATION

The project site is located within the New River Plateau Ecoregion of the Blue Ridge physiographic province. The continental divide is located along the Blue Ridge, which separates the Little River Watershed from adjacent drainages in the Yadkin Basin. The Blue Ridge region consists of "crystalline thrust sheets of allochthonous Precambrian basement rocks and late Precambrian to early Proterozoic metasedimentary and metavolcanic rocks" (W.K. Dickson & Co., Inc. 2004). The watershed topography can be characterized as a "mountainous area of steep ridges, inter-mountain basins and valleys that intersect at all angles, giving the areas rugged character" (NCGS, 2004). Several peaks in the Blue Ridge province exceed 5,000 feet in elevation.

2.1 Drainage Area

The project watershed containing the study area, as seen in Figure 3, drains approximately 2.64 square miles (1,689 acres) and occupies the northeastern corner of the headwaters of the Little River. The project watershed is to the west of the Blue Ridge Parkway and NC-18 crosses through the middle portion of the watershed. The project watershed is located primarily in Alleghany County with the top portion of the watershed extending into Grayson County, Virginia.

2.2 Surface Water Classification

The NCDWQ assigns surface water classifications in order to help protect, maintain, and preserve water quality. UT1 and UTCC are designated as Class C and Trout Waters (NCDENR, 2007). The project site is in a unique position to improve water quality in a trout-supporting water.

- **Class C Waters** in North Carolina are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses suitable for Class C. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner. There are no restrictions on watershed development or types of discharges (NCDENR, 2006).

- **Trout Waters** are intended to protect freshwaters for natural trout propagation and survival of stocked trout. This designation affects wastewater quality but not the type of discharges and there are no watershed development restrictions except for the stream buffer zone requirements of NC Division of Land Resources (NCDENR, 2006).

2.2.1 Water Quality

Section 303(d) of the Clean Water Act requires states to recognize waters not meeting current water quality standards by listing them as impaired and/or by support rating. These ratings refer to whether the uses of water such as water supply, aquatic life protection and recreation are being met. No waters were listed as impaired in Subbasin 05-07-03. All waters in the subbasin are listed as supporting aquatic life, recreation, fish consumption, and water supply based on the 2005 status. Fish consumption in the subbasin was listed as Not Rated due to insufficient data (NCDENR, 2005).

2.3 Geology and Soils

The local geology consists of a mixture of igneous, sedimentary and metamorphic rock of the Blue Ridge Belt (NCGS, 1985).

The Alleghany County Soil Survey classifies the project area soils as Alluvial Land, Wet (Ad) and Codorus complex (Cx). The Alluvial Land, Wet (Ad) consists of poorly drained, nearly level soils that are variable in texture and subject to very frequent flooding. These soils are on floodplains and in upland draws and depressions. The soil material is unconsolidated alluvium and fairly recently deposited. The surface layer, 6 to 10 inches in thickness, is dominantly very dark grayish brown, but ranges from grayish brown to black. The underlying layer ranges from dark-gray to black loamy sand to silty clay loam, 30 to 48 inches in thickness, underlain by stratified sandy material, gravel, or stones. Alluvial land, wet is generally low in natural fertility and organic matter content. The acreage is about equally divided between forest and pasture or meadow. Only a small acreage is typically cultivated. (USDA, 1973)

A small portion of the project site is mapped as Codorus Complex (Cx). This complex consists of somewhat poorly drained to poorly drained, nearly level soils on floodplains. These soils are subject to very frequent flooding. In a typical profile the surface layer is dark brown silt loam about 9 inches thick. The subsoil is loam and silt loam to a depth of about 40 inches. It is dark brown to brown in the upper part and is mottled grayish brown, dark grayish brown, and strong brown in the lower part. Below the subsoil, to a depth of about 64 inches, is stratified sand and gravel. The Codorous soils are low in natural fertility and organic matter content and are high in available water capacity (USDA, 1973).

According to the NRCS, Alleghany County Soil Survey, Alluvial Land, Wet (Ad) is the dominant soil type in the project area. However, this classification was inconsistent with the observed soil conditions at the site. A detailed soil investigation by a licensed soil scientist identified Nikwasi soils as occupying the central portion of the site (See Appendix I).

2.4 Historical Land Use and Development Trends

2.4.1 Historical Resources

Historical aerial photographs were obtained from the Ashe County Natural Resources Conservation Service (NRCS), the U.S. Geological Survey (USGS) and Alleghany County GIS in order to enhance the assessment of existing site conditions. The intent of the review was to understand the chronology of land disturbance and aid in the evaluation of the site and the development of an appropriate restoration strategy. Aerial photographs were available for the site from 1941, 1964, 1976, 1982, 1993, 1998, and 2005 (Figures 4A-4G).

In 1941, UT1 and UTCC are visible. The upstream section of UTCC appears to have a highly sinuous pattern and is not channelized as it is currently. The middle portion of UTCC goes through the center of the site and shows large meander curves. There are no visible ditches in the current UTCC cropland area. The upstream section of UT1 and downstream section of UTCC are not heavily forested. The adjacent properties have already been cleared for agriculture by this time.

In 1964, UT1 and UTCC are visible and resemble current conditions with the ditches visible in the UTCC cropland area. The downstream section of UTCC is forested and resembles current conditions. The adjacent property to the west of the project site is cleared for agriculture.

In 1976, UT1 and UTCC remain unchanged from 1964. The northern section of the project area is heavily forested. The adjacent agricultural fields to the west of UT1 appear to be entirely under cultivation. The adjacent property to the south of the project site is forested.

In 1982, UT1 and UTCC exhibit no changes from the 1976 photograph. A portion of the northern section of the project area near UT1 has been cleared and is no longer forested. The adjacent properties remain unchanged.

By 1993, UT1 and UTCC have not changed. The northern section of the project area has been forested. A pond and a residence are located adjacent to the subject property to the east of UTCC. A mobile home trailer is located on the subject property to the south of UTCC and along NC-18.

By 1998, UT1 and UTCC have not changed. The adjacent properties have remained the same.

In 2005, UT1 and UTCC and the subject property resemble current conditions; no significant differences are discernable.

Both UTCC and the lower section of UT1 have been channelized. Based on the aerial photograph record, channelization occurred between 1941 and 1964. The highly sinuous, meandering channel of UTCC in 1941 is no longer present in later photographs.

2.4.2 Land Use and Development Potential

The land cover evaluation indicates that the project watershed consists of: forest/wetland (53%) and pasture/managed herbaceous (45%) (NCDENR, October 2005). The project subbasin 05-07-03 is primarily forest. However, the following agricultural activities also take place; pasture, orchards, cultivated cropland, livestock, dairy farms and Christmas tree production. The entire watershed is rural with moderate development pressure with the nearest town being the Town of Sparta (NCDENR, October 2005).

Population density for the portion of the New River Basin in Alleghany County is helpful in determining what streams are likely to be affected by population growth. Approximately 91% of the North Carolina section of the basin is located in Alleghany County and this area has an estimated population growth of 12.1% between the years 2000-2020. In contrast to this data, the Town of Sparta is actually decreasing in

population. There was a 16.0% increase in population from 1980-1990, while from 1990-2000 there was a 7.2% decrease in population (NCDENR, October 2005).

The primary land uses on the subject property are pasture/agriculture and forest. Christmas trees, seasonal pumpkins, and no till corn are currently being grown directly adjacent to UT1 and UTCC on the eastern portion of the site. According to the NCDWQ monitoring plan for Crab Creek, a fungicide (mancozeb) is applied to the pumpkins on the property in the fall for production (NCDWQ, July 2007). The pumpkin fields are located on a hill adjacent to the streams and may possibly enter the streams through stormwater runoff, affecting aquatic life. The NCDWQ monitoring plan states that the fungicide has a "low mobility and due to its high adsorption capacity will tend to adsorb to sediment. It has a moderate to high acute toxicity range for fish (Orme, 2006). Ethylenethiourea (ETU), mancozebs metabolite, is not acutely toxic but is a concern in that is persists in the environment for 5 to 10 weeks and is water-soluble" (NCDWQ, July 2007). NCDWQ will continue to monitor the site for the fungicide following fall applications.

2.5 Endangered/Threatened Species

KCI conducted an informal file review at the North Carolina Natural Heritage Program's (NHP) office in order to identify the potential for the presence of rare, threatened, or endangered species for the Cumberland Knob Quadrangle and Alleghany County. The search revealed that the project site was reviewed by the NHP in July 1989 and a Significant Natural Heritage Area Report was completed for the Southern Appalachian Bog wetland area on-site. During the site review, the following significant species were found on the project site: *Clemmys muhlenbergii* (bog turtle), *Veronica americana* (American speedwell), and *Sanguisorba canadensis* (Canadian burnet).

The Bog Turtle is the smallest turtle in North America, measuring only 4 to 5 inches in length. The turtle has a dark brown shell with red, orange, or yellow markings on the neck. Its habitat ranges from wetlands, meadows, bogs, and open cattle pastures in western North Carolina. Bog turtles have been observed in 22 counties in western North Carolina. The southern bog turtle population is listed as "threatened due to similarity of appearance" as a result of the close similarities to the northern population (NCWRC, 2006). Habitat loss is one of the greatest threats to the bog turtle population resulting from draining or filling wetlands for development. Additionally, many wetlands and bogs are not maintained and trees tend to take over, drying out the bog and mosses, which are prime habitat for the bog turtle (NCWRC, 2006). The State of North Carolina lists the bog turtle as a Threatened State Species. *"Any native or once-native species of wild animal which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, or one that is designated as a threatened species pursuant to the Endangered Species Act" (Article 25 of Chapter 113 of the General Statutes, 1987).*

The American speedwell is a herbaceous plant with a blue flower that grows partly in and partly out of water. The species is found in swamps or along stream banks with stems reaching as much as 2 feet in length (Virginia Tech Weed Identification Guide). The State of North Carolina lists the American speedwell as a Significantly Rare-Peripheral State Species (SR-P). *(SR): Species which are very rare in North Carolina, generally with 1-20 populations in the state, generally substantially reduced in numbers by habitat destruction (and sometimes also by direct exploitation or disease). (P): The species is at the periphery of its range in NC. These species are generally more common somewhere else in their ranges, occurring in North Carolina peripherally to their main ranges, mostly in habitats which are unusual in North Carolina (NCNHP, 2006).*

The Canadian burnet is not listed for Alleghany County or the Cumberland Knob Quadrangle as a state species of concern.

KCI also requested a formal review by the NHP. The formal review stated that the NHP "has records of rare plant and animal species and a significant natural heritage area within the project area." Furthermore, the Natural Heritage Program stated that "because of the high potential for rare species and high quality

natural areas" occurring within the project area, "a careful survey should be conducted during the growing season" for location of species (Appendix A).

A site walk was conducted by KCI on September 24, 2007 using random GPS points created in GIS to ensure coverage of the area. None of the endangered or threatened species mentioned above were located in the survey. The results of the rare and endangered plant survey are included in Appendix A.

Bog turtle populations are documented to be present at the site and coordination with North Carolina Wildlife Resources Commission has been initiated in order to minimize any impacts to the species during construction. Additional bog turtle surveys or evaluations will not be required. The bog turtle and American speedwell habitat will be preserved along with the downstream portion of UTCC. There will be no disturbance to the channel and adjacent riparian zone; therefore, these species are not anticipated to be affected by the proposed restoration project.

2.6 Cultural Resources

To evaluate the presence of significant cultural resources on the subject property and the potential impacts of the proposed project, KCI requested a formal review by the North Carolina Department of Cultural Resources. The formal review by the State Historic Preservation Office (SHPO) has "determined that the project as proposed will not affect any historic structures."

A formal review was also requested from the State Archeology Office and they stated: "there are no known-recorded archaeological sites within the project boundaries. Based on the topographic and hydrological situation, there is a very high probability for the presence of prehistoric or historic archeological sites. We recommend that a comprehensive survey be conducted by an experienced archaeologist to identify and evaluate the significance of archaeological remains that may be damaged or destroyed by the proposed project" (Appendix A). Currently, the site is still being evaluated for an archaeology survey.

KCI also made a request for a formal review by the Eastern Band of Cherokee Indians (EBCI). The project site is located in a county claimed as territory by the EBCI. Currently, no return correspondence has been received from EBCI.

2.7 Potential Constraints

The presence of conditions or characteristics that have the potential to hinder restoration activities on the project site were evaluated. Existing information regarding project site constraints was acquired and reviewed. In addition, any site conditions that have the potential to restrict the restoration design and implementation were documented during the field investigation. A Categorical Exclusion Checklist (CE) was prepared for the project site that summarizes any potential impacts to the environment (Appendix C). Table 2 lists the identified constraints related to the implementation of site restoration activities.

2.7.1 Property Ownership and Boundary

The Crab Creek project site is located on one private property owned by Mr. Keith Andrews, 218 Willow Bend, Galax, VA, 24333. NCEEP holds a conservation easement on the land necessary to undertake the project and the mitigation will be protected by a conservation easement, in perpetuity.

2.7.2 Site Access

A gravel road off of NC-18 at the southeastern property boundary provides access to the project site.

2.7.3 Utilities

A power line easement held by Blue Ridge Electric Membership Corporation (BREMCO) transects the subject property parallel to the UTCC in a west to east orientation. The utility line crosses UTCC three

times. BREMCO has a 30-foot right-of-way along the utility line. During construction and post construction, BREMCO will have access to the utility poles located on the project site. BREMCO will access the site by way of the existing site entrance mentioned in Section 2.7.2. The utility company will have machinery access to utility lines via the existing roadway crossing adjacent to the stream (Refer to Plan Sheet 7). Vegetation planted with the powerline easement will consist of shrubs and herbaceous vegetation as described in Section 7.4.2. No trees will be planted that will interfere with the utility easement.

2.7.4 FEMA/Hydrologic Trespass

UT1 and UTCC are not located within a flood study area based on FEMA documentation. Therefore, no floodplain elevations have been established.

The Crab Creek project site is contained entirely within one private property. A ditch located on the southeast edge of the property will be filled to restore hydrology for the proposed wetland restoration. Proper measures will be taken while designing the wetland in this area to ensure that water will not back up onto the adjacent property. A HEC-RAS model has been developed that indicates the design will not increase flood elevations on the neighboring properties (Appendix D).

Table 2. Summary of Design Constraints

Potential Constraint	Nature of Constraint	Proposed Resolution
Current Land Use (Specify)	Pasture (Christmas trees, pumpkins, and no till corn productions)	Plant riparian buffer
	Overhead Utility Line	The stream design has been modified according to the utility line easement.
Adjacent Property Land Use	Forest, Low-Density Residential Development	N/A
Project Constructibility/Access	NONE	N/A
Structures	Corrugated metal pipe crossing along UT1	Remove metal pipe and discontinue use of crossing.
	Three corrugated metal pipes at road crossing.	Install a 1-box culvert and 2 corrugated metal pipes. The restoration will not interfere with the function of the structure. The streambed will be designed to match the invert of the pipe outlet.
Cultural (Historical)	No historic structure occurrences per NCDCR review.	N/A
Cultural (Archaeological)	No recorded archaeological sites. However, there is a possibility for presence of prehistoric or historic archaeological sites	Recommend a comprehensive site survey by an archaeologist.
Rare, Threatened, and Endangered Species	NCNHP findings letter indicated records of rare plant and animal species. They recommended a survey should be conducted during the growing season.	KCI conducted a site survey with no occurrences of the species.
Natural Features (Soils, Bedrock)	Bedrock outcrops in streambed and banks.	Incorporate known bedrock into the design. Further discovery of bedrock may necessitate in-field modifications of the design.
Hydrologic Trespass	Fill a ditch to restore a wetland; the ditch is located adjacent to a neighboring property.	HEC-RAS analysis combined with proper design of the wetland to ensure no hydrologic trespass occurs.
FEMA Regulated Area	NONE	N/A

3.0 PROJECT SITE STREAMS (EXISTING CONDITIONS)

A site field assessment was conducted in April 2007 to document existing conditions and evaluate the stream restoration potential. Observations and collected data are summarized below, illustrated in Figure 5, and documented in the site photographs (Appendix E). Two stream gauges were installed in December 2006. The site was revisited several times from December 2006 to June 2007 to take further measurements and to collect hydrology data from the instruments. The gauge locations and other existing hydrologic features are shown in Figure 6.

3.1 General Site Description

The project includes the restoration of approximately 4,026 linear feet and the enhancement of 583 linear feet, of UT1 and UTCC-Upstream (UTCC-US). Also, the project includes the preservation of approximately 2,172 linear feet of UTCC-Downstream (UTCC-DS). The project streams have been separated into three sections for design criteria development. UT1 consists of approximately 1,621 linear feet of stream restoration and 583 linear feet of stream enhancement. The UT1 project reach begins at the northern property boundary at Station 100+00 Existing and flows south approximately 2,313 linear feet before connecting to UTCC at Station 124+78 Existing. The second reach, UTCC-US, enters the property at the northeastern boundary at Station 10+00 and proceeds to flow south and west for approximately 2,087 linear feet to Station 30+87 (Existing). The UTCC-DS section begins at the tree line and flows west for approximately 2,172 linear feet before exiting the property through a culvert under NC-18.

UT1 exhibits characteristics of an unstable stream channel. It originates in a pasture several hundred feet north of where it enters the project site. This section of stream located upstream of the project site is heavily impacted by cattle which has caused active bank erosion, torturous meanders, heavy sedimentation, undercutting banks and widening. This upstream section of the stream has affected the project site and as a result, the banks along UT1 are eroding, undercutting, and have sections that are nearly vertical. Several log and leaf debris jams exist along the stream with past litter of old, rusty cars and appliances. Portions of UT1 have defined riffles and pools, but the section further upstream contains heavy sedimentation. A corrugated metal pipe is located in UT1 and serves as an existing crossing. Upstream and downstream of the culvert, the stream is heavily incised and the banks are actively widening.

The UTCC-US reach lacks pattern, natural features, and riparian vegetation. The lack of a natural pattern has caused long riffle/runs with minimal pool habitat and there is no natural riffle-pool sequencing. Grass and shrubby vegetation exist sporadically along the stream banks, but the stream lacks a forested buffer. As a result of past channelization, the channel has vertical banks with a straight pattern that contains only one meander bend. Also, the channelization has increased sedimentation due to the down cutting and widening of the stream. The straightening, deepening and widening of the channel adversely affects habitat quality and diversity as demonstrated by the existing conditions.

The UTCC-US stream channel passes through a culvert with three corrugated metal pipes at the project site entrance. The existing access road from NC-18 will be improved and constructed as part of the project. The access will provide the landowner with an equivalent level of service as currently provided (farm trucks, tractors and agricultural equipment). The proposed crossing will consist of one 8 by 8 feet reinforced concrete box culvert and two 5 foot corrugated metal pipes. All three are separate structures, with a 10-foot spacing between the 8 by 8 box culvert and the metal pipes. The road is 24-foot wide roadway of compacted gravel.

The UTCC-DS reach begins at the tree line after leaving the open field area. The downstream section of UTCC has a stable pattern with an extensive forested buffer with side channel bars present. Overall, the stream represents a stable channel with a natural forested buffer.

Currently, agricultural use and unforested riparian buffers in the watershed have led to increased surface runoff, erosion, and sedimentation in the UT1 and UTCC reaches. Agriculture fields including pumpkin, Christmas tree, and no till corn production are located on the subject property immediately to the west of UT1 and UTCC. The fields are located on a slope that drains directly into UT1 and UTCC-US. Christmas trees are located on the right bank floodplain along the downstream portion of UT1.

Three drainage features in Wetlands 2, 3, and 7 (existing) were evaluated using NCDWQ Stream Classification Forms in January 2007 (Appendix F). The NCDWQ forms were used to determine if the drainage features were classified as intermittent streams and none of these features were classified as streams. The vegetated drainage feature in Wetland 4 was determined to be a man-made ditch; therefore, the classification form was not necessary. Wetland Determination Forms were then used to delineate these areas as jurisdictional wetlands (See Section 5.0). These data forms are included in Appendix F.

3.2 Channel Classification

UT1 begins as an "F4" stream type with an entrenchment ratio of 1.2, a moderate to high width-to-depth ratio of 16.7 and a bank height ratio of 2.4. The start of the UT1 reach is overwidened with a bankfull width of 15.8 feet. Downstream, the channel narrows and classifies as an "E4" stream type with a lower width-to-depth ratio of 5.8 and an entrenchment ratio of 6.3. Low width-to-depth ratios and high entrenchment ratios are typical of "E" type streams. Further downstream, the stream classifies as a "C4" stream type with an entrenchment ratio of 3.5 and a moderate width-to-depth ratio of 15.7. The stream then continues downstream with an entrenchment ratio of 3.3 and a moderate width-to-depth ratio of 10.6, classifying the stream as an "E4". UT1 exits the forested area and enters an open pasture where the channel narrows before connecting to UTCC. Past channelization has altered the downstream portion of UT1.

UTCC-US is classified as a modified "E4" stream type. The stream begins with an entrenchment ratio of 3.7, a moderate width-to-depth ratio of 10, and a bank height ratio of 1.0.

UTCC-DS is classified as an "E4" stream type. This section of stream begins as an entrenched channel with an entrenchement ratio of 3.7 with a moderate width-to-depth ratio 9.8 and a bank height ratio of 1.1. The stream classification remains consistent as an "E4" stream throughout the project reach.

3.3 Channel Morphology (Pattern, Dimension, and Profile)

A Rosgen Level III assessment was conducted to gather existing stream dimension, pattern, and profile data and to determine the degree of channel instability. Channel cross-sections were surveyed at ten representative locations along UT1, seven places along UTCC-US and three locations along UTCC-DS. Data developed from these surveys are presented in the existing conditions summary (Appendix G).

3.4 Channel Stability Assessment

A quantitative stability assessment was performed to estimate the level of departure from a stable system and to determine the likely causes of the channel disturbance. This assessment facilitates the decision-making process with respect to analyzing restoration alternatives and establishing goals for successful restoration. Bank Erodibility Hazard Index (BEHI) rating forms were prepared for reaches along UT1 and UTCC (Appendix G). One BEHI rating form was performed on UT1 and two BEHI rating forms were completed for the UTCC reach. UT1 exhibited a high BEHI rating of 30.5 with bank height ratios in the project reach ranging from 1.0 to 2.4. The UTCC-US assessment exhibited a moderate BEHI rating of 28.9 with bank height ratios ranging from 1.0 to 1.3. High bank height ratios (>1-2) are typical of incised and/or channelized streams. The UTCC-DS sample exhibited a low BEHI rating of 15.4 with bank height ratios ranging from 1.0 to 1.1.

UT1 and UTCC-US exhibit characteristics of unstable stream channels. Most notably, the channels show evidence of bank erosion and undercutting along with channelization in portions of each reach. Furthermore, several sections of UT1 and UTCC-US do not have vegetation on the banks and

consequently lack rooting strength and cover protection. The UTCC-DS section has an adequate forested buffer and surface protection resulting in a more stable condition.

3.5 Bankfull Verification

The standard methodology used in natural channel design is based on the ability to select the appropriate bankfull discharge and generate the corresponding bankfull hydraulic geometry from a stable reference system(s). The determination of bankfull stage is the most critical component of the natural channel design process.

Bankfull can be defined as "the stage at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of the channels," (Dunne and Leopold, 1978). Several characteristics that commonly indicate the bankfull stage include: incipient point of flooding, breaks in slope, changes in vegetation, highest depositional features (i.e. point bars), and highest scour line. The identification of bankfull stage, especially in a degraded system, can be difficult. Therefore, verification measures were undertaken to validate the correct identification of the bankfull stage on UT1 and UTCC.

Field identification of bankfull indicators on the existing cross-sections was utilized on UT1 and UTCC-US. For UT1, XS-7 and XS-10 demonstrated bankfull discharges of 62 ft^3/s and 71 ft^3/s respectively. For UTCC-US, XS-13 and XS-18 had bankfull discharges of 115 ft^3/s and 129 ft^3/s, respectively.

The methods used to confirm bankfull stage at UT1 and UTCC were bankfull field identification and a pressure transducer / data logger combination gauge that monitored actual water levels in UTCC throughout the study period. The regional hydraulic geometry relationships (regional curves) were utilized to compare the bankfull discharge from the pressure transducers and field identification.

Stream stage data (water levels) were collected from two gauges on UTCC-US and UTCC-DS. Data were collected for seven months (December 2006 through June 2007) and water levels were correlated to an estimated discharge using a rating curve generated for the gauged sections. During the gauging period, three significant storm events were recorded for each gauge. For the UTCC-US gauge, the maximum discharge event recorded was 254 ft^3/s from a 3.3 feet stage on January 1st. The second largest event recorded was 61 ft^3/s for a stage event of 1.6 feet on March 2nd. The third event recorded was 18 ft^3/s from a 0.86 feet stage event on March 16th. At the UTCC-DS gauge, the maximum discharge event recorded was 184 ft^3/s for 3.1 feet on January 1st. The second largest event recorded was 30 ft^3/s from a 1.3 feet stage event on March 2nd. The third event recorded was 19 ft^3/s for a 1.0 foot stage event on April 15th. Continuous hydrographs were developed for both UTCC-US and UTCC-DS and are provided in Appendix G.

Regional curves are typically utilized in ungauged areas to approximate bankfull discharge, area, width, and depth as a function of drainage area based on interrelated variables from other similar streams in the same hydrophysiographic province. Regional curves and corresponding equations from "Bankfull Hydraulic Geometry Relationships for North Carolina Streams" (Harman et al., 1999) were used to approximate bankfull in the project reaches. Based on the regional curves, a bankfull discharge and cross-sectional area were estimated for all three reaches. For UT1, the regional curve estimates a bankfull discharge of 62 ft^3/s and a cross sectional area of 14 ft^2. For UTCC-US, the regional curve estimates a bankfull discharge of 197 ft^3/s and a cross sectional area of 39 ft^2. For UTCC-DS, the values were estimated at 210 ft^3/s and 42 ft^2.

After analyzing the bankfull verification results, the design discharges were set for the project reaches. The design bankfull discharge for UT1 is 66 ft^3/s, which is comparable with the pressure transducer recording for the second largest event of 61 ft^3/s and the field bankfull indicators at XS-7 and XS-10. The

design bankfull discharge for UTCC is 117 ft^3/s, which is comparable with the field bankfull indicators at XS-13 and XS-18. The design bankfull discharges are shown in Table 3.

Table 3. Bankfull Discharge

Parameters	UT1 (Discharge)	UTCC-US (Discharge)	UTCC-DS (Discharge)
Regional Curve	62 ft^3/s	197 ft^3/s	
Pressure Transducer			
Maximum Event		254 ft^3/s	184 ft^3/s
Second Event		61 ft^3/s	30 ft^3/s
Third Event		18 ft^3/s	19 ft^3/s
Bankfull Field Indicators			
XS-7	62 ft^3/s		
XS-10	71 ft^3/s		
XS-13		115 ft^3/s	
XS-18		129 ft^3/s	
XS-19			146 ft^3/s
XS-21			178 ft^3/s
Design Discharge	66 ft^3/s	117 ft^3/s	

3.6 Vegetation

During the month of December 2006, Steven Stokes and April Davis conducted a field investigation of the project area to document the existing vegetative communities (Figure 7). Six existing natural communities were classified in accordance with a "Classification of the Natural Communities of North Carolina, Third Approximation" (Schafale and Weakley, 1990). The field investigation focused on flora, fauna and overall habitat structure. The flora, including dominant species per stratum, were identified and recorded.

The first community was classified as Swamp Forest-Bog Complex. This community is located along the northern portion of the project site along the floodplain of UT1. The dominant species observed in this community were witch hazel (*Hamamelis virginiana*), sweet birch (*Betula lenta*), muscadine grape (*Vitis rotundifolia*), silky dogwood (*Cornus amomum*), red osier dogwood (*Cornus sericea*), spicebush (*Lindera benzoin),* multiflora rose (*Rosa multiflora*)*,* rosebay rhododendron (*Rhododendron maximum)*, American holly (*Ilex opaca*), skunk cabbage (*Symplocarpus foetidus),* red maple (*Acer rubrum*), common elderberry (*Sambucus canadensis*), black cherry (*Prunus serotina*), oak species, and green ash *(Fraxinus pennsylvanica).*

The Swamp Forest-Bog Complex community also currently exists along the floodplain of UTCC-DS. Additional species observed in this area were common elderberry, black cherry, oak species*,* green ash, multiflora rose*,* green hawthorn (*Crataegus viridis),* red maple, red osier dogwood, skunk cabbage, muscadine grape, spicebush, peat moss (*Sphagnum spp.*), American holly, and tag alder *(Alnus serrulata).*

A second community was classified as White Pine Forest. This community is located along the northern portion of the project site outside of the floodplain on the hill slope. The dominant species observed in this community were eastern white pine *(Pinus strobus),* Christmas fern (*Polystichum acrostichoides),* and red maple.

Another portion of the site was classified as a cropland community. This community is located sporadically throughout the project site. There is a small area located in the northern portion of the project site near UT1. The majority of the cropland community is in the southeastern portion of the project in UTCC-US area. Two more areas reside in the southwestern portion of the project site near UTCC-DS and the bog habitat area. The dominant species observed in the community are as follows:

various grasses, red maple, multiflora rose, muscadine grape, black cherry, tag alder, pokeberry (*Phytolacca americana),* spicebush, and honeysuckle (*Lonicera japonica*).

A fourth community was classified as Montane Alluvial Forest. This community is located along UTCC-DS outside of the Swamp Forest-Bog Complex floodplain and adjacent to the Southern Appalachian Bog. The dominant species observed in the community were as follows: greenbriar (*Smilax sp.*), cucumber tree (*Magnolia acuminata*), scarlet oak (*Quercus coccinea*), black walnut (*Juglans nigra*), red maple, multiflora rose, green hawthorn, hickory (*Carya sp*.), skunk cabbage, green ash, peat moss, tag alder, and muscadine grape.

A small portion of the site was classified as a Hillside Seepage. This community is located in the north-central part of the site. The dominant species observed in the community are as follows: red maple, elderberry, skunk cabbage, black cherry, American holly, white pine, peat moss, tag alder, muscadine grape, and cattail (*Typha angustifolia*).

A sixth area was classified as a Southern Appalachian Bog community. This community is located along the southwestern portion of the project. The dominant species observed in the community were as follows: tag alder, woolgrass (*Scirpus cyperinus*), arrowleaf tearthumb (*Polygonum sagittatum***)**, common rush (*Juncus effusus*), and sedges (*Carex spp*.).

The investigation also included the fauna observed throughout the project area. Techniques used to identify the presence of animal species included direct visual/audible observations and indirect observations such as the presence of tracks, cavities, nests, fecal material, and carcasses. During several field visits, numerous wild turkeys and deer were observed on the project site.

4.0 REFERENCE STREAM

A reference reach is a channel with a stable dimension, pattern, and profile within a particular valley morphology. The reference reach is used to develop dimensionless morphological ratios (based on bankfull stage) that can be extrapolated to disturbed/unstable streams to restore a stream of the same type and disposition as the reference stream (Rosgen, 1998). One reference reach was used for this project, Lost Cove Creek in Avery County, North Carolina. Many potential sites were evaluated for suitability as a reference for UT1 and UTCC-US. Agriculture and roads heavily impacted the majority of the streams visited in the New River Basin. The search area was broadened to include the Watauga Basin and the western portions of the Catawba and French Broad River Basins.

4.1 Lost Cove Creek Reference Site

A reach of Lost Cove Creek was surveyed by North Carolina State University's Water Quality Group in June 1998 (Appendix H). The reference site is located in the southeastern portion of Avery County adjacent to the Caldwell County line (Figure 8). The reach was classified as a "C3" channel at this location. Morphological data from this reference stream were used for the design of UTCC-US. Lost Cove Creek drains approximately 24.8 square miles of low-density residential and forested lands (Figure 9). The reach is located in the Blue Ridge province, which is where the UTCC site is also located. The valley slope is similar to the project valley slope. The D84 at Lost Cove Creek is 512 mm, compared to 110 mm for UTCC-US. There is a considerable difference in the D84 sediment size, but a more suitable reference reach could not be located. To compensate for the sediment size difference, the designed channel was modified to accommodate the flow and sediment transport. The dimensionless hydraulic geometry relationships were developed from stable channel dimensions to facilitate the design of the proposed channel cross-sections for UTTC-US restoration reach.

4.2 Reference Watershed Characterization

Lost Cove Creek is situated within the northern portion of the Catawba River Basin. The reference stream is within the USGS 14-digit Hydrologic Unit 03050101070030 and is located within the DWQ Subbasin 03-08-31.

The portion of the Lost Cove Creek evaluated as the reference reach is located in the Pisgah National Forest and is north of Morganton in Avery County. The section of stream surveyed is west of the town of Edgemont and is accessible from Forest Service Road 464. The topographic relief within the reference watershed ranges from approximately 1560 feet AMSL to 4600 feet AMSL at the top of Grandmother Mountain.

5.0 PROJECT SITE WETLANDS (EXISTING CONDITIONS)

There were eight existing distinct wetlands identified on the project site. The soils in the project area were delineated by using data from soil borings throughout the site. A Detailed Soils Investigation and Mapping for the Crab Creek Site is included in Appendix I. Portions of the project site are currently forested with actively farmed cropland located in the southeastern portion of the project site.

5.1 Jurisdictional Wetlands

Existing wetlands were delineated in December 2006 using the methods outlined by the US Army Corps of Engineers (USACE, 1987). Eight existing wetlands were mapped in the project area (Figure 7). Wetland 1 is located in the northern portion of the project site on the floodplain of UT1 and includes approximately 2.1 acres. Wetlands 2 and 3 are both located in the southeastern corner of the property adjacent to UTCC-US and are approximately 0.4 and 0.3 acre, respectively. Wetland 4 is located on the southern portion of the project site and is approximately 0.3 acre. Wetland 5 includes UTCC-DS and is approximately 4.7 acres, while Wetland 6 is a small pocket consisting of 0.1 acre. Wetland 7 and 8 are located on the southwestern portion of the project and are approximately 3.6 and 2.2 acres, respectively. The wetlands at the project site are currently under review by the USACE for a jurisdictional determination. Wetlands 2, 3, and 4 are all man-made vegetated drainage features that drain standing water directly into UTCC.

5.2 Hydrological Characterization

Existing Wetland 1

This wetland has formed along sections of UT1 with an adjacent floodplain. Several small springs and seeps along with UT1 extend the length of this wetland. Spring, along with occasional overbank flooding from UT1, contribute hydrology to the wetland.

Existing Wetland 2

Wetland 2 is a vegetated drainage feature, which flows south and then west before connecting to UTCC-US. The area has been dug out to facilitate drainage off the site. An artesian well located off the property is the primary hydrologic source for Wetland 2.

Existing Wetland 3

Wetland 3 is a vegetated drainage feature that flows west and then north until continuing underground to connect to UTCC-US. This wetland is an excavated area that runs along the edge of the agricultural field. Hillside and roadway drainage from a culvert under NC-18 is a major hydrologic source for Wetland 3.

Existing Wetland 4

Wetland 4 is a vegetated drainage feature that flows west before connecting to a spring, which then flows into UTCC-DS. Groundwater from an artesian spring and several seeps flow into the wetland. The artesian spring is the primary hydrologic source for Wetland 4. The wetland has formed where a ditch had been created. Wetland 4 has formed in an excavated area that drains the adjacent farmland.

Existing Wetland 5
There are several small springs and seeps along with UTTC-DS that extend the length of the wetland through a forested area. The springs along with the occasional overbank flooding from UTTC-DS contribute hydrology to the wetland.

Existing Wetland 6 and 7
Wetland 6 receives direct hydrology from a spring from a hillside slope that discharges groundwater into the wetland. These sources also provide hydrology to Wetland 7.

Existing Wetland 8
Wetland 8 is located in the southwestern portion of the project area and is a functioning Southern Appalachian Bog system. A small, seasonally intermittent stream was identified in the bog area. This stream flows south and provides water to the bog area before flowing underground to connect to UTCC-DS.

5.2.1 Hydrologic Budget for Restoration Site

Existing Conditions
Existing site hydrology was modeled by developing an annual water budget that calculates hydrologic inputs and outputs in order to estimate the change in storage on a monthly time step (Appendix J). The analysis divided the site into four different wetland areas using the boundaries shown in Appendix J.

In order to set up the water budget, historic climatic data were obtained from the North Carolina State Climatic Office. The weather station Sparta 2 SE (318158) in Sparta, North Carolina was used, because it is the nearest station with daily precipitation and temperature records. Monthly precipitation totals from the entire period of record (1948-2006) were reviewed and three years were selected to represent a range of precipitation conditions: a dry year (1988), an average year (1966), and a wet year (1989).

Potential inputs to the water budget include precipitation, groundwater, and surface inputs. For precipitation, the data from the three selected years were used in the budget. Groundwater inputs from hillside seepage were assumed within a certain range for each wetland area. Surface water input was calculated using the USDA Soil Conservation Service runoff curve number equation (USDA, SCS 1986).

Outputs from the site include potential evapotranspiration (PET), groundwater, and surface water outlets. PET was calculated by the Thornthwaite method using mean monthly temperatures determined from the chosen years of record: 1988, 1966, and 1989. Surface water is currently lost from the site without any wetland microtopography to retain water between minor grade fluctuations. Groundwater loss was considered negligible in comparison to surface outputs. A substantial amount of water is lost through the existing ditches on-site. A DRAINMOD model was set up to simulate the effect of the existing drainage network on wetland hydrology. The program evaluated 40 years of available precipitation data and produced a monthly loss due to the ditches and UTCC for the three selected years. Although DRAINMOD is not as suited to montane environments, it was only used to provide approximate output values for the stream and ditch drainage network.

Once the inputs and outputs were determined, a net monthly total was calculated in inches and used to estimate a yearly water budget. The model assumes unsaturated conditions at the beginning of the year. A maximum wetland water volume of 4.68 inches was calculated based on the specific yield of 0.13 for 36 inches of Nikwasi soil in order to analyze conditions in the upper three feet of the soil profile. The resulting hydrographs for the average, dry, and wet years show a seasonal pattern. The water budgets in the beginning of the year show an elevated rise in groundwater. The site loses groundwater saturation during the growing season as the stream and ditches drain surface and precipitation inputs. The late fall sees a slight increase in hydrologic inputs again. The budget for Wetland Area 1 does not show any

jurisdictional hydrology except during a wet year and Wetland Areas 2 and 3 show similar trends. Wetland Area 4 shows little groundwater hydrology at all except during a spike midsummer during the wet year.

Proposed Conditions
Modified water budgets were developed to analyze the effect of restoration actions on the site hydrology (see Section 7.3 below). The loss of water from the existing drainage network was altered in DRAINMOD to reflect the change in effective depth and stream spacing based on the proposed design. Surface and groundwater are assumed to remain on-site after the completed restoration of wetland topography, which will slow down and capture overland flow.

After inserting these changes for the proposed conditions, the water budgets show increased hydroperiods at all of the wetland sites. Wetland Areas 1, 2, and 3 all predict jurisdictional hydrology during the early spring, but show groundwater levels decreasing into the summer months. The proposed streams still provide an outlet for hydrology off of the site but there is a degree of uncertainty attached to these results using DRAINMOD. The difference between the actual and assumed inputs from hillside seepage on the site could also alter the post-construction results. For example, the water budget for Wetland Area 4 does not predict a large increase in site hydrology, but this area is most heavily influenced by groundwater inputs (hillside seeps were flowing strongly during site visits throughout the 2007 drought). The site will be closely monitored to track groundwater levels across the site following restoration.

5.3 Soil Characterization
A soils investigation was conducted by a certified soil scientist from KCI to determine the extent and distribution of the hydric soils on the site and to classify the predominate soils to the soil series level. The investigation consisted of delineating the hydric soil boundaries with pink flagging in accordance with the US Army Corps of Engineers (1987). Areas that were identified as possible hydric soil mapping units were surveyed at a higher intensity until the edge of the mapping unit was identified. The boundary of the hydric and non-hydric soil mapping units were then followed by continual sampling and observations as the boundary line was identified and delineated. In those areas where the boundary was found to be a broad gradient rather than a distinct break, microtopography, landscape position, soil textural changes, redoximorphic features, and depleted matrices were additionally considered to identify the extent of the hydric soils.

5.3.1 Taxonomic Classification
According to the NRCS, Alleghany County Soil Survey, Alluvial Land (Ad) is the dominant soil type in the project area (Figure 10). After a detailed field investigation, Steven Stokes, LSS mapped the dominant soil type for all wetlands as Nikwasi (Coarse-Loamy over Sandy or Sandy-Skeletal, Mixed, Superactive, Nonacid, Mesic Cumulic Humaquepts).

5.3.2 Profile Description
The Alleghany County Soil Survey classifies all the soils underlying the site Alluvial Land, Wet (Ad) and Codorus complex (Cx). However, this classification was inconsistent with the observed soil conditions at the site. A detailed soils investigation by a KCI soil scientist identified Nikwasi soils as occupying the central portion of the site (Appendix I). This detailed soils investigation was conducted by augering numerous soil borings across the site in areas identified by landscape position, vegetation, and slope. The soils in the south central and eastern portion of the project site do not have hydric features until a depth of approximately 18-24 inches. This is likely caused from overfill that has been placed on top of the Nikwasi soil below (see Figure 5).

The Nikwasi soil series is described as very poorly drained, moderately permeable soils on floodplains in the Blue Ridge. These soils formed in recent alluvium consisting of loamy material that is moderately deep to strata of sand, gravel, and cobbles (USDA, NRCS 2007). Slopes are typically 0 to 3 percent.

Typically, the surface layer is very dark grayish brown loam and 8 inches thick. The A-horizon from 0 to 8 inches contains very dark grayish brown fine sandy loam and dark grayish brown dry with a moderate fine granular structure. The A-horizon from 8 to 26 inches contains a very dark gray fine sandy loam and dark gray dry with a weak medium granular structure. The C-horizon from 26 to 60 inches contains dark grayish brown and multicolored gravel to coarse sand, including water worn gravel with many cobbles (USDA, NRCS 2007).

5.4 Wetland Plant Community Characterization

The existing wetland communities were classified in accordance with a "Classification of the Natural Communities of North Carolina, Third Approximation" (Schafale and Weakley, 1990). Wetlands 1 and 5 consist of Swamp Forest-Bog Complex Community. Wetlands 2, 3, and 4 are all vegetated drainage features that consist of various grass species. Wetland 6 is classified as a Hillside Seepage Bog Community, Wetland 7 is a Montane Alluvial Forest Community, and Wetland 8 is classified as a Southern Appalachian Bog Community. The existing wetland communities and their vegetation are described in detail in Section 3.6.

6.0 REFERENCE WETLANDS

The two reference wetlands are located on the project site and consist of the Swamp Forest-Bog Complex Community (Existing Wetland 5) and Southern Appalachian Bog Community (Existing Wetland 8). The locations of the reference wetlands are depicted in Figure 7 with the existing natural communities.

6.1 Hydrological Characterization

The Swamp Forest-Bog Complex wetland receives hydrologic inputs from several small springs, seeps, and precipitation along with overbank flooding from UTTC-DS. The Southern Appalachian Bog wetland receives direct groundwater and surface hydrology from a small intermittent stream located in the wetland. This stream flows to the south and provides hydrology to the bog area before flowing underground to connect to UTCC-DS.

6.1.1 Gauge Data Summary

The groundwater within the reference wetlands will be evaluated by monitoring the water levels with on-site HOBO recording pressure gauges. One gauge will be placed in each reference wetland. Data from these gauges will be compared to gauges at the restoration areas. The gauge will be programmed to measure water levels once daily. The data will be downloaded periodically and evaluated to determine the depth and duration of the groundwater level at the reference sites. The two reference wetland gauges were installed in August 2007 and their locations are shown in Figure 7.

6.2 Soil Characterization

The soil type for the Swamp Forest-Bog Complex and Southern Appalachian Bog wetland is consistent with the Nikwasi soil type as described in detail in Section 5.3.

6.3 Plant Community Characterization

The composition of plant species at the reference wetlands is best described as a Swamp Forest-Bog Complex and Southern Appalachian Bog. These communities are described in detail in Section 4.4.

7.0 PROJECT SITE RESTORATION PLAN

The restoration project involves approximately 2,405 linear feet and the preservation of 2,172 linear feet of UTCC. UT1 will also include approximately 1,621 linear feet of restoration along with 583 linear feet of enhancement. In addition, the project will also involve approximately 4.7 acres of wetland preservation, 3.7 acres of wetland enhancement, 0.2 acre of wetland creation, and 7.9 acres of wetland restoration.

7.1 Restoration Project Goals and Objectives

The restoration goals for this project are as follows:

- Improve water quality for Crab Creek, which is categorized by NCDWQ as Class C, Trout Waters (Tr).
- Enhance and preserve riparian buffers to a headwater trout stream.
- Enhance aquatic and terrestrial habitat along an intact stream corridor.
- Improve wetland functions by connecting and expanding the following wetland communities: Swamp Forest-Bog Complex, Southern Appalachian Bog, and Montane Alluvial Forest.
- Improve and expand Southern Appalachian Bog wetland habitat for the Bog Turtle.

The objectives that must be accomplished to reach these goals are:

- Restore 4,026 linear feet of stable stream channel with the appropriate pattern, profile, and dimension to support a gravel transport system.
- Re-establish the natural stream features (bed heterogeneity) to restore aquatic habitat.
- Improve aquatic organism passage and habitat corridor continuity by replacing the culvert.
- The conversion of existing croplands into Swamp Forest Bog-Complex Community and Southern Appalachian Bog Community.

The UTCC-DS section has a relatively stable pattern and an extensive forested buffer. Preserving this natural streamside vegetation is a restoration goal and objective. Several benefits of vegetated buffers include "filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife" (NCDENR, October 2005).

As a restoration goal and objective, approximately 11.03 acres of cropland will be restored along with preserving existing habitat for Bog Turtle. The bog turtle prefers "open wet meadows, shallow water marshes, spring seeps, flood plain wetlands, bogs, and fens" (Shiels, 1997-2007). The intent of the restoration for the Southern Appalachian Bog wetland is to offer a variety of depressional microtopography for occasional surface water storage. The UTCC-US will be designed as a riverine stream, which will provide the occasional overbank flooding for these depressional wetland areas. The existing seeps and springs on the project site will provide additional groundwater flow to the wetlands.

Table 4. Mitigation Type and Extent

	Stream Restoration (lf)	Stream Enhancement (lf)	Stream Preservation (lf)	Wetland Restoration (Acres)	Wetland Enhancement (Acres)	Wetland Creation (Acres)	Wetland Preservation (Acres)
UT1	1,621	583	-	-	-	-	-
UTCC-US	2,405	-	-	-	-	-	-
UTCC-DS	-	-	2,172	-	-	-	-
Proposed Wetland #1	-	-	-	-	-	-	0.5
Proposed Wetland #2	-	-	-	1.0	-	-	-
Proposed Wetland #3	-	-	-	3.0	-	-	-
Proposed Wetland	-	-	-	2.7	0.1	-	-

#4							
Wetland #5	-	-	-	0.1	0.6	-	-
Proposed Wetland #6	-	-	-	-	-	-	2.0
Proposed Wetland #7	-	-	-	0.9	3.0	-	-
Proposed Wetland #8	-	-	-	0.3	-	0.2	-
Proposed Wetland #9			-	-	-	-	2.2
TOTAL	**4,026**	**583**	**2,172**	**7.9**	**3.7**	**0.2**	**4.7**

7.1.1 Designed Channel Classification

Below is a description of the specific design approach used for UT1 and UTCC-US.

The design for UT1 proposes constructing approximately 2,204 linear feet of "B4c/C4" channel. The restoration design for UT1 is based on a Priority 3 approach as described in "A Geomorphological Approach to Restoration of Incised Rivers" (Rosgen, 1993). The Priority Approach 3 design which restores a "B4c" type stream, generally within the existing stream corridor/belt width, through adjustments to the stream dimension and profile. Because an appropriate reference reach could not be found for UT1, the proposed stream dimension is based on an analytical design approach for a "B4c/C4" channel type. The pattern and profile were developed from detailed morphological criteria and hydraulic geometry relationships taken from stable sections of the existing UT1 (see Table 5). There are approximately 583 linear feet of stream enhancement (Enhancement II) as part of the UT1 design. There are four Enhancement II reaches that go from proposed Station 101+70 to 102+82, Station 104+28 to 105+22, Station 110+62 to 113+12, and Station 116+30 to 119+60. Revegetation and stream bank stabilization constitute the work proposed in the enhancement reaches.

The design for UTCC-US proposes restoring 2,405 linear feet of meandering "C4" channel and associated floodplain. The Priority 2 restoration will establish a bankfull channel with a new floodplain, a channel bed at its current elevation in an existing gravel layer, and the cross-section dimensions necessary to provide stable flow maintenance and sediment transport. The Lost Cove Reference Site provided the morphological criteria and hydraulic geometry relationships that were the basis for the proposed stream dimension, pattern, and profile (Table 5).

In-stream structures, including step pools and riffle grade control, will be used to stabilize the restored channels (Refer to Plan Sheet 2). These structures are designed to reduce bank erosion, influence secondary circulation in the near-bank region of stream bends, and provide grade control. The structures further promote efficient sediment transport and produce/enhance in-stream habitat. Riffle areas will also be enhanced with graded gravel material to mimic existing stable riffle features. Coir fiber matting and seeding will be used to stabilize the newly graded stream banks and live stakes will be planted to provide long-term rooting strength.

7.1.2 Target Wetland and Buffer Communities

There are three targeted wetland communities that comprise approximately 7.9 acres of wetland restoration, 3.7 acres of wetland enhancement, 0.2 acre of wetland creation, and 4.7 acres of wetland preservation. These community types fit into the natural topography of the project site and its watershed. Reference wetlands exist on the site and will connect to proposed wetland communities. The wetland communities were classified according to "Classification of the Natural Communities of North Carolina, Third Approximation" (Schafale and Weakley, 1990). Refer to Section 3.6 for the dominant species in each community.

The target buffer communities consist of approximately 3.0 acres of Swamp Forest-Bog Complex and 5.3 acres of Southern Appalachian Bog. The Swamp Forest Bog will be located along UT1, while the Southern Appalachian Bog will be located along UTCC-US.

Table 5. Morphological Design Criteria

Variables		Project Site Existing Channel			Reference Reach	Restored Reach	
		UT1 Restoration	UT1 Enhancement	UTCC-US	Lost Cove Creek	UT1	UTCC-US
Rosgen Stream Type		G4/C4	C4	C4	C3	B4c/C4	C4
Drainage Area (mi^2)		0.53	0.53	1.65	24.80	0.53	1.65
Bankfull Width (W_{bkf}) (ft)		9.9 – 15.8	12.2 – 15.8	17.6 – 24.5	59.7 – 64.9	13.1 **	24.0
Bankfull Mean Depth (d_{bkf}) (ft)		1.0 – 1.5	1.0 – 1.2	1.4 – 1.8	3.3 – 3.4	1.1 **	1.4
Bankfull Cross Sectional area (A_{bkf}) (ft^2)		14.9 – 15.0	14.1 – 15.9	30.8 – 34.0	198 – 218	14.8 **	34.2
Width/depth Ratio (W_{bkf}/d_{bkf})		6.5 – 16.7	10.6 – 15.7	10.0 – 17.9	18.1 – 19.1	12.0 **	17.1
Maximum Depth (d_{mbkf}) (ft)		1.2 – 2.2	1.4 – 2.4	2.3 – 3.2	5.0 – 5.8	2.0 **	2.3
Width of flood prone area (W_{fpa}) (ft)		18 – >55	44 – >55	65 - >80	200 – 296	22-33 **	54
Entrenchment Ratio (ER)		1.2 – 5.6	3.2 – 3.5	3.1 – 4.1	3.1 – 5.0	1.7 **	2.3
Sinuosity (stream length/valley length) (K)		1.19	1.19	1.04	1.20	1.14	1.20
Dimension	Pool Depth (ft) (mean)	1.3-1.5	1.2	3.0 – 3.3	7.7	1.0	1.9
	Riffle Depth (ft)	1.0 – 1.5	1.0 – 1.2	1.4 – 1.8	3.3 – 3.4	1.1	1.4
	Pool Width (ft)	8.8 – 11.0	11.1-11.5	12.5 – 15.3	59.5	14.5	24.0
	Riffle Width (ft)	9.9 – 15.8	12.2 – 15.8	17.6 – 24.5	59.7 – 64.9	13.1	24.0
	Pool XS Area (sf)	13.0 - 14.0	13.6 – 14.3	28.2 – 33.7	251.2	20.9	44.4
	Riffle XS Area (sf)	14.9 – 15.0	14.1 – 15.9	30.8 – 34.0	198 - 218	14.8	34.2
	Pool depth/mean riffle depth	0.9 – 1.5	1.0 – 1.2	1.2 – 1.6	1.3	1.1	1.4
	Pool width/riffle width	0.6 – 1.1	0.7 – 0.9	0.5 – 0.9	1.0	1.1	1.0
	Pool area/riffle area	0.9	0.9 - 1.0	0.8 – 1.1	1.2	1.4	1.3
	Max pool depth/d_{bkf}	1.9 – 2.1	2.2	1.7 – 2.4	2.3	3.0	3.8
	Bank Height Ratio	1.2 – 2.4	1.0 – 1.7	1.0 – 1.3	1.0	1.0	1.0
	Mean Bankfull Velocity (V) (fps)	3.9 – 4.7	3.9 – 4.5	3.3 – 3.8	-	4.5	3.3
	Bankfull Discharge (Q) (cfs)	59 – 71	62 – 71	111 – 130	-	66	117
Pattern	Meander length (L_m) (ft)	90 - 191	90 - 191	*	51 – 54	90-191 ^	20 – 228
	Radius of curvature (Rd) (ft)	11 - 37	11 - 37	0 – 51*	110 - 304	20-37 ^	43 – 128
	Belt width (W_{blt}) (ft)	21 - 58	21 - 58	13 – 43	193 - 500	32-58 ^	75 – 211
	Meander width ratio (w_{blt}/W_{bkf})	1.3 – 5.8	1.3 – 4.7	0.5 – 2.4	3.0 – 8.4	2.4-4.4	3.0 – 8.4
	Radius of curvature/bankfull width	0.7 – 3.7	0.7 – 3.0	0 – 2.9*	1.7 – 5.1	1.5-2.8	1.7 – 5.1
	Meander length/bankfull width	5.7- 19.3	5.7 – 15.7	*	0.79 – 9.0	6.9-14.6	0.8 – 9.0
Profile	Valley slope	0.025	0.025	0.010	0.008	0.025	0.010
	Average water surface slope	0.021	0.021	0.009	0.009	0.021	0.008
	Riffle slope	0.023 – 0.057	0.006 – 0.100	0.020 – 0.042	0.015 – 0.048	0.014-0.03 ^	0.014 – 0.045
	Pool slope	0.004 – 0.018	0.0001-0.002	0.002 – 0.006	0- 0.004	0.004-0.009^	0- 0.004
	Pool to pool spacing	60-65	90-130	95	116 - 323	54-126 ^	45-136
	Pool length	7 -13	4 - 36	29 – 53	-	14-47 ^	21-105
	Riffle slope/avg water surface slope	1.09 – 2.71	0.28 – 4.76	2.22 – 4.67	1.7 – 5.4	0.66-1.4	1.7-5.6
	Pool slope/avg water surface slope	0.19 – 0.86	0.004 – 0.095	0.22 – 0.67	0 – 0.5	0.19	0 – 0.5
	Run slope/avg water surface slope	-	-	-	0.2 – 3.7	-	0.2 – 3.6
	Run depth/d_{bkf}	-	-	-	-	-	-
	Pool length/bankfull width	0.4 – 1.3	0.2 – 2.9	1.18 – 3.01	-	0.23-1.06	0.87-4.40
	Pool to pool spacing/bankfull width	3.7 – 6.5	5.6 – 10.6	1.8-5.4	1.7-5.4	4.1-9.6	1.8-5.6

* The existing stream has been channelized and does not have a natural meander pattern with distinct pool and riffle features.

* * The design cross-section criteria for UT1 were developed using an analytical design approach.

^ The pattern and profile data for UT1were derived from stable enhancement reaches from the existing UT1data.

7.2 Sediment Transport Analysis

With respect to sediment transport in fluvial systems, there is a threshold level of bedload movement that will result in a noticeable change in the channel bed. The flow associated with this threshold movement is the reference condition upon which that sediment transport analysis is based. In natural streambeds, there are particles of a wide range of sizes. At low flow levels, only the smallest particles will move, with the larger particles resisting the flow of the stream. This is the condition of partial sediment transport. As the stream flow increases, eventually every particle on the streambed will show threshold movement; this is the condition of full sediment transport.

In order to analyze the existing sediment conditions within the project streams, the bar and bulk sampling methods were utilized at UT1 and UTCC. In addition, the streams were sampled by the pebble count method at five riffle sites along UT1 and six riffle sites along UTCC for trend analysis. These data are provided in Appendix G. The mean channel shear stresses and shear velocities were calculated for the existing conditions. Determinations of the design shear stresses and velocities were then made based on the sediment distribution from the surface, subsurface, and depositional feature sampling.

After analyzing the existing sediment conditions, the site was studied with respect to sediment transport in UTCC-US. UTCC-US is an active bed channel and has been designed as such. In active bed systems, there is a threshold level of bedload movement. At low flow levels, only the smallest particles will move, with the larger particles resisting the flow of the stream; this is the condition of partial sediment transport. As the stream flow increases, eventually every particle on the streambed will show threshold movement. This is the condition of full sediment transport. If the largest particle that moves during a bankfull event can be identified, then the flow conditions that produced this movement can be determined and this flow condition (channel competency) can be used in the design of the restored stream.

These shear stresses were validated for the proposed riffle cross-section and channel gradient using the equation:

$$\tau = \gamma R s$$

Where: τ = shear stress (lbs/ft^2)
γ = specific gravity of water (62.4 lbs/ft^3)
R = hydraulic radius (ft)
s = average water slope (ft/ft)

For UTCC, the target shear stress value (0.72 lbs/ft^2) converted to a shear velocity for the design riffle cross-section was u* = 0.58 m/s. This velocity is sufficient to move the sampled d_{84} particle size (110 mm) and provide adequate channel maintenance (based on the collected sediment data), while maintaining the vertical stability of the UTCC. The sediment competence calculation forms are included in Appendix K.

7.3 Wetland Hydrologic Modification

Hydrologic modifications will focus on restoring hydrology to the proposed wetland restoration areas and improving the hydroperiod of enhancement areas. Currently, ditches in the proposed wetland restoration areas drain the surface water directly into UTCC. The ditches prevent surface water from remaining on-site and recharging groundwater. These ditches will be filled and stabilized to allow longer retention times and reduce/eliminate shallow groundwater loss from the area. The restoration and enhancement actions for the wetlands are shown in Figure 11.

7.3.1 Narrative of Modifications to Proposed Wetlands

To restore and enhance the wetlands, several ditches will be filled to block water from draining the site. Ditch plugs will be placed in the existing ditch outlets. In addition to blocking the major outlets from the site, KCI will also recreate wetland microtopography for the proposed Southern Appalachian Bog wetland area. The site will be graded to form small depressions and rises throughout the site that resemble the minor variations in elevation found in natural wetland systems. These modifications will allow precipitation and overland flow to remain on the wetland site. The removal of the ditches will also allow the groundwater level to rise. These actions are shown in Figure 11.

Proposed Wetland 1 – 0.5 acre of preservation

Wetland 1 has adequate wetland hydrology and is an intact Swamp Forest-Bog Complex. The proposed stream design will go through this wetland and the preservation wetland will be limited to areas outside of the stream buffer.

Proposed Wetland 2 – 1.0 acre of restoration

Wetland 2 is approximately 1.0 acres and contains approximately 18 inches of overfill soil. The hydric Nikwasi soil exists below the overfill soil. The restoration will involve excavating approximately 2,500 cubic yards of soil to restore the wetland. Following excavation, the site will be graded to allow water to spread across the wetland. Wetland 2 will be restored to a Southern Appalachian Bog Community.

Proposed Wetland 3 – 3.0 acres of restoration

Wetland 3 has two drainage features located on the southern and eastern edges of the property that drain water directly to UTCC-US. This wetland restoration will involve filling the two existing ditches to provide hydrology to the wetland. Wetland 3 will be restored to a Southern Appalachian Bog Community.

Proposed Wetland 4 – 2.7 acres of restoration and enhancement

Wetland 4 is approximately 2.7 acres and contains approximately 24 inches of overfill soil. The restoration will involve excavating approximately 3,500 cubic yards of soil to restore the wetland. An existing ditch will be filled to restore the hydrology in the wetland along with the removal of an existing wellhead, which will allow existing hillside seeps to spread across the site. Wetland 4 will be restored to a Southern Appalachian Bog Community.

Proposed Wetland 5 – 0.7 acre of restoration and enhancement

Wetland 5 will benefit from filling two ditches along with the additional hydrologic input from Wetland 4. Wetland 5 will be a Swamp Forest-Bog Complex.

Proposed Wetland 6 – 2.0 acres of preservation

Wetland 6 will preserve approximately 2.0 acres of Swamp Forest-Bog Complex wetland along the floodplain of UTCC-DS.

Proposed Wetland 7 – 3.9 acres of restoration and enhancement

The actions for Wetland 7 will involve filling a ditch, removing existing fill and debris, and removing a culvert that currently drains the site. Existing seep heads will also be developed in order to allow water to distribute evenly down the slope. A portion of Wetland 7 has adequate wetland hydrology and an intact forest community. This area will be enhanced by removing species such as green ash and red maple and increasing the diversity by planting additional hardwood species. The removal of these species will benefit the adjacent Southern Appalachian Bog Community by preventing these early successional species from spreading into the bog. Wetland 7 will be restored and enhanced to a Montane Alluvial Forest wetland.

Proposed Wetland 8 – 0.5 acre of restoration and creation
The mitigation activities in Wetland 8 will involve removing soil and exposing groundwater springs to create additional Southern Appalachian Bog wetland along with planting bog wetland species.

Proposed Wetland 9 – 2.2 acres of preservation
The existing Southern Appalachian Bog wetland has wetland hydrology and intact vegetation. No hydrologic alterations will take place in this preservation area on the western side of the project site.

7.4 Natural Plant Community Restoration

Restoring natural vegetation will focus primarily on the Southern Appalachian Bog and Swamp Forest-Bog Complex areas as well as the UT1 and UTCC floodplains. These areas will receive species consistent with the associated community. The typical Southern Appalachian Bog Community is permanently saturated to intermittently dry. Vegetation consists of an open shrub layer with areas dominated by herbaceous vegetation. The Swamp Forest-Bog Complex Community is seasonally to semipermanently saturated. The vegetation consists of a forest community with closed or open canopy and a dense shrub layer with open, boggy areas (Schafale and Weakley, 1990).

7.4.1 Planting Zones

Six planting zones will be incorporated into the planting plan. Zone A is classified as a Stream Zone Area, which consists of the UT1 and UTCC-US stream banks. Zone B is the Swamp Forest-Bog Floodplain Planting Area, which will cover the UT1 floodplain. Zone C is classified as a Southern Appalachian Bog Floodplain Planting Area, which consists of the current existing cropland areas located in UTCC-US area. Zone D is classified as Southern Appalachian Bog Planting Area in an open herbaceous planting area located adjacent to UTCC-US. Zone E is classified as Montane Alluvial Forest Planting Area, located at the southwestern portion of the site. Zone E-1 contains 100 stems/acre for the enhancement area while Zone E-2 contains 436 stems/acre for the restoration area. Zone F is classified as Southern Appalachian Bog Planting Area in the creation and restoration areas at the southwestern portion of the project site. Plan Sheet 15 illustrates the six zones that will be used to target the riparian vegetation planting.

During the NHP site review in 1989, a list of Southern Appalachian Bog species was compiled (Appendix A). The species chosen for Zones C, D, and F were selected from the NHP site review list along with suitable wetland vegetation (NCNHP, 1989).

7.4.2 Plant List

Plantings shall consist of the following native species based on availability during the time of planting. In general, the six planting zones will consist of the following species groupings:

Zone A: Stream Zone (Livestakes) (2.0 acres)
436 stems/acre

Black Willow	*Salix nigra*	OBL
Elderberry	*Sambucus canadensis*	FACW-
Silky Willow	*Salix sericea*	OBL
Silky Dogwood	*Cornus amomum*	FACW+

Zone B: Swamp Forest Bog Floodplain Planting Area (2.5 acres)
436 stems/acre

Spicebush	*Lindera benzoin*	FACW
Hazel Alder	*Alnus serrulata*	FACW
Sweet Birch	*Betula lenta*	FACU

Common Winterberry	*Ilex verticillata*	FACW
Possumhaw	*Viburnum nudum*	FACW+

Zone C: Southern Appalachian Bog Floodplain Planting Area (3.9 acres)
436 stems/acre

Spicebush	*Lindera benzoin*	FACW
Hazel Alder	*Alnus serrulata*	FACW
Red Chokeberry	*Aronia arbutifolia*	FACW
Swamp Rose	*Rosa palustris*	OBL
Common Winterberry	*Ilex verticillata*	FACW

Zone D: Southern Appalachian Bog Planting Area (6.7 acres)
436 stems/acre

Maleberry	*Lyonia ligustrina*	FACW
Swamp Rose	*Rosa palustris*	OBL
Green Bulrush	*Scirpus atrovirens*	OBL
Nutsedge	*Cyperus esculentus*	FACW

Herbaceous vegetation to be planted in Zone D shall consist of the following:

Fox Sedge	*Carex vulpinoidea*	OBL
Spotted Jewelweed	*Impatiens capensis*	FACW
Soft Rush	*Juncus effusus*	FACW+
Prickly Bog Sedge	*Carex atlantica*	FACW

Zone E-1: Montane Alluvial Forest Planting Area (3.7 acres)
100 stems/acre

Spicebush	*Lindera benzoin*	FACW
River Birch	*Betula nigra*	FACW
Hazel Alder	*Alnus serrulata*	FACW
American Hornbeam	*Carpinus caroliniana*	FAC

Zone E-2: Montane Alluvial Forest Planting Area (0.2 acres)
436 stems/acre

Spicebush	*Lindera benzoin*	FACW
River Birch	*Betula nigra*	FACW
Hazel Alder	*Alnus serrulata*	FACW
American Hornbeam	*Carpinus caroliniana*	FAC

Zone F: Southern Appalachian Bog Planting Area (0.5 acres)
436 stems/acre

Maleberry	*Lyonia ligustrina*	FACW
Swamp Rose	*Rosa palustris*	OBL
Green Bulrush	*Scirpus atrovirens*	OBL
Nutsedge	*Cyperus esculentus*	FACW

Herbaceous vegetation to be planted in Zone D shall consist of the following:

Fox Sedge	*Carex vulpinoidea*	OBL

Spotted Jewelweed	*Impatiens capensis*	FACW
Soft Rush	*Juncus effusus*	FACW+
Prickly Bog Sedge	*Carex atlantica*	FACW

In addition, the following native grasses will be planted within the limits of disturbance and shall consist of a mix that may include:

Bluestem	*Andropogon glomeratus*
Deertongue	*Panicum clandestinum*
Orchardgrass	*Dactylis glomerata*
Switchgrass	*Panicum virgatum*
Virginia Wildrye	*Elymus virginicus*

Rye grain (*Secale cereale*) and/or brown top millet (*Pennisetum glaucum*) will be used for temporary stabilization.

Woody vegetation planting shall take place during the dormant season (October-April).

7.4.3 On-site Invasive Species Management

The project site has been affected by several nonnative plant species in the existing Swamp Forest-Bog Complex and Montane Alluvial Forest communities. The most significant invasive species is multiflora rose (*Rosa multiflora*). Invasive species management will take place in October-November, which is the ideal time to target these species, and will focus on removing multiflora rose. These species will be marked and treated with a glyphosate herbicide. Native grass cover will be retained to the maximum extent possible during the construction process to minimize the amount of bare soil available to invasive plants.

8.0 PERFORMANCE CRITERIA

Monitoring shall consist of the collection and analysis of stream stability and riparian/stream bank vegetation survivability data to support the evaluation of the project in meeting established restoration objectives. Specifically, project success will be assessed utilizing measurements of stream dimension, pattern, and profile, site photographs, and vegetation sampling.

8.1 Stream Stability

The purpose of monitoring is to evaluate the stability of the restored stream. Following the procedures established in the USDA Forest Service Manual, *Stream Channel Reference Sites* (Harrelson, et.al, 1994) and the methodologies utilized in the Rosgen stream assessment and classification system (Rosgen, 1994 and 1996), data collected will consist of detailed dimension and pattern measurements, longitudinal profiles, and bed materials sampling. Width/depth ratio, entrenchment ratio, meander width ratio, radius of curvature (on newly constructed meanders during 1st year monitoring only), pool-to-pool spacing and the average, riffle and pool water slopes will be calculated from the collected data. Pebble count data will be plotted by size distribution in order to assess the D50 and D84 size class. During the third and fifth years of monitoring, BEHI data will be collected along the project stream to aid in the assessment of stream stability.

Dimension – Both UTCC-US and UT1 will be monitored with seven permanent cross-sections each. The two reaches will each have five riffles and two pool cross-sections. Permanent monuments will be established by conventional survey. The cross-section surveys shall provide a detailed measurement of the stream and banks, to include points on the adjacent floodplain, at the top of bank, bankfull, at all breaks in slope, the edge of water, and thalweg. Subsequently, width/depth ratios and entrenchment ratios will be calculated for each cross-section.

Cross-section measurements should show little or no change from the as-built cross-sections. If changes do occur, they will be evaluated to determine whether they are minor adjustments associated with settling and increased stability or whether they indicate movement toward an unstable condition.

Pattern – Measurements associated with the restored channel pattern shall be taken on the section of the stream included in the longitudinal profiles. These will include belt width, meander length, and radius of curvature. Subsequently, sinuosity, meander width ratio, radius of curvature, and meander length/bankfull width ratio will be calculated.

Profile – Longitudinal profiles will be conducted on the entire length for both UT1 and UTCC-US. Measurements will include slopes (average, pool, riffle) as well as calculations of pool-to-pool spacing. Annual measurements should indicate stable bedform features with little change from the as-built survey. The pools should maintain their depth with lower water surface slopes, while the riffles should remain shallower and steeper.

Bed Materials – Pebble counts will be conducted at each representative cross-section for the purpose of repeated classification and to evaluate sediment transport.

Photograph Reference Points – Ten photograph reference points (PRP) will be established to assist in characterizing the site and to allow qualitative evaluation of the site conditions. The location and bearing/orientation of each photo point will be permanently marked in the field and documented to allow for repeated use.

Cross-section Photograph Reference Points – Each cross-section will be photographed to show the form of the channel with the tape measure stretched over the channel for reference in each photograph. Effort will be made to consistently show the same area in each photograph.

Longitudinal Photograph Reference Points – Additional PRPs will be located, as needed, to document the condition of specific in-stream structures such as cross vanes, rock sills, and enhanced riffles.

8.2 Stream Riparian Vegetation

The success of the riparian buffer plantings will be evaluated using two ten by ten meter vegetative sampling plots along UT1 and three vegetative sampling plots along UTCC-US (5% of the total buffer area). The corners of each monitoring plot will be permanently marked in the field. The monitoring will consist of a physical inventory within each plot and a subsequent statistical analysis in order to determine the following: composition and number of surviving species and total number of stems per acre. Additionally, a photograph will be taken of each plot that will be replicated each monitoring year. Riparian vegetation must meet a minimum survival success rate of 320 stems/acre after five years. If monitoring indicates that the specified survival rate is not being met, appropriate corrective actions will be developed to include invasive species control, the removal of dead/dying plants, and replanting.

8.3 Wetland Hydrology

Groundwater elevations will be monitored to evaluate the attainment of jurisdictional wetland hydrology. Verification of wetland hydrology will be determined by automatic recording well data collected within the project wetland. Within the restoration area, 6 automatic recording gauges will be established to ensure adequate coverage per the 8 acres of wetland restoration on the project site. Daily data will be collected from the automatic gauges over the 5-year monitoring period following wetland construction.

Wetland hydrology will be considered established if well data from the site indicate that groundwater is within 12 inches of the soil surface for 5% of the growing season during normal weather conditions. The growing season was taken from Ashe County; the elevation for Alleghany County was approximately 1,000 feet difference in elevation than the project site. According to the NRCS, the growing season is

considered to be the period with a 50% probability that the daily minimum temperature is higher than 28° F. The growing season for Ashe County extends from May 2 to October 5 for a total of 157 days (USDA, NRCS 1985). Based on this growing season, success will be achieved at the project site if the water table is within 12 inches of the soil surface for 8 consecutive days or more during the growing season.

8.4 Wetland Vegetation

The success criteria for the planted species in the wetland restoration area will be based on survival and growth. Beginning at the end of the first growing season, the vegetation will be monitored for five years following the planting.

Three permanent monitoring plots measuring ten by ten meters will be established in the wetland restoration area exceeding the 2% monitoring coverage of the total restoration acreage. Plots will be systematically located to ensure even placement. Data will be collected at each plot for: total number of stems, species, percent survival, height, estimated percent cover of all species, and evidence of insects, disease or browsing. Survival of planted species must be 320 stems/acre at the end of five years of monitoring. Non-target species must not constitute more than 20% of the woody vegetation based on permanent monitoring plots. Management actions such as controlling invasive species, removing dead/dying plants and replanting will be undertaken as necessary.

8.5 Schedule/Reporting

The first scheduled monitoring will be conducted during the first full growing season following project completion. Monitoring shall subsequently be conducted annually for a total period of five years or until the success criteria are met.

Annual monitoring reports will be prepared and submitted after all monitoring tasks for each year are completed. Each report will provide the new monitoring data and compare the new data against previous findings. The monitoring report will be submitted to the EEP according to the description in the most current version of "Content, Format and Data Requirements for EEP Monitoring Reports."

9.0 REFERENCES

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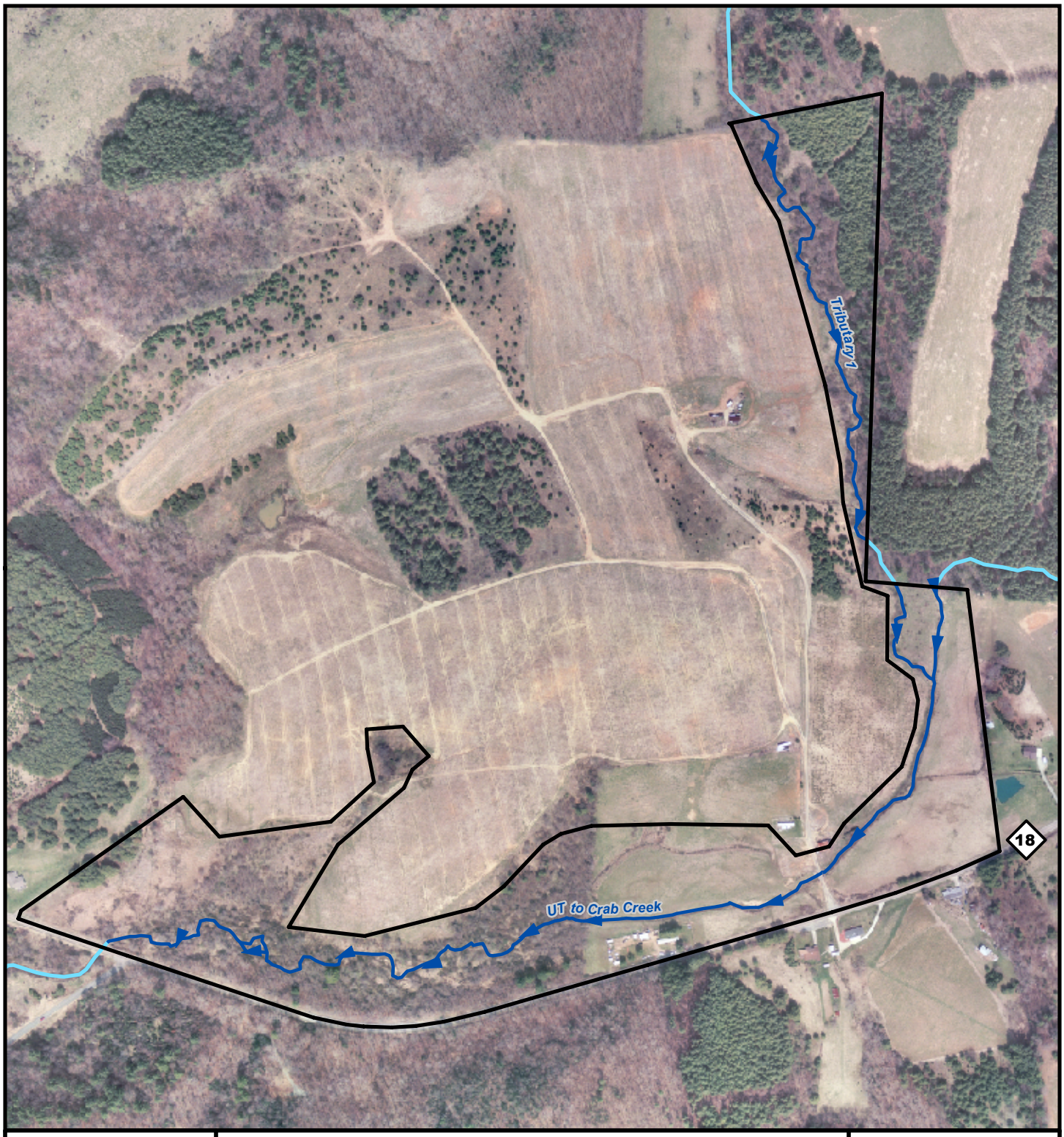
Figures



KCI ASSOCIATES OF NC

Figure 1. Study Area Map

Project Boundary

Project Streams

Other Streams

1:6,000

1 inch equals 500 feet

500 250 0 500 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

Ecosystem Enhancement PROGRAM

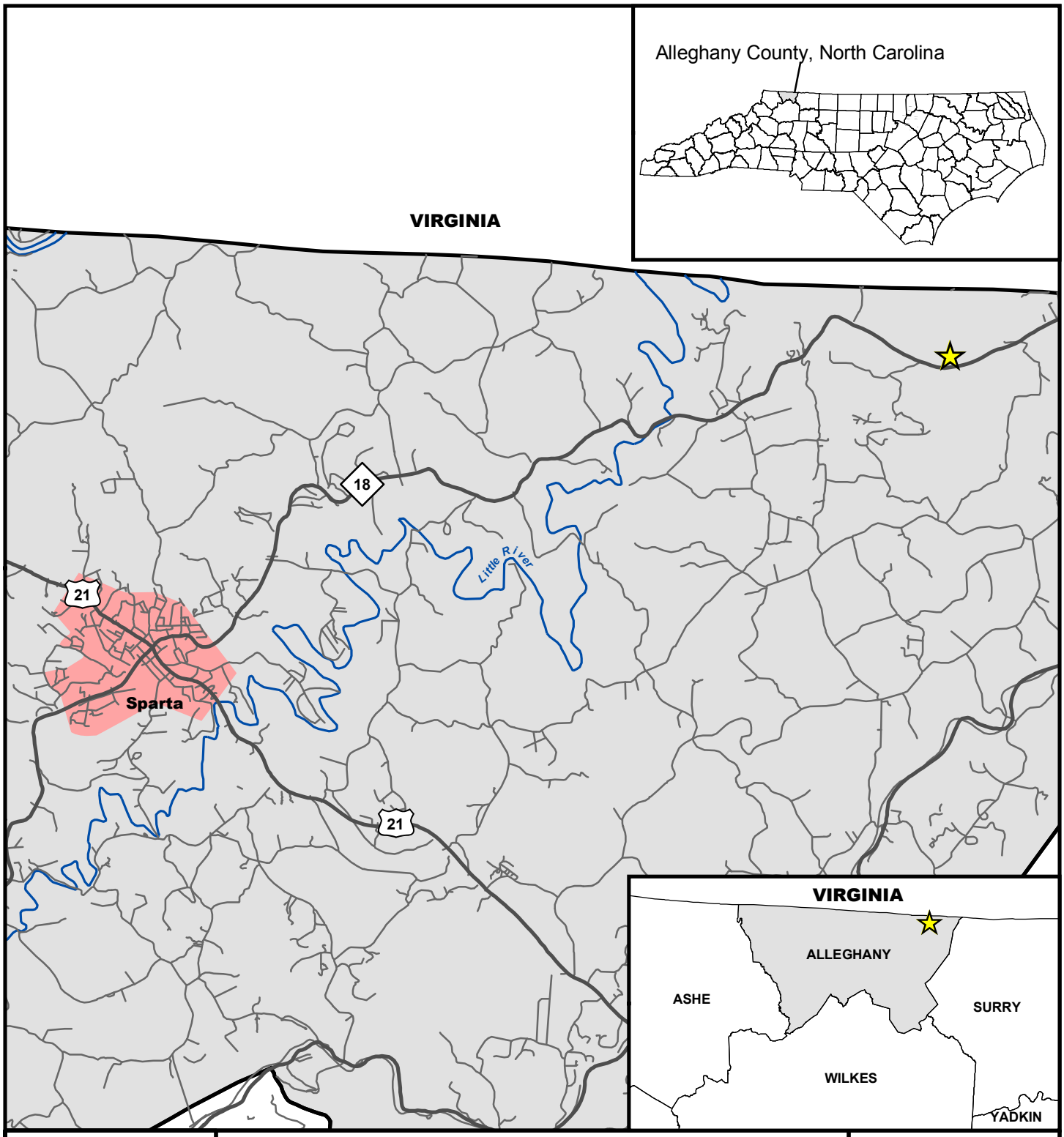


Figure 2. Vicinity Map

- Project Site Location
- Major Rivers
- Major Roads
- Other Roads
- Cities and Towns
- County Boundaries

1:95,040
1 inch equals 1.5 miles
1 0.5 0 1
Miles

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

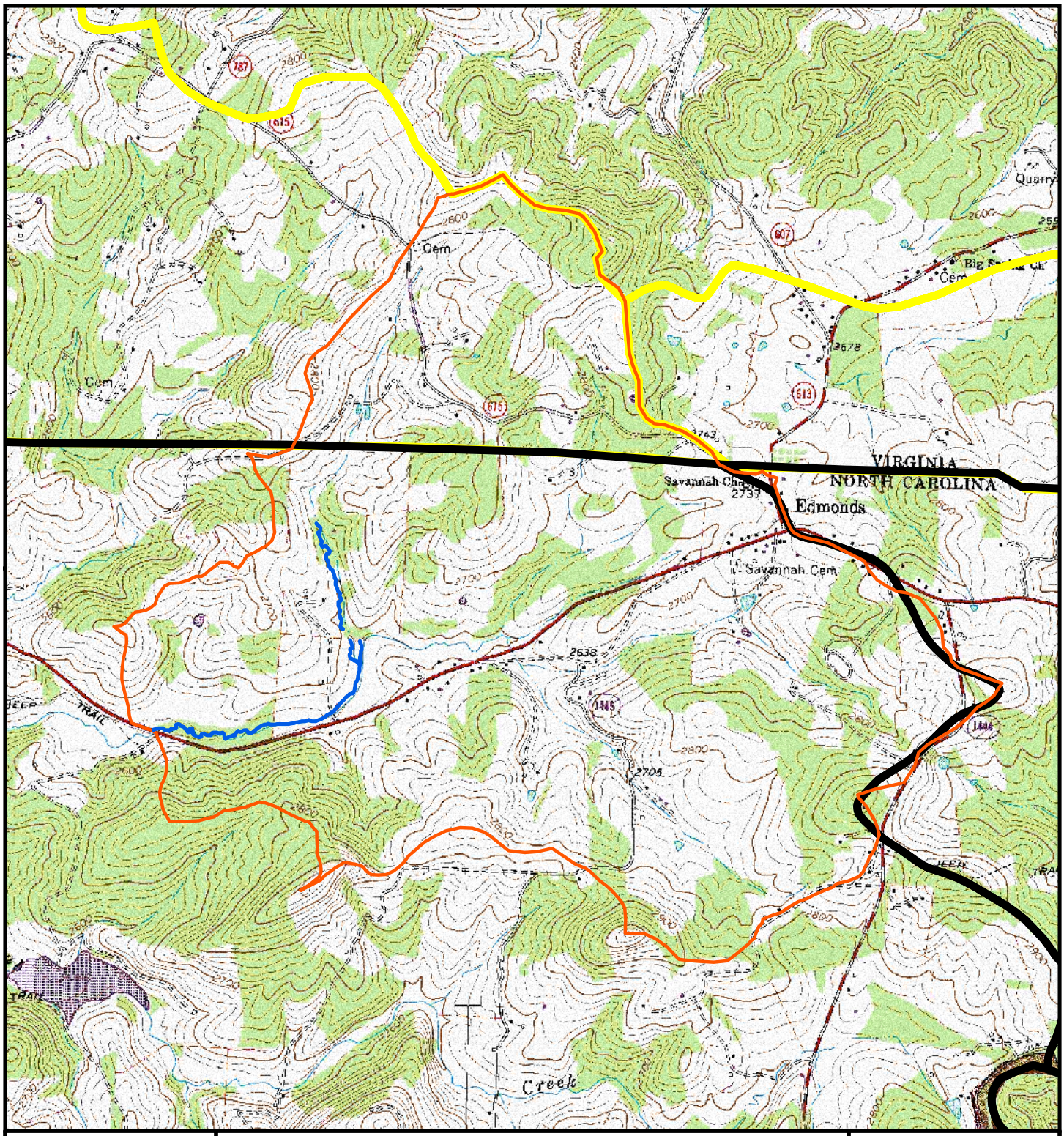


Figure 3. Project Watershed

Project Watershed (2.64 sq. miles)

14-digit HUC Boundaries (North Carolina)

12-digit HUC Boundaries (Virginia)

Project Streams

1:24,000

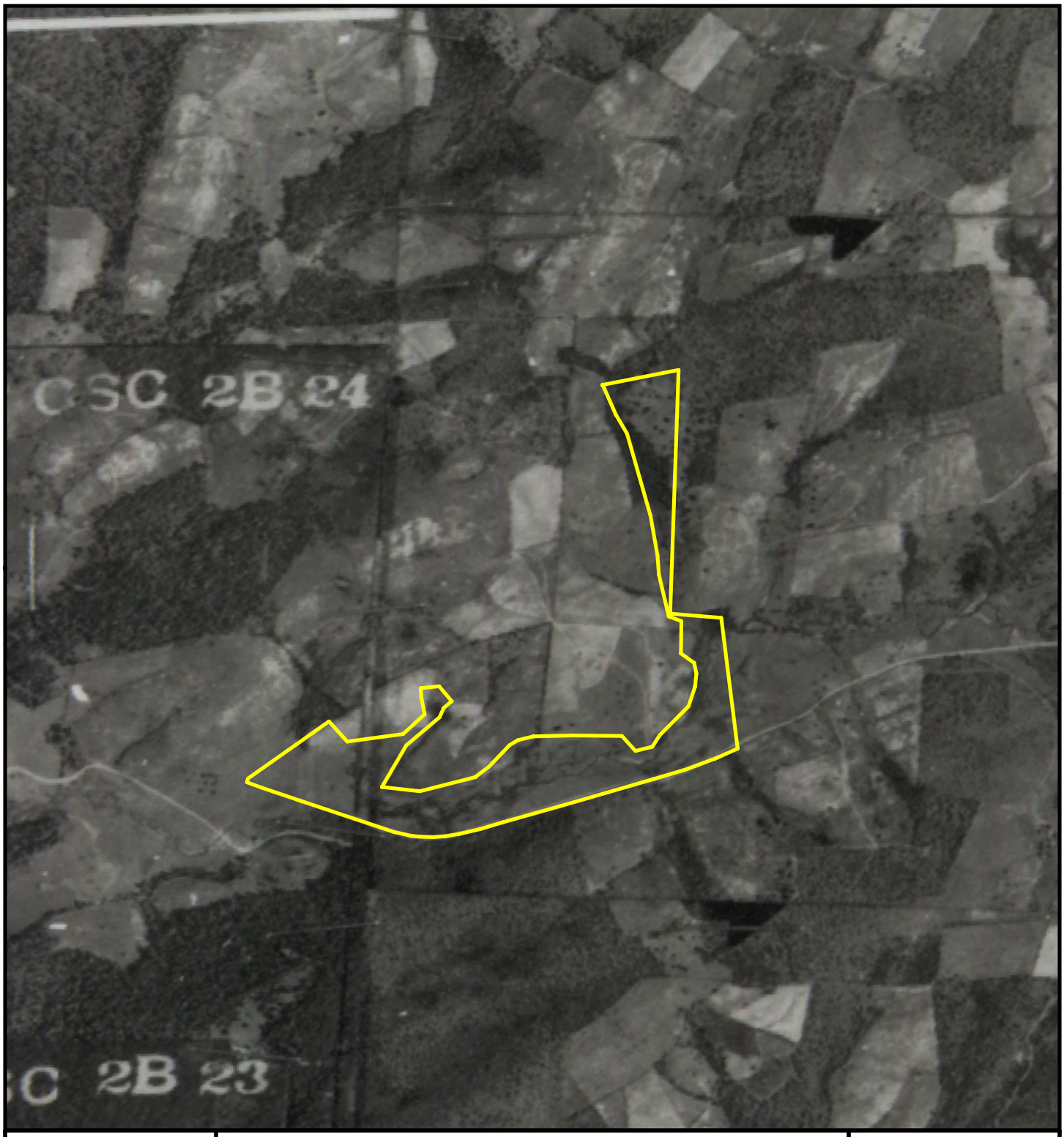
1 inch equals 2,000 feet

2,000 1,000 0 2,000 Feet

Image Source: USGS Topographic Quadrangle, Cumberland Knob 1977

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM



KCI ASSOCIATES OF NC

Figure 4A. Historic Aerial 1941

Project Boundary

N
W E
S

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000 Feet

Image Source: USDA, 1941

Ecosystem Enhancement PROGRAM

Figure 4B. Historic Aerial 1964

Project Boundary

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000 Feet

Image Source: USDA, 1964

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Ecosystem Enhancement PROGRAM

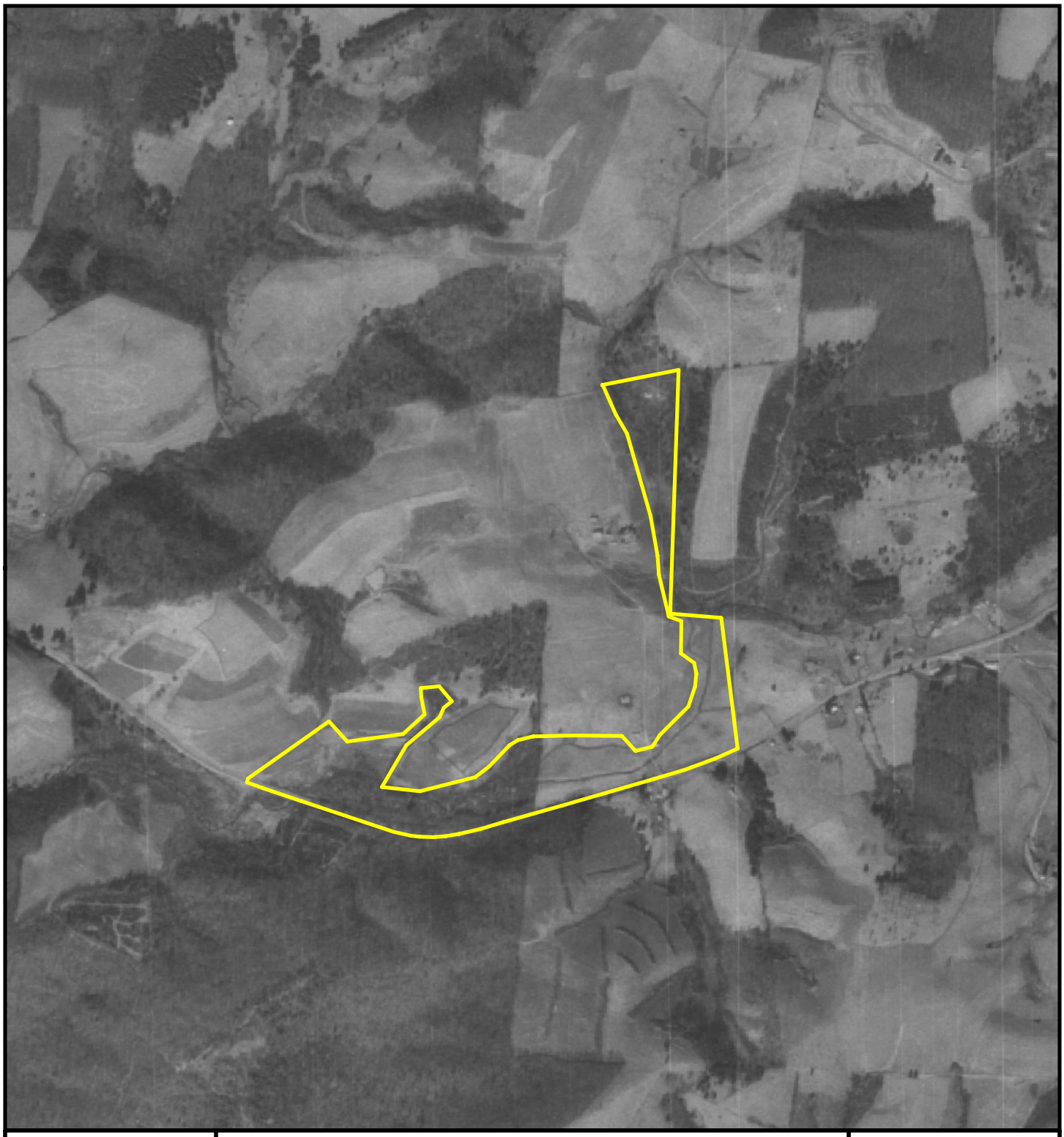

Figure 4C. Historic Aerial 1976

Project Boundary

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000
Feet

Image Source: USDA, 1976

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

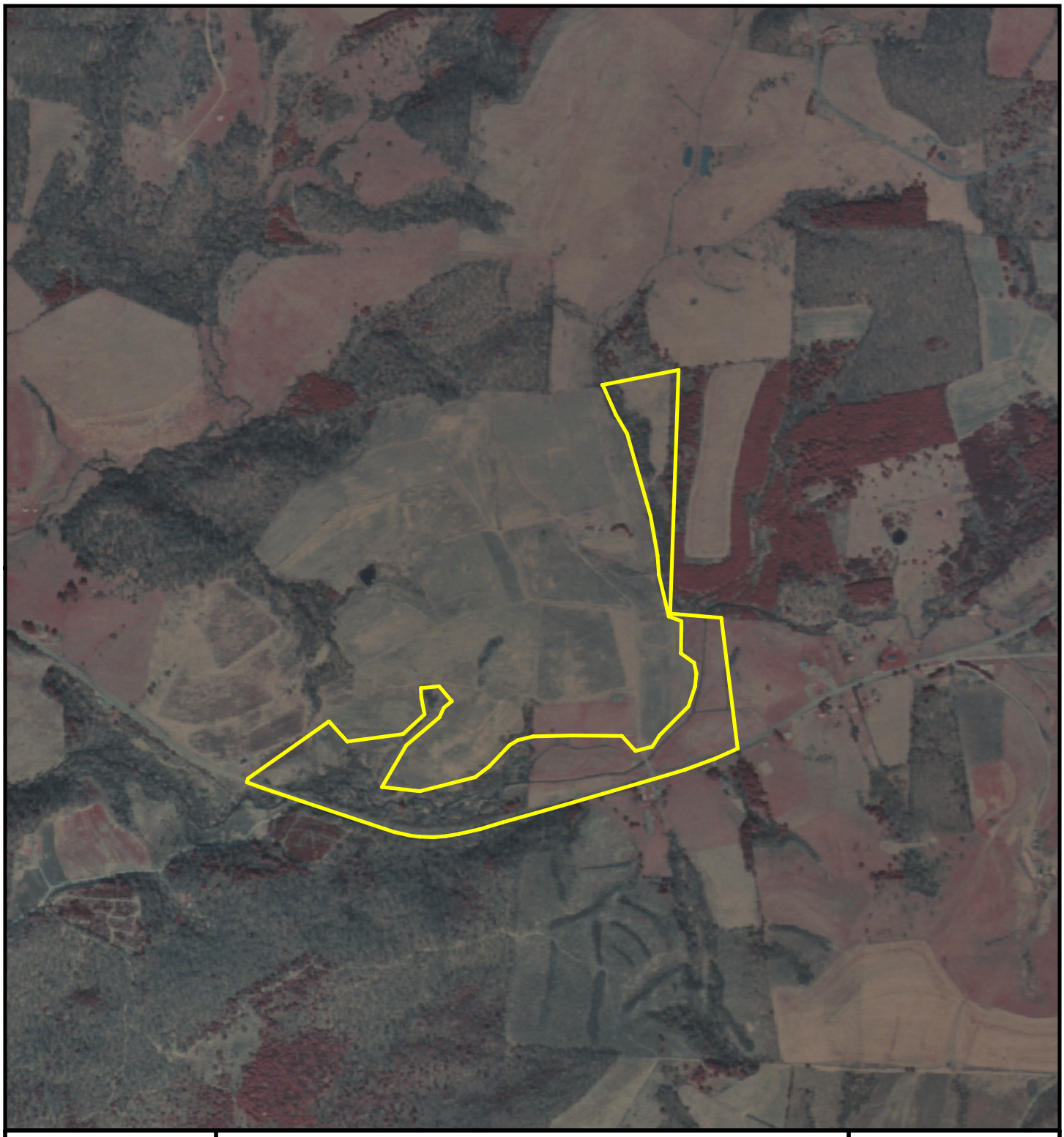

Figure 4D. Historic Aerial 1982

Project Boundary

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000 Feet

Image Source: USDA, 1982

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

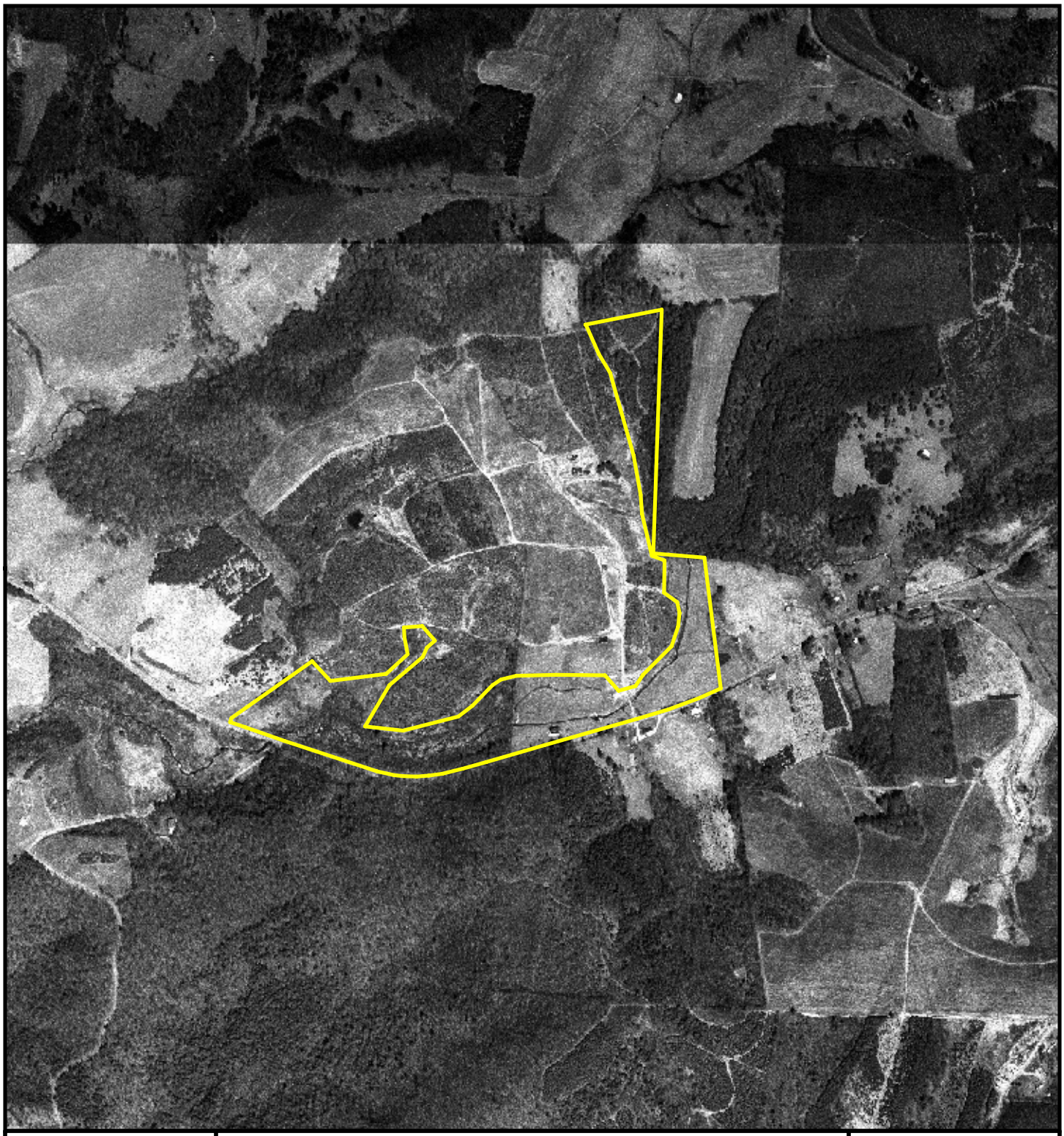

Figure 4E. Historic Aerial 1993

KCI ASSOCIATES OF NC

Project Boundary

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000 Feet

Image Source: USGS DOQ, Cumberland Knob 1993

Ecosystem Enhancement PROGRAM

KCI ASSOCIATES OF NC

Figure 4F. Historic Aerial 1998

Project Boundary

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000 Feet

Image Source: USGS DOQ, Cumberland Knob 1998

Ecosystem Enhancement PROGRAM

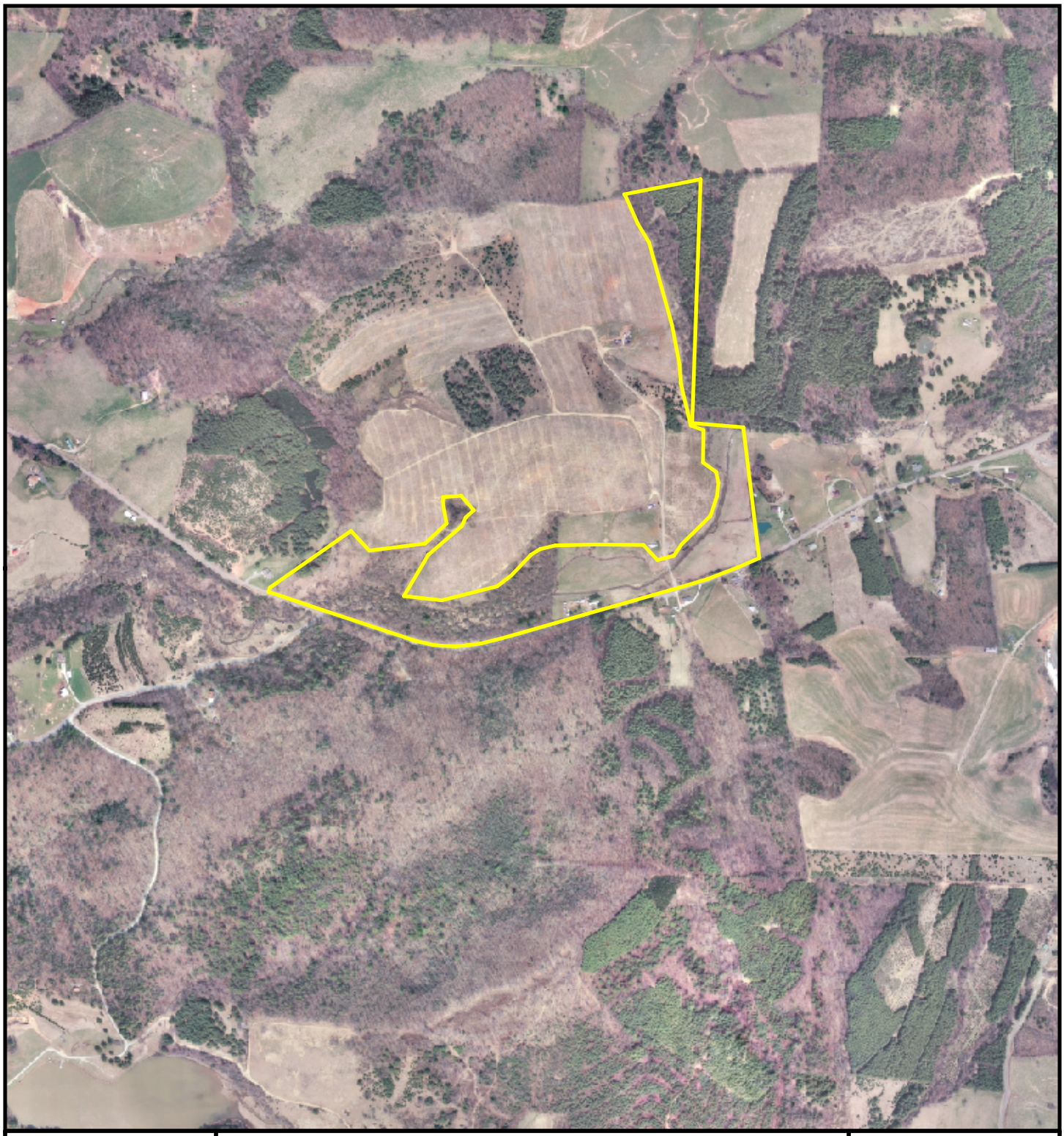

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Figure 4G. Historic Aerial 2005

Project Boundary

1:12,000
1 inch equals 1,000 feet

1,000 500 0 1,000 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

Ecosystem Enhancement PROGRAM

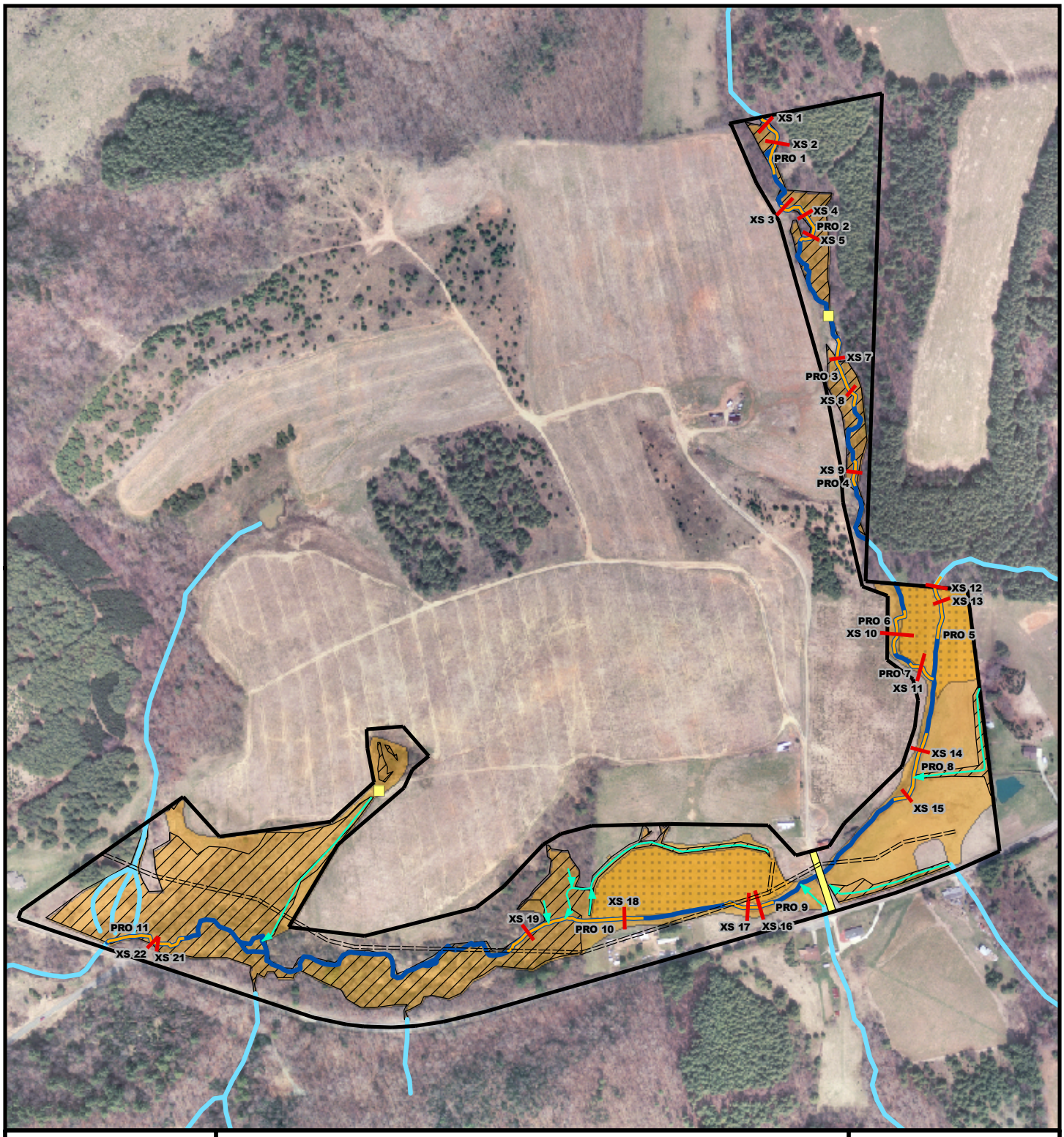

Figure 5. Existing Conditions

- Project Boundary
- Project Streams
- Other Streams
- Ditches
- Cross-Section
- Longitudinal Profile
- Power Line
- Culverted Road Crossing
- Existing Wetland
- Hydric Soils
- Hydric Soils within 18-24" overburden

*Wetland calculations are based on a preliminary delineation by KCI and are dependent on concurrence from the USACE.

1:6,000
1 inch equals 500 feet

500 250 0 500 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

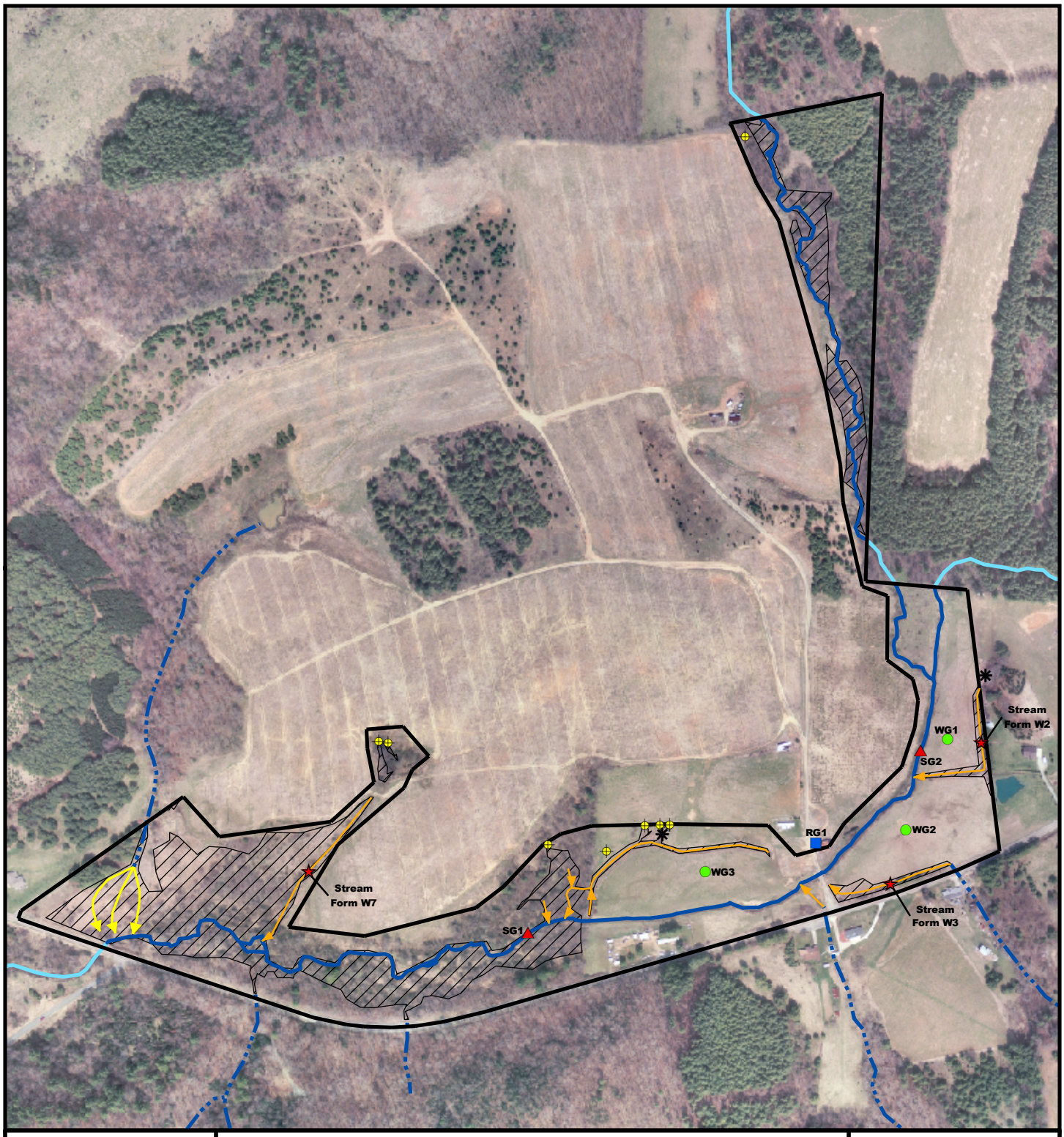

Figure 6. Hydrologic Features

- Project Boundary
- Project Streams
- Other Streams
- Other Streams (Intermittent)
- Diffuse Channel
- Ditches
- Existing Wetland
- Stream Form Locations
- Rain Gauge
- Stream Gauge
- Wetland Gauge
- Seep
- Artesian Well

1:6,000
1 inch equals 500 feet
500 250 0 500 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

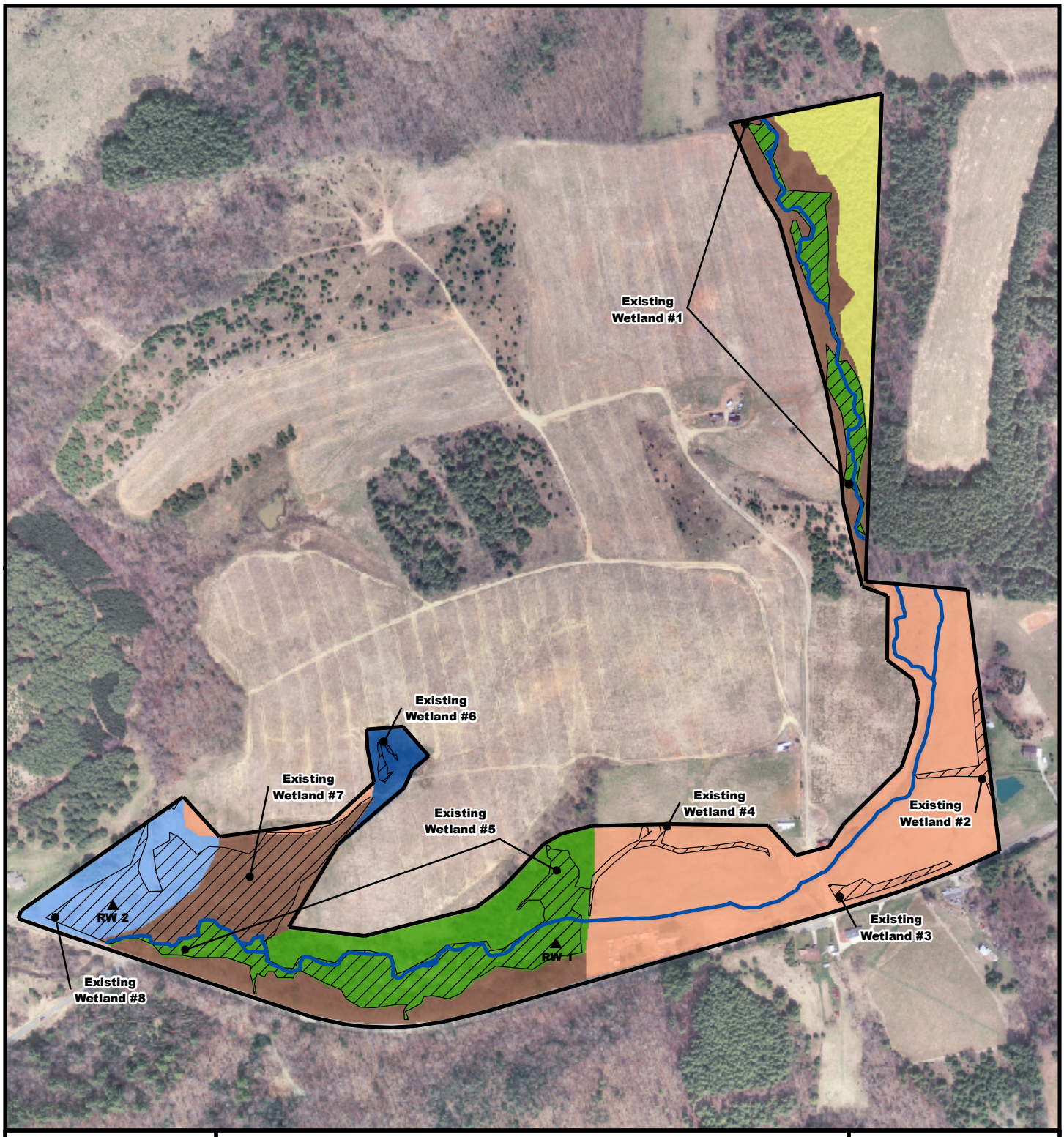

Figure 7. Existing Natural Communities

- Cropland - Fallow (17.0 ac)
- Hillside Seepage (1.0 ac)
- Montane Alluvial Forest (10.4 ac)
- Southern Appalachian Bog (3.8 ac)
- Swamp Forest-Bog Complex (10.4 ac)
- White Pine Forest (4.0 ac)

- Project Boundary
- Reference Wetland Location
- Existing Streams
- Existing Wetland

1:6,000
1 inch equals 500 feet

500 250 0 500 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

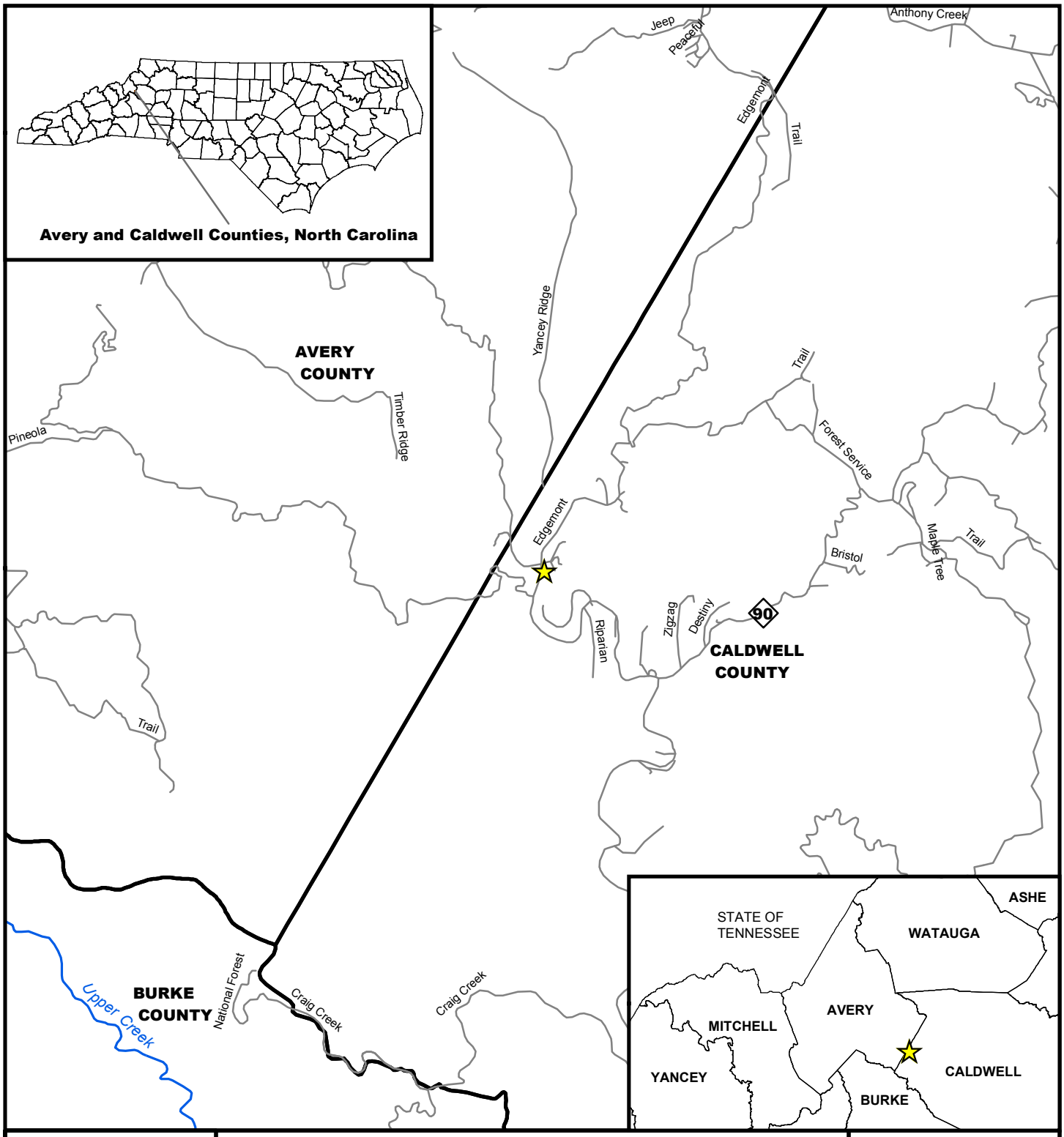

Figure 8. Reference Site Vicinity Map (Lost Cove Creek)

KCI ASSOCIATES OF NC

Project Site Location
Roads
County Boundaries

1:63,360
1 inch equals 1 miles
1 0.5 0 1
Miles

Ecosystem Enhancement PROGRAM

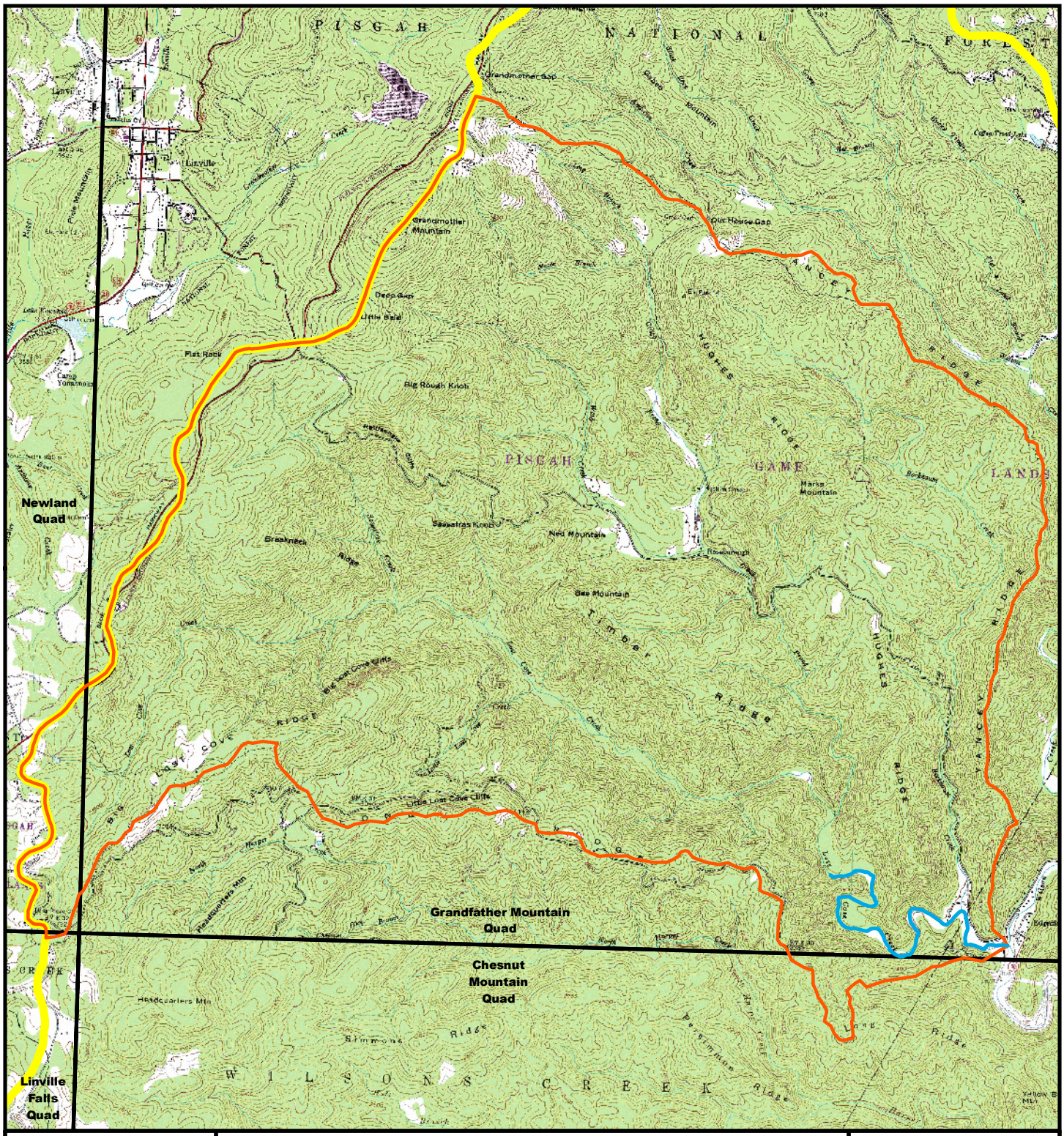

Figure 9. Reference Site Watershed (Lost Cove Creek)

Lost Cove Creek (Reference Reach)

Reference Site Watershed (24.8 sq. miles)

14-digit HUC Boundaries

Quadrangle Boundaries

1:54,000

1 inch equals 4,500 feet

4,500 2,250 0 4,500 Feet

Image Source: USGS Topographic Quadrangles Chestnut Mountain (1956), Grandfather Mountain (1978), Linville Falls (1956), and Newland (1978)

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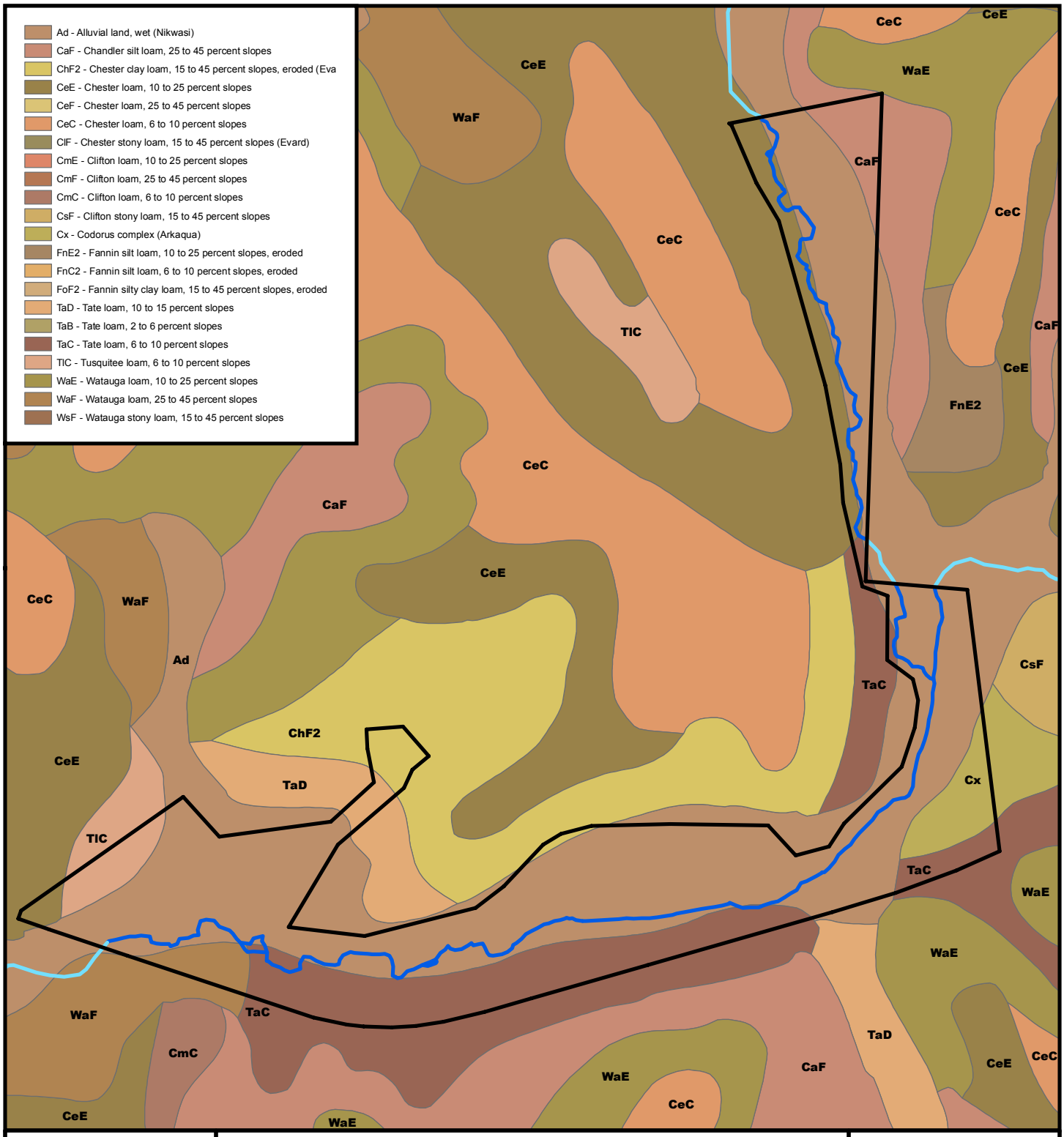
Ecosystem Enhancement PROGRAM



KCI ASSOCIATES OF NC

Figure 10. Project Site NRCS Soil Survey

Project Boundary

Project Streams

Other Streams

1:6,000

1 inch equals 500 feet

500 250 0 500 Feet

Source: Soil Survey of Alleghany County, North Carolina USDA, SCS 1973

Ecosystem Enhancement PROGRAM

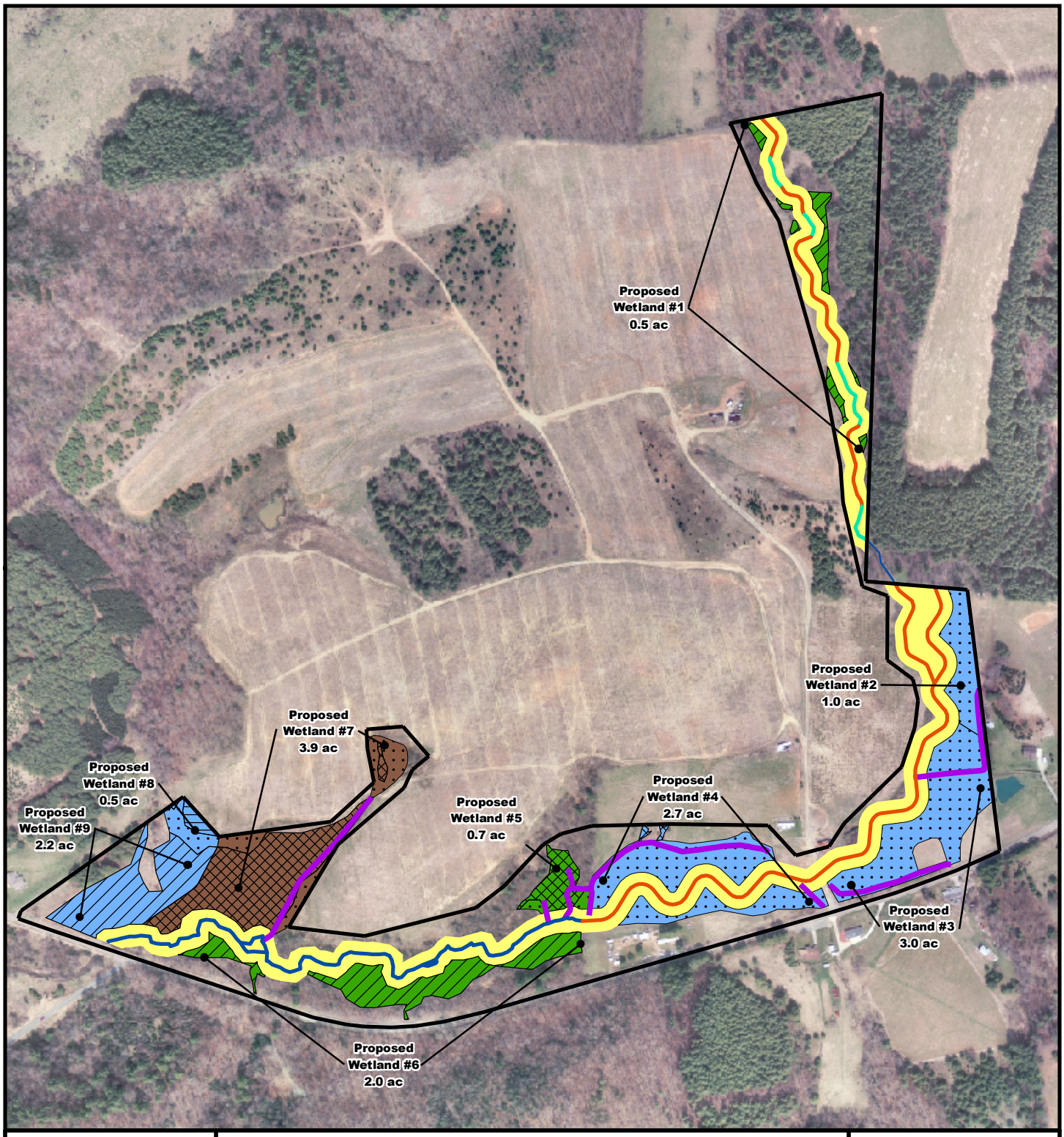


Figure 11. Proposed Stream and Wetland Design

- Project Boundary
- Wetland Creation (0.2 ac)
- Wetland Enhancement (3.7 ac)
- Wetland Preservation (4.6 ac)
- Wetland Restoration (7.9 ac)
- Ditches to be filled
- 30-ft Stream Buffer
- Stream Enhancement II
- Stream Restoration
- Stream Preservation
- Montane Alluvial Forest
- Southern Appalachian Bog
- Swamp Forest-Bog Complex

1:6,000
1 inch equals 500 feet

500 250 0 500 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

Plan Sheets

CONTRACT #: D07027S

KCI JOB# : 12053743H

STATE OF NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

STATE	CONTRACT NUMBER	SHEET NO.	TOTAL SHEETS
N.C.	D07027S	1	30

A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07	
SYM.	DESCRIPTION	DATE	APPROVED

REVISIONS

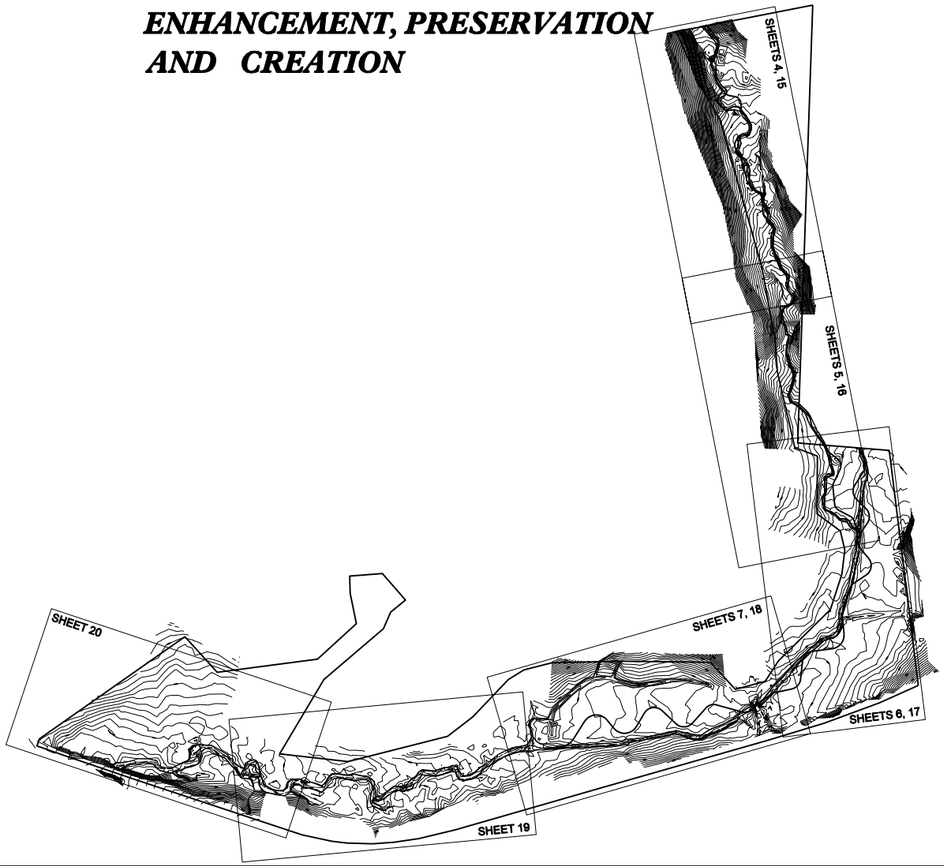
ALLEGHANY COUNTY

LOCATION: UT TO CRAB CREEK
ENNICE, NORTH CAROLINA

TYPE OF WORK: STREAM AND WETLAND RESTORATION, ENHANCEMENT, PRESERVATION AND CREATION

VICINITY MAP
NOT TO SCALE

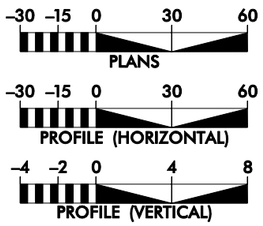
DIRECTIONS FROM RALEIGH:
PROCEED WEST ON INTERSTATE-40 (I-40). CONTINUE ON I-40 WEST TOWARD WINSTON SALEM. TAKE EXIT 193B (NC-8N/ US-52N) TO MOUNT AIRY. PROCEED ON 52N AND TAKE THE I-74W RAMP TO WYTHEVILLE I-77. TAKE EXIT 6 (BEFORE I-77 SOUTH), TURN LEFT ONTO NC-89, AND PROCEED WEST ON NC-89. TURN LEFT AT NC-18 AND PROCEED APPROXIMATELY 6 MILES TO THE PROJECT SITE. THE CRAB CREEK PROJECT SITE IS LOCATED ON THE NORTH OF NC-18. AN ALLEGHANY CHRISTMAS TREE SIGN IS AT THE ENTRANCE OF THE PROJECT SITE.



INDEX OF SHEETS

* INCLUDED IN RESTORATION PLAN

GRAPHIC SCALES



PROJECT DATA

STREAM RESTORATION LENGTH = 4,026 FEET
STREAM ENHANCEMENT LENGTH = 583 FEET
STREAM PRESERVATION LENGTH = 2,172 FEET

WETLAND CREATION AREA = 0.2 ACRES
WETLAND RESTORATION AREA = 7.9 ACRES
WETLAND ENHANCEMENT AREA = 3.7 ACRES
WETLAND PRESERVATION AREA = 4.7 ACRES

Prepared In the Office of:

KCI Associates of North Carolina, P.A.
SUITE 220 LANDMARK CENTER II, 4601 SIX FORKS RD., RALEIGH, NC
ENGINEERS • PLANNERS • ECOLOGISTS

LETTING DATE:

GARY M. MRYNCZA, P.E.
PROJECT ENGINEER
APRIL DAVIS / ALEX FRENCH
NATURAL CHANNEL DESIGN

PROJECT ENGINEER

P.E.
SIGNATURE:

Prepared for:

Ecosystem Enhancement

HARRY TSOMIDES
NCEEP PROJECT MANAGER
SALAM MURTADA
NCEEP REVIEW COORDINATOR

GENERAL NOTES

GENERAL NOTES:

BEARING AND DISTANCES:
ALL BEARINGS ARE NAD 1983 GRID BEARINGS.
ALL DISTANCES AND COORDINATES SHOWN ARE HORIZONTAL (GROUND) VALUES.
ALL INFORMATION IS BASED ON THE FOLLOWING GPS CONTROL POINTS.

GPS#1	N=1028530.5926	E=1422346.3221	ELEV.=2671.39
GPS#2	N=1028131.5545	E=1422488.7356	ELEV.=2649.75
GPS#3	N=1027057.1177	E=1422711.6147	ELEV.=2619.16
GPS#4	N=1026547.7100	E=1422725.4800	ELEV.=2598.51
GPS#5	N=1025845.1323	E=1419923.0164	ELEV.=2542.79
GPS#6	N=1025962.9577	E=1419573.2655	ELEV.=2550.27

GRADING:
-ALL EXCAVATED MATERIALS, INCLUDING NATURAL STONE MEETING SIZE LIMITATIONS, ARE TO BE SALVAGED FOR REUSE WITHIN THE PROJECT AT THE DISCRETION OF THE DESIGNER.
-ALL INFLECTION POINTS BETWEEN SLOPE ANGLES SHALL BE ROUNDED SLIGHTLY IN ORDER TO PROVIDE FOR SMOOTH TRANSITIONS AND A MORE NATURAL APPEARANCE.

UTILITY/SUBSURFACE PLANS:
-NO SUBSURFACE PLANS ARE AVAILABLE ON THIS PROJECT. EXISTING UNDERGROUND UTILITIES HAVE NOT BEEN VERIFIED. THE CONTRACTOR IS RESPONSIBLE FOR CONTACTING A UTILITY LOCATOR AND ESTABLISHING THE EXACT LOCATION OF ANY AND ALL EXISTING UTILITIES IN THE PROJECT REACH.

SITE CONTROL POINTS

Point	Northing	Easting	Elevation	Desc.
7	1028670.3448	1422541.7503	2621.3256	KCI#7
8	1028570.8364	1422597.7212	2617.7067	KCI#8
9	1028391.6475	1422670.6411	2612.0069	KCI#9
10	1027511.8191	1422748.0359	2613.3103	KCI#10
11	1025942.4562	1422787.2050	2566.8792	KCI#11
12	1025805.8541	1421944.6738	2554.2896	KCI#12
13	1025788.4690	1421725.5654	2551.8630	KCI#13
14	1025894.3808	1421455.1527	2573.7180	KCI#14
15	1025921.7310	1421119.0778	2552.6375	KCI#15
16	1026278.0387	1420843.1843	2561.4100	KCI#16
17	1025664.5878	1420870.4748	2545.0081	KCI#17
18	1025554.9050	1420771.0755	2561.1614	KCI#18
19	1025610.7214	1420630.6907	2556.3650	KCI#19
20	1025701.2791	1420315.3639	2548.4020	KCI#20
21	1025776.4608	1420093.7311	2543.0797	KCI#21
22	1026144.5769	1420534.5059	2547.6954	KCI#22

PROJECT LEGEND

STREAM RESTORATION

Proposed Thalweg w/Approximate Bankfull Limits

Proposed Offset Rock Cross Vane

Proposed Step Pool

Proposed Stone Toe Stabilization

Proposed Channel Block

Proposed Riffle Grade Control

Proposed Riffle Enhancement

CONTRACTOR SHALL COLLECT RIFFLE MATERIALS AT OFFLINE ABANDONED SECTIONS OF THE EXISTING STREAM AND RE-USE THEM IN NEW RIFFLE ENHANCEMENT LOCATIONS.

IF THERE IS ADEQUATE EXISTING GRAVEL BED MATERIAL AT CUT LOCATIONS, RIFFLE ENHANCEMENT MATERIALS WILL NOT BE NEEDED. CONTRACTOR SHALL CONSULT WITH DESIGN REPRESENTATIVE ON SITE TO MAKE THIS DETERMINATION.

VEGETATION

Existing Woods Line

Single Tree

TOPOGRAPHY

Minor Contour Line

Major Contour Line — 720

MISCELLANEOUS

Existing Barbed Wire Fencing

Existing Overhead Electric Utility — OHE

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07	

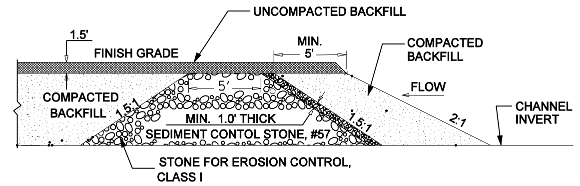
KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION
ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

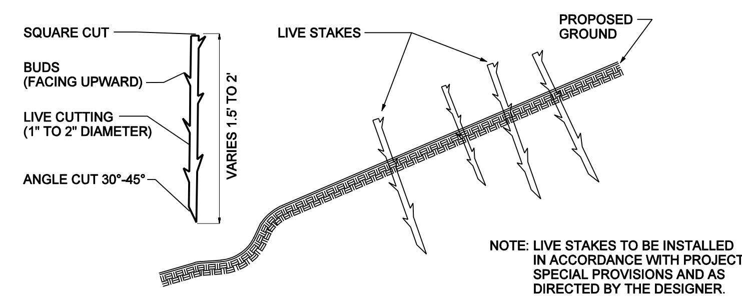
DATE: AUGUST 2007
SCALE: N.T.S.

GENERAL NOTES & PROJECT LEGEND

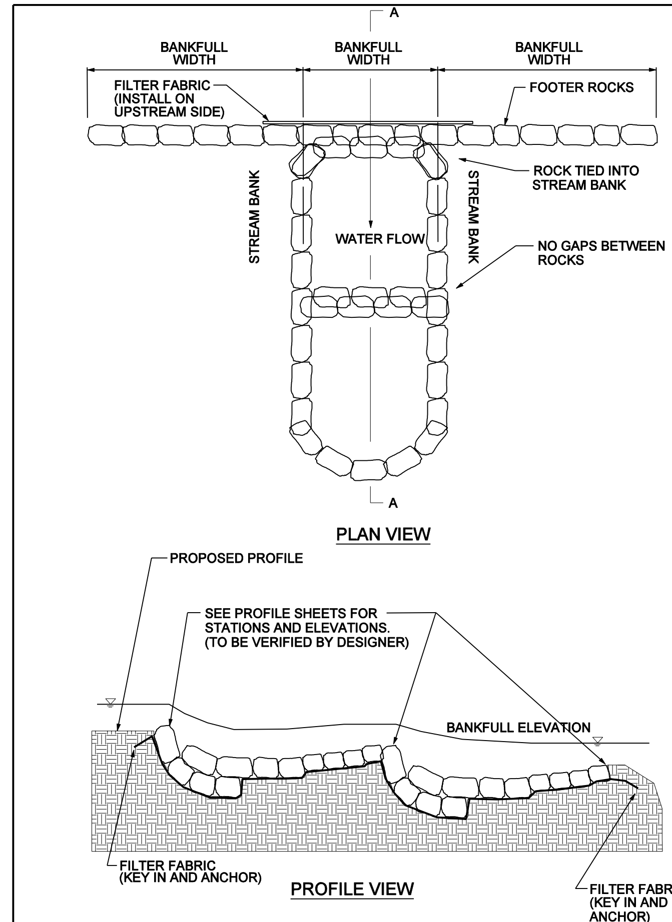
SHEET 1A OF 28



CHANNEL BLOCK
SCALE: NTS

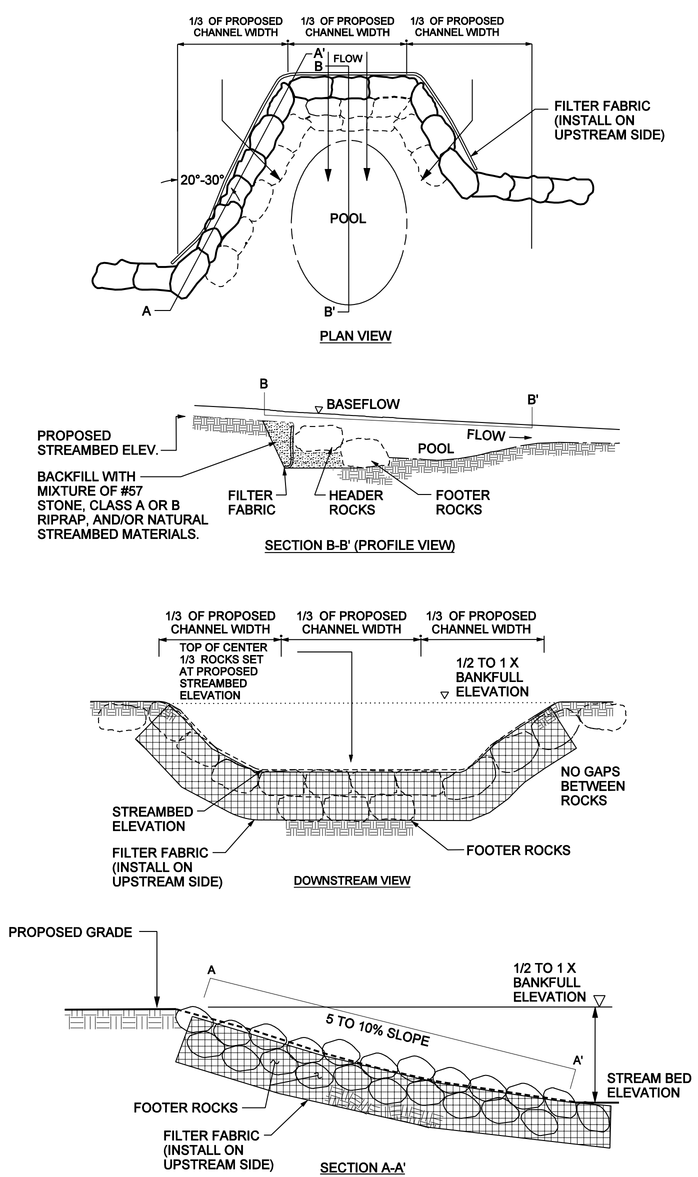


LIVE STAKES
SCALE: NTS



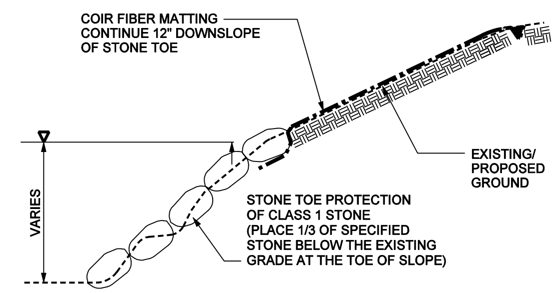
DOUBLE STEP POOL
SCALE: NTS

*** NOTES: - ALL ROCKS OR STONES ARE RIP RAP, CLASS I
- DETAIL SHOWN IS FOR A DOUBLE STEP POOL. ADJUST ACCORDINGLY FOR SINGLE AND TRIPLE STEP POOLS. (SEE PROFILE SHEET TO DETERMINE AMOUNT)

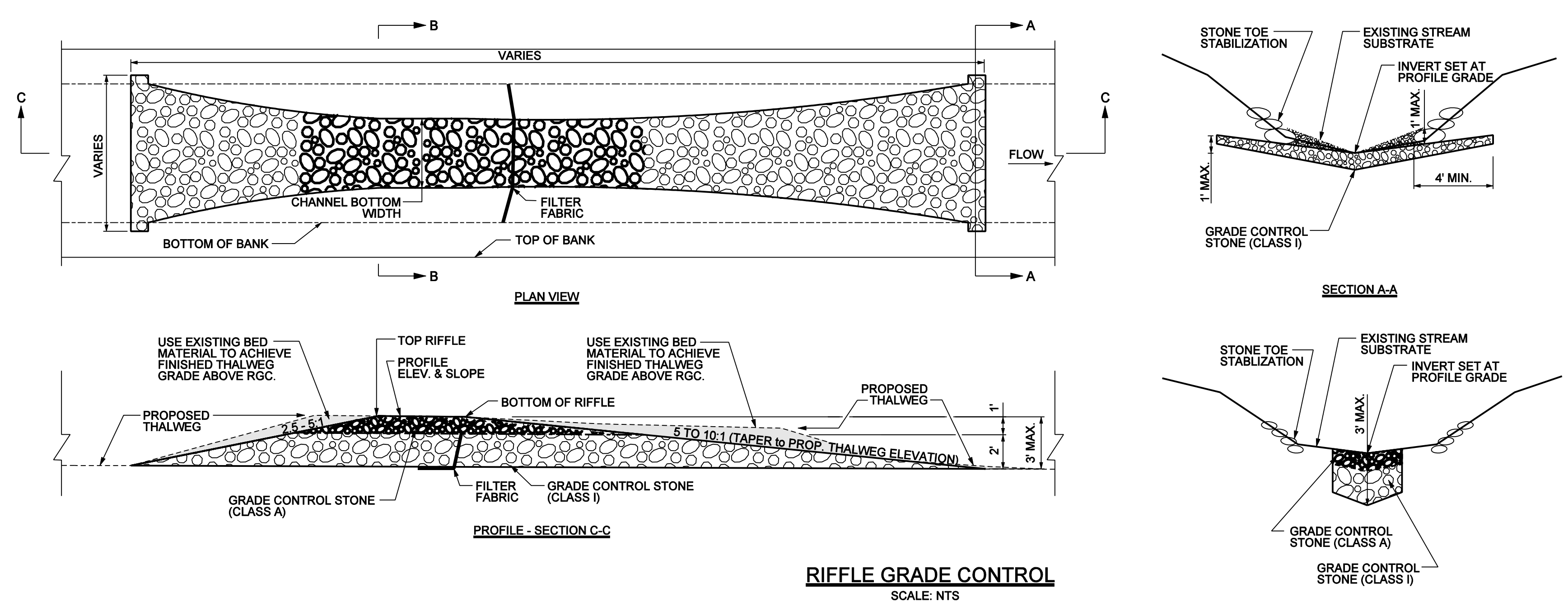


OFFSET ROCK CROSS VANE
SCALE: NTS

NOTE: (1) ALL ROCKS OR STONES IN THE VANE STRUCTURE ARE STONE BOULDERS.
(2) SHORT CROSS VANE ARM TO BE HALF THE SLOPE OF THE FULL ARM SLOPE.



STONE TOE STABILIZATION
SCALE: NTS



RIFFLE GRADE CONTROL
SCALE: NTS

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07	

REVISIONS

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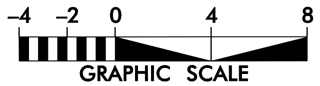
RALEIGH, NORTH CAROLINA 27609

UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION
ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

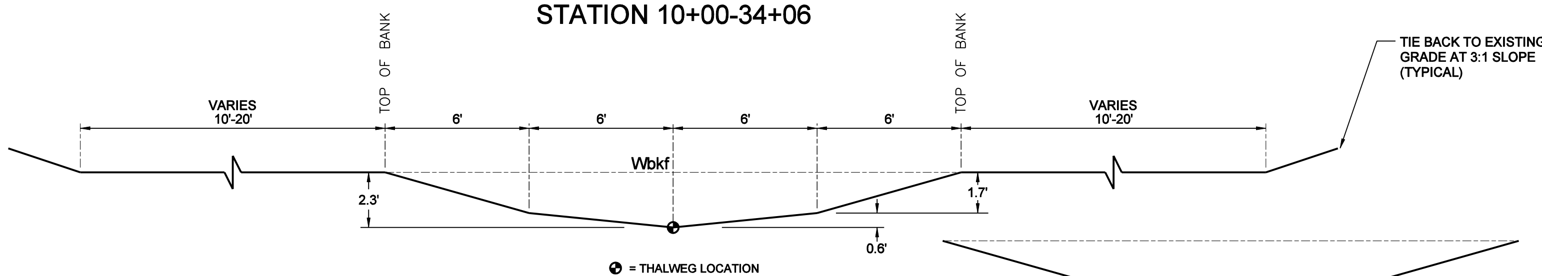
DATE: AUGUST 2007
SCALE: N.T.S.

DETAILS:
STABILIZATION

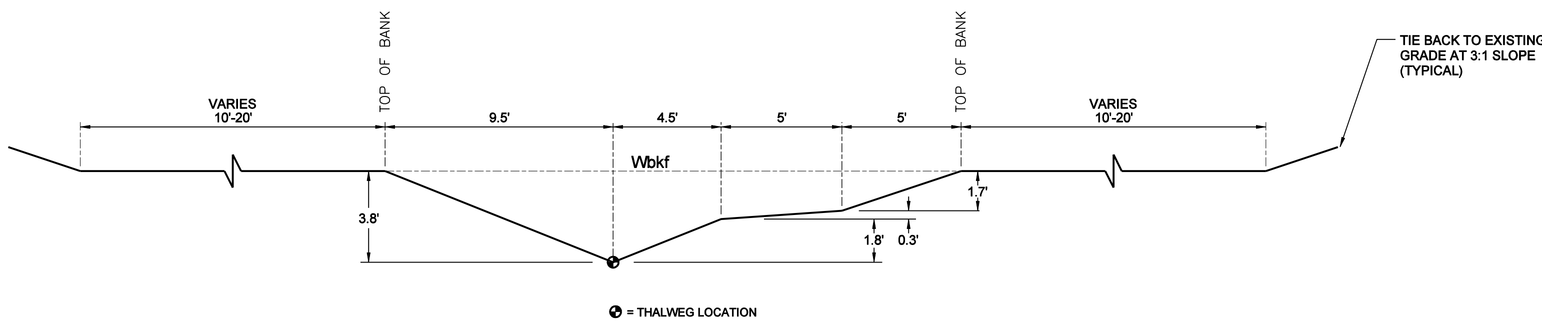


MAIN CHANNEL TYPICAL CROSS-SECTIONS "C4" STREAM TYPE

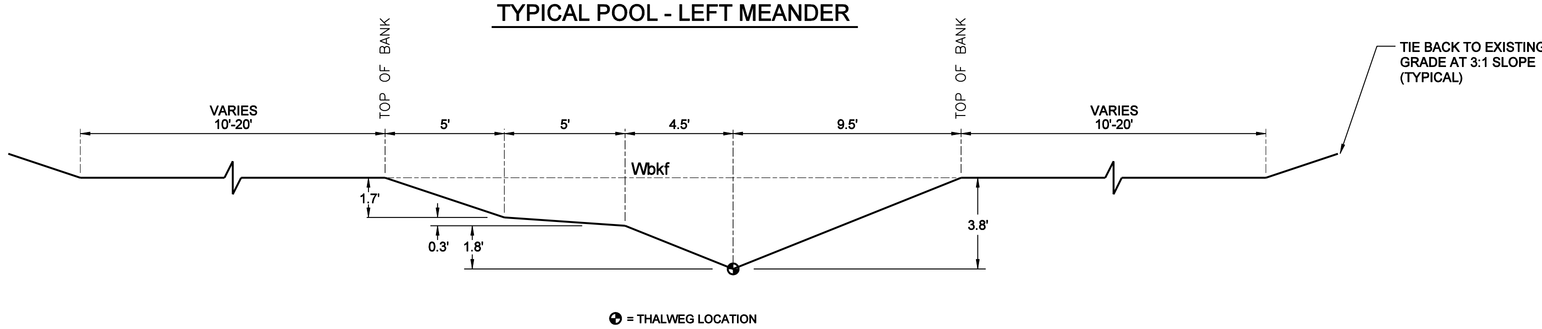
STATION 10+00-34+06



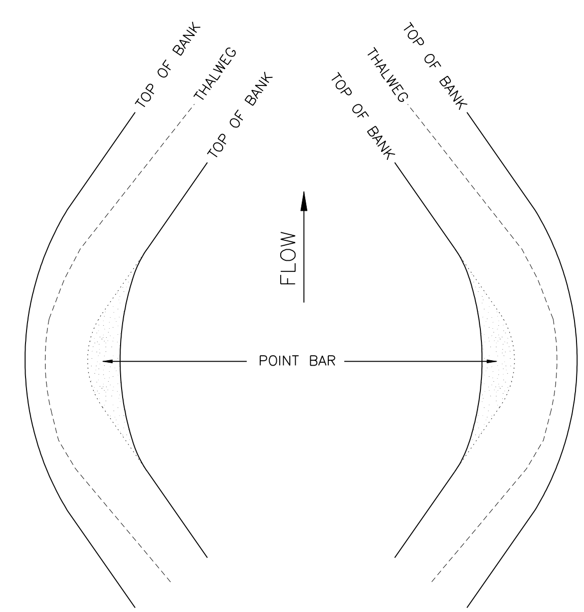
TYPICAL RIFFLE



TYPICAL POOL - LEFT MEANDER



TYPICAL POOL - RIGHT MEANDER

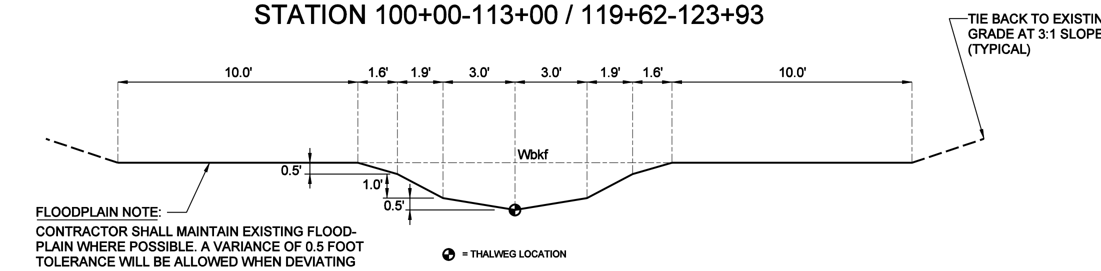


LEFT MEANDER
NOT TO SCALE

RIGHT MEANDER
NOT TO SCALE

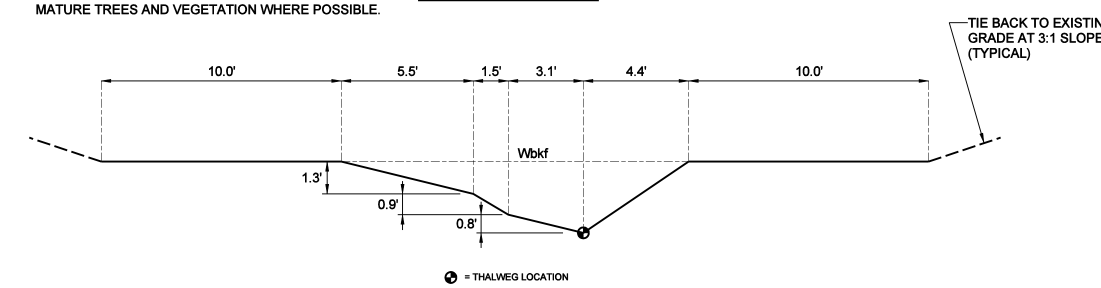
TRIBUTARY CHANNEL TYPICAL CROSS-SECTIONS "C4" STREAM TYPE (DO NOT USE AT STEP POOL MEANDERS)

STATION 100+00-113+00 / 119+62-123+93

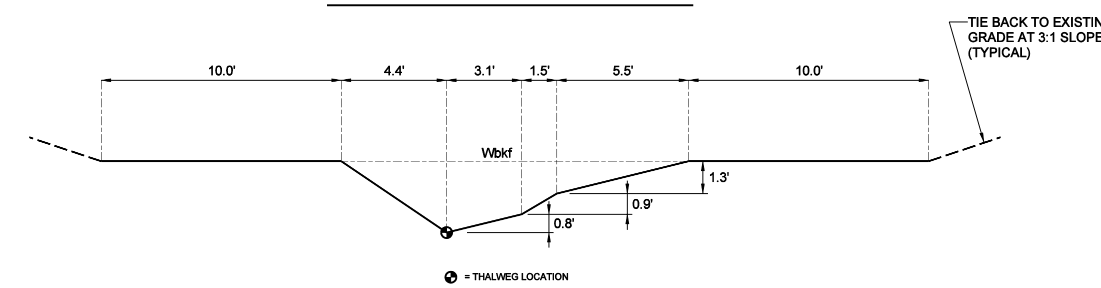


FLOODPLAIN NOTE: CONTRACTOR SHALL MAINTAIN EXISTING FLOODPLAIN WHERE POSSIBLE. A VARIANCE OF 0.5 FOOT TOLERANCE WILL BE ALLOWED WHEN DEVIATING FROM THE PROPOSED MAX CROSS SECTION DEPTH. CONTRACTOR SHALL ALSO PROTECT ALL EXISTING MATURE TREES AND VEGETATION WHERE POSSIBLE.

TYPICAL RIFFLE



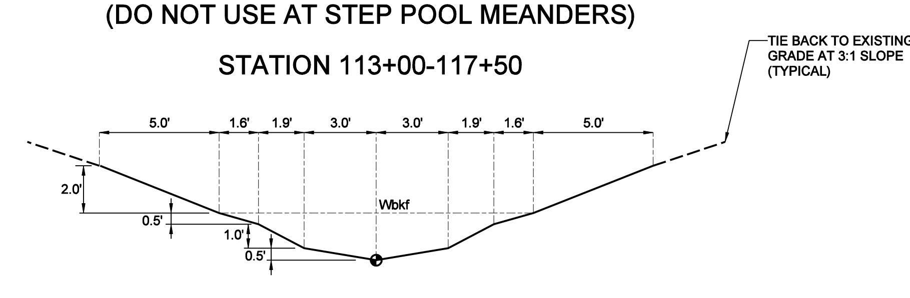
TYPICAL POOL - RIGHT MEANDER



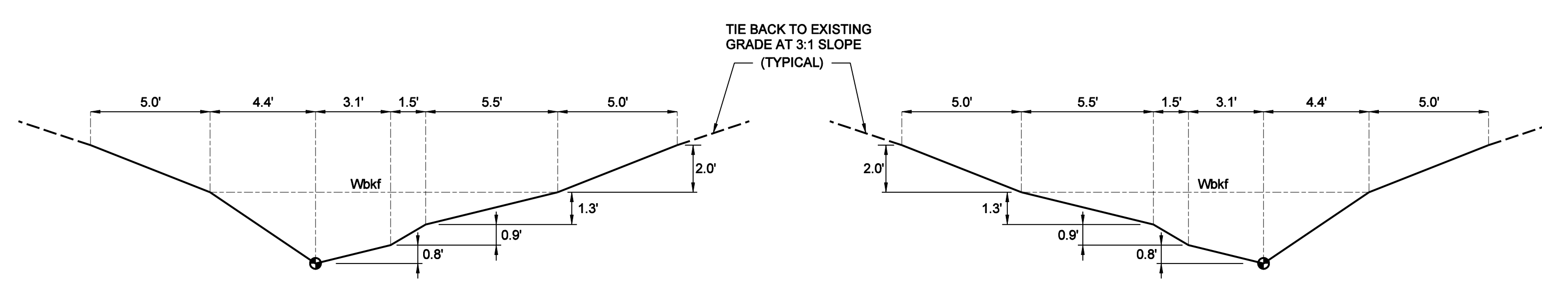
TYPICAL POOL - LEFT MEANDER

TRIBUTARY CHANNEL TYPICAL CROSS-SECTIONS "B4c" STREAM TYPE (DO NOT USE AT STEP POOL MEANDERS)

STATION 113+00-117+50



TYPICAL RIFFLE



TYPICAL POOL - LEFT MEANDER

TYPICAL POOL - RIGHT MEANDER

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07	

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UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION
ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

DATE: AUGUST 2007
SCALE: N.T.S.

DETAILS:
TYPICAL XS

SHEET 2A OF 28

UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION

ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

STATION 100+00 TO STATION 112+15

PLAN AND PROFILE

SHEET 4 OF 28

DATE: AUGUST 2007

SCALE: 1"=30'

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Ecosystem Enhancement Program

SYM.	DESCRIPTION	DATE	APPROVED
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REVISIONS

NC GRID
NAD '83

-40 -20 0 40 80
GRAPHIC SCALE

CONTRACTOR SHALL COLLECT RIFFLE MATERIALS AT OFFLINE ABANDONED SECTIONS OF THE EXISTING STREAM AND RE-USE THEM IN NEW RIFFLE ENHANCEMENT LOCATIONS.

IF THERE IS ADEQUATE EXISTING GRAVEL BED MATERIAL AT CUT LOCATIONS, RIFFLE ENHANCEMENT MATERIALS WILL NOT BE NEEDED. CONTRACTOR SHALL CONSULT WITH DESIGN REPRESENTATIVE ON SITE TO MAKE THIS DETERMINATION.

(TYPICAL FOR ALL PROPOSED RIFFLE ENHANCEMENTS)

MATCHLINE - SEE SHEET 4

SEE SHEETS 6-9 FOR MAIN STEM

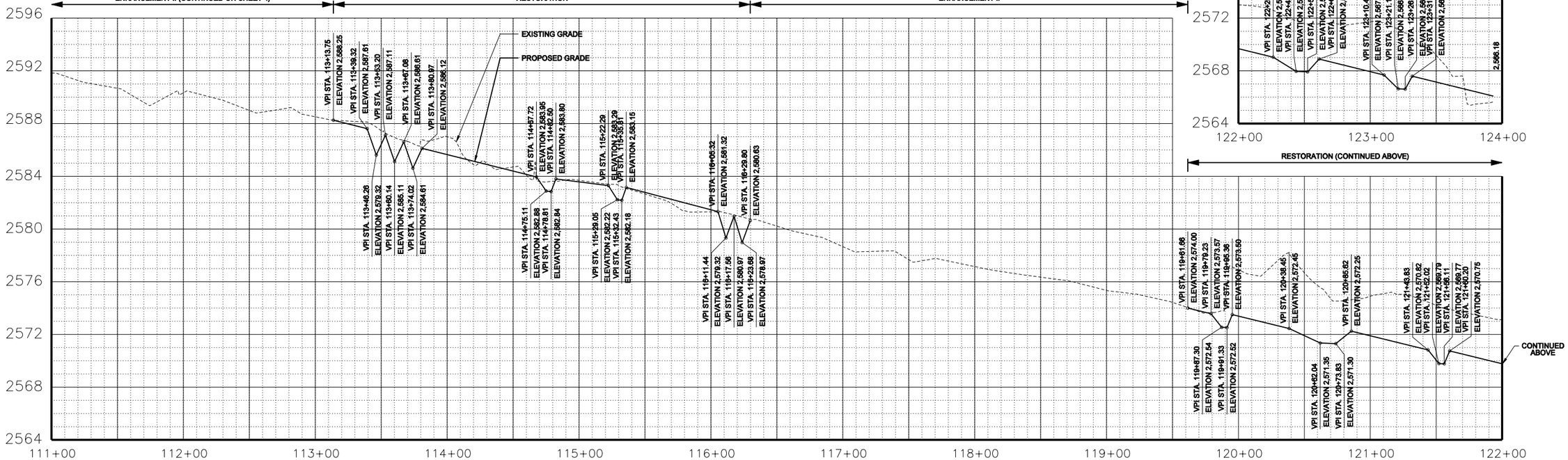
PROPERTY LINE - CONSERVATION EASEMENT

EXISTING SCRAP METAL TO BE REMOVED

RESTORATION (CONTINUED BELOW)

RESTORATION (CONTINUED ABOVE)

CONTINUED ABOVE



A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07		
		SYM.	DESCRIPTION	DATE	APPROVED

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UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION

ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

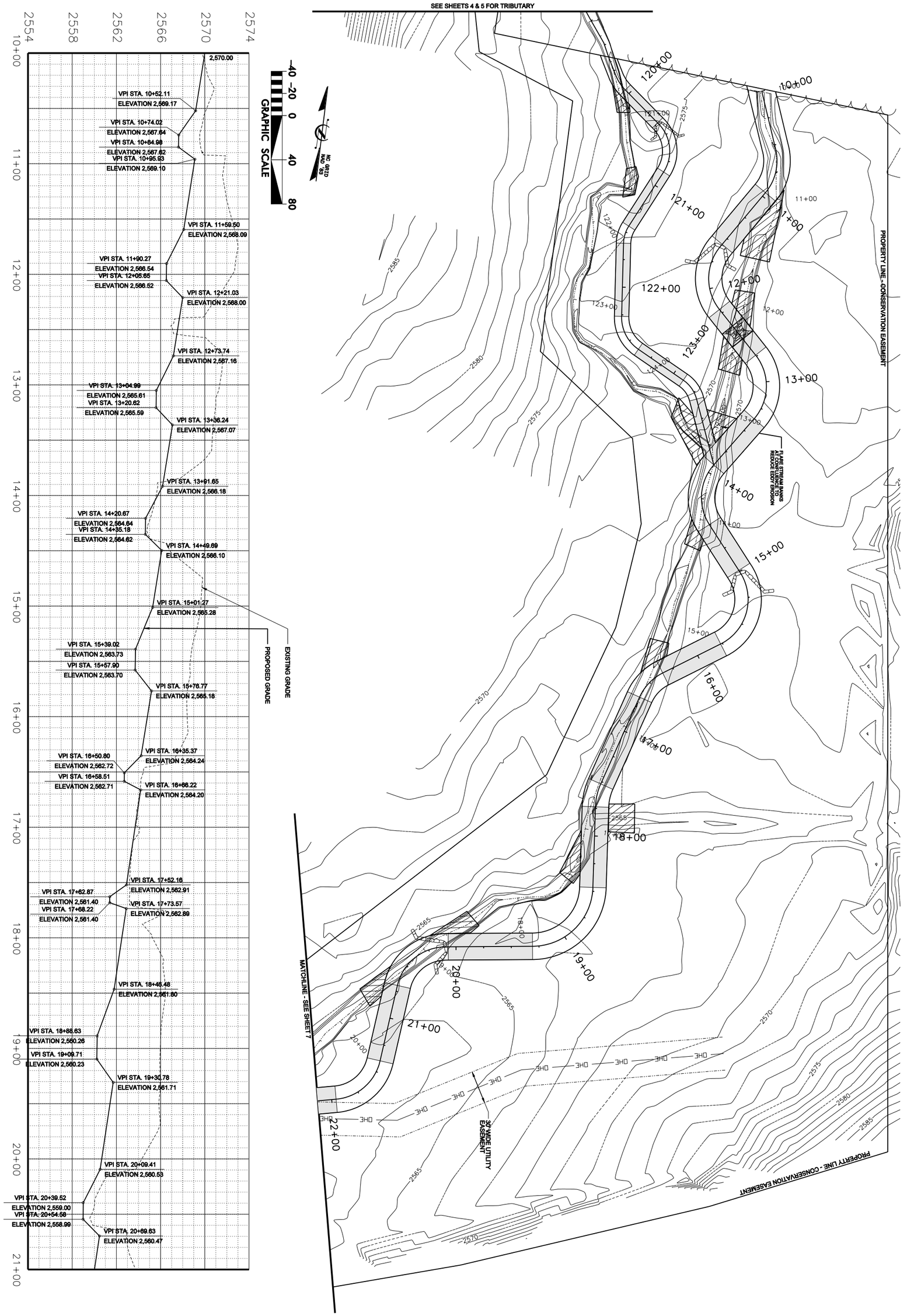
STATION 112+15 TO STATION 123+93

DATE: AUGUST 2007

SCALE: 1"=30'

PLAN AND PROFILE

SHEET 5 OF 28



SHEET 6 OF 28	PLAN AND PROFILE	DATE: AUGUST 2007	SCALE: 1"=30'

UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION

ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

STATION 10+00 TO STATION 22+13

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SYM.	DESCRIPTION	DATE	APPROVED
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REVISIONS

PROPERTY LINE - CONSERVATION EASEMENT

MATCHLINE - SEE SHEET 6

MATCHLINE - SEE SHEET 8

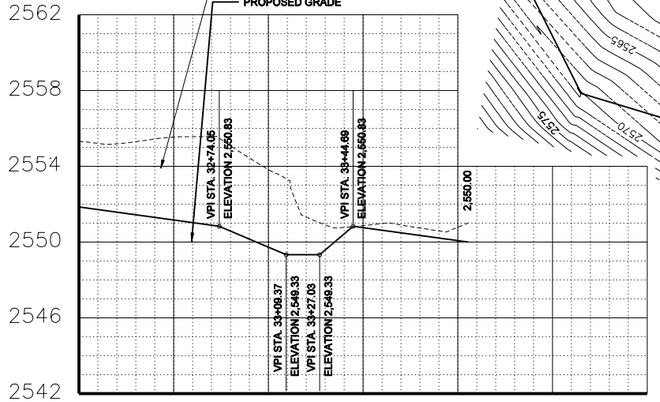
FUTURE 8'x8' BOX CULVERT WITH (2) 6'x6' FLOODPLAIN BOX CULVERTS

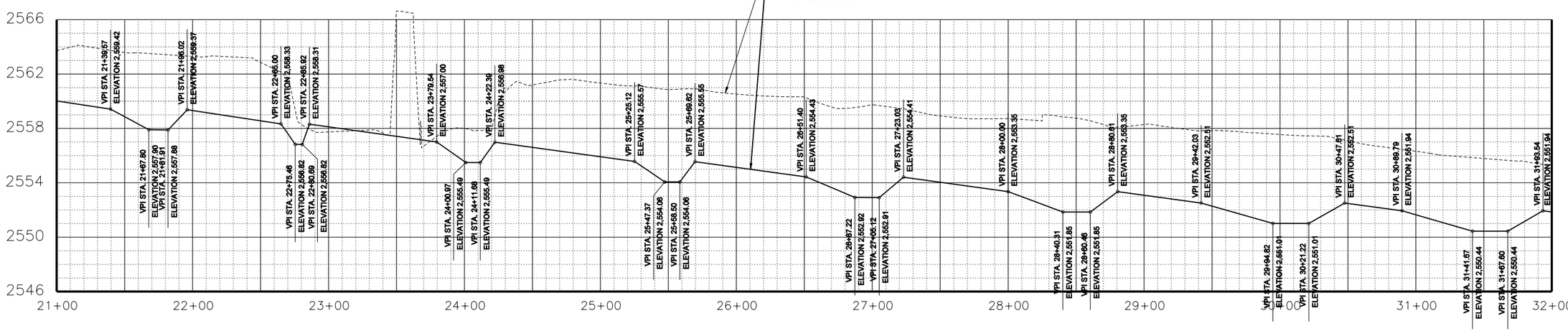
PROPERTY LINE - CONSERVATION EASEMENT

NO GRID AND NO SCALE

GRAPHIC SCALE

–40 –20 0 40 80





A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07				

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION

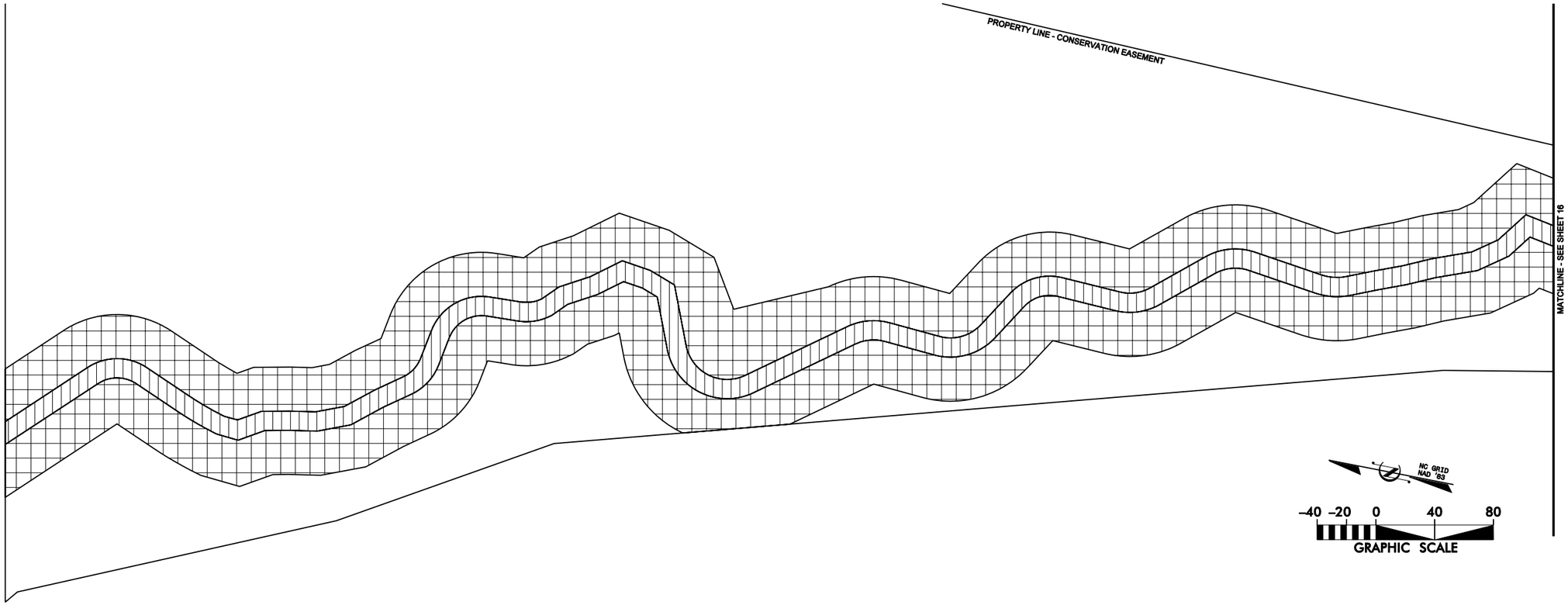
ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

STATION 22+13 TO STATION 34+05

DATE: AUGUST 2007

SCALE: 1"=30'

PLAN AND PROFILE



PLANTING PLAN AND SPECIES COMPOSITION

ZONE A

STREAM ZONE = 1.98 ACRE (86,334 SQ.FT.)

LIVE STAKES: 1.5' TO 2' LENGTHS, 1/2" TO 2" DIAMETER,
3' CENTER SPACING, RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	WETLAND INDICATOR
BLACK WILLOW	SALIX NIGRA	OBL
SILKY WILLOW	SALIX SERICEA	OBL
SILKY DOGWOOD	CORNUS AMOMUM	FACW+
ELDERBERRY	SAMBUCUS CANADENSIS	FACW-

NOTE: NO SINGLE LIVE STAKING SPECIES SHALL COMPOSE MORE THAN 40% OF THE 11,050 TOTAL NUMBER OF LIVE STAKES TO BE INSTALLED

ZONE B

SWAMP FOREST BOG FLOODPLAIN PLANTING AREA = 2.45 ACRES

18" - 24" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	WETLAND INDICATOR	% OF TOTAL	# OF PLANTS
SPICEBUSH	LINDERA BENZOIN	FACW	20	214
HAZEL ALDER	ALNUS SERRULATA	FACW	20	214
SWEET BIRCH	BETULA LENTA	FACU	20	214
COMMON WINTERBERRY	ILEX VERTICILLATA	FACW	20	214
POSSUMHAW	VIBURNUM NUDUM	FACW+	20	214
			100	1,070

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

ZONE C

SOUTHERN APPALACHIAN BOG FLOODPLAIN PLANTING AREA = 3.86 ACRES

18" - 24" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	WETLAND INDICATOR	% OF TOTAL	# OF PLANTS
HAZEL ALDER	ALNUS SERRULATA	FACW	20	337
SPICEBUSH	LINDERA BENZOIN	FACW	20	337
RED CHOKEBERRY	ARONIA ARBUTIFOLIA	FACW	20	337
POSSUMHAW	VIBURNUM NUDUM	FACW+	20	337
SWAMP ROSE	ROSA PALUSTRIS	OBL	20	337
			100	1,683

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

ZONE D

SOUTHERN APPALACHIAN BOG PLANTING AREA = 6.68 ACRES

18" - 24" BARE ROOT MATERIAL AND HERBACEOUS PLUGS
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	WETLAND INDICATOR	% OF TOTAL	# OF PLANTS
MALEBERRY	LYONIA LIGUSTRINA	FACW	5	146
SWAMP ROSE	ROSA PALUSTRIS	OBL	5	146
WOODLAND BULRUSH	SCIRPUS EXPANSUS	OBL	15	437
STRAWCOLORED FLATSEDGE	CYPERUS STRIGOSUS	OBL	15	437
PRICKLY BOG SEDGE	CAREX ATLANTICA	FACW	15	437
BROOM SEDGE	CAREX SCOPARIA	FACW	15	437
SPOTTED JEWELWEED	IMPATIENS CAPENSIS	FACW	15	437
SOFT RUSH	JUNCUS EFFUSUS	FACW+	15	437
			100	2,914

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

ZONE G

EXISTING 30-FT STREAM BUFFER

EXISTING TREE LINE

ZONES E-1/E-2

E-1: MONTANE ALLUVIAL FOREST PLANTING AREA = 3.67 ACRES

18" - 24" BARE ROOT MATERIAL
100 STEMS/ACRE, RANDOM SPECIES PLACEMENT AMONG EXISTING VEGETATION

COMMON NAME	SCIENTIFIC NAME	WETLAND INDICATOR	% OF TOTAL	# OF PLANTS
HAZEL ALDER	ALNUS SERRULATA	FACW	25	92
SPICEBUSH	LINDERA BENZOIN	FACW	25	92
RIVER BIRCH	BETULA NIGRA	FACW	25	92
AMERICAN HORNBEAM	CARPINUS CAROLINIANA	FAC	25	92
			100	368

E-2: MONTANE ALLUVIAL FOREST PLANTING AREA = 0.22 ACRES

18" - 24" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	WETLAND INDICATOR	% OF TOTAL	# OF PLANTS
HAZEL ALDER	ALNUS SERRULATA	FACW	25	24
SPICEBUSH	LINDERA BENZOIN	FACW	25	24
RIVER BIRCH	BETULA NIGRA	FACW	25	24
AMERICAN HORNBEAM	CARPINUS CAROLINIANA	FAC	25	24
			100	96

ZONE F

SOUTHERN APPALACHIAN BOG WETLAND PLANTING AREA = 0.49 ACRES

18" - 24" BARE ROOT MATERIAL AND HERBACEOUS PLUGS
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

COMMON NAME	SCIENTIFIC NAME	WETLAND INDICATOR	% OF TOTAL	# OF PLANTS
MALEBERRY	LYONIA LIGUSTRINA	FACW	5	11
SWAMP ROSE	ROSA PALUSTRIS	OBL	5	11
WOODLAND BULRUSH	SCIRPUS EXPANSUS	OBL	15	32
STRAWCOLORED FLATSEDGE	CYPERUS STRIGOSUS	OBL	15	32
PRICKLY BOG SEDGE	CAREX ATLANTICA	FACW	15	32
BROOM SEDGE	CAREX SCOPARIA	FACW	15	32
SPOTTED JEWELWEED	IMPATIENS CAPENSIS	FACW	15	32
SOFT RUSH	JUNCUS EFFUSUS	FACW+	15	32
			100	214

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

REVISIONS			
DESCRIPTION	DATE	APPROVED	
A SUBMITTED WITH RESTORATION PLAN (80%)	AUG 07		

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Ecosystem Enhancement Program

UT TO CRAB CREEK STREAM AND WETLAND RESTORATION

ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

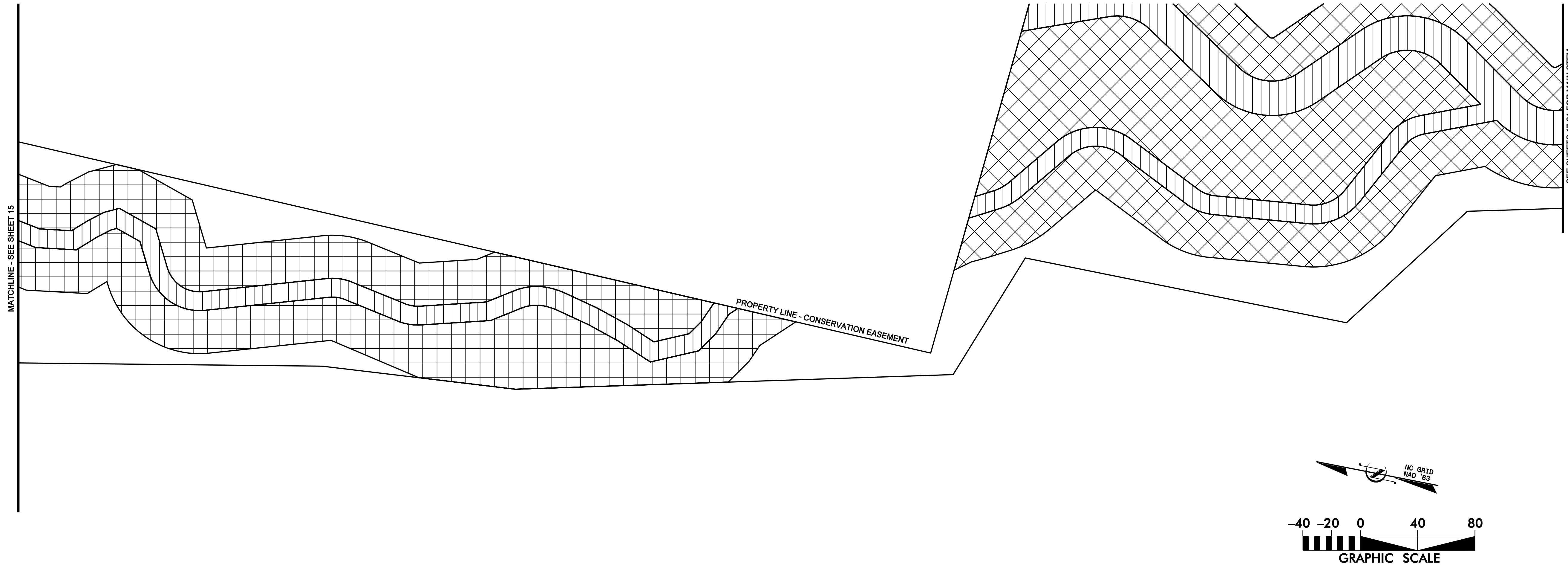
STATION 100+00 TO STATION 112+15

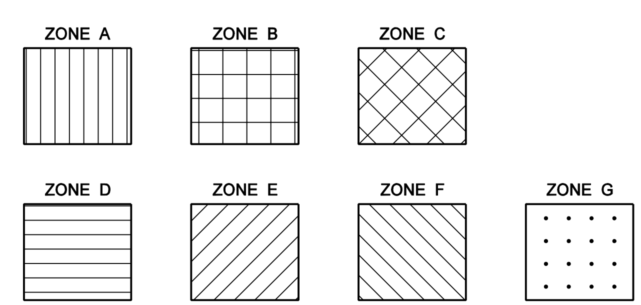
DATE: AUGUST 2007

SCALE: 1"=30'

PLANTING PLAN

SHEET 15 OF 28





(SEE SHEET 15 FOR ZONE DESCRIPTIONS)

SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07	

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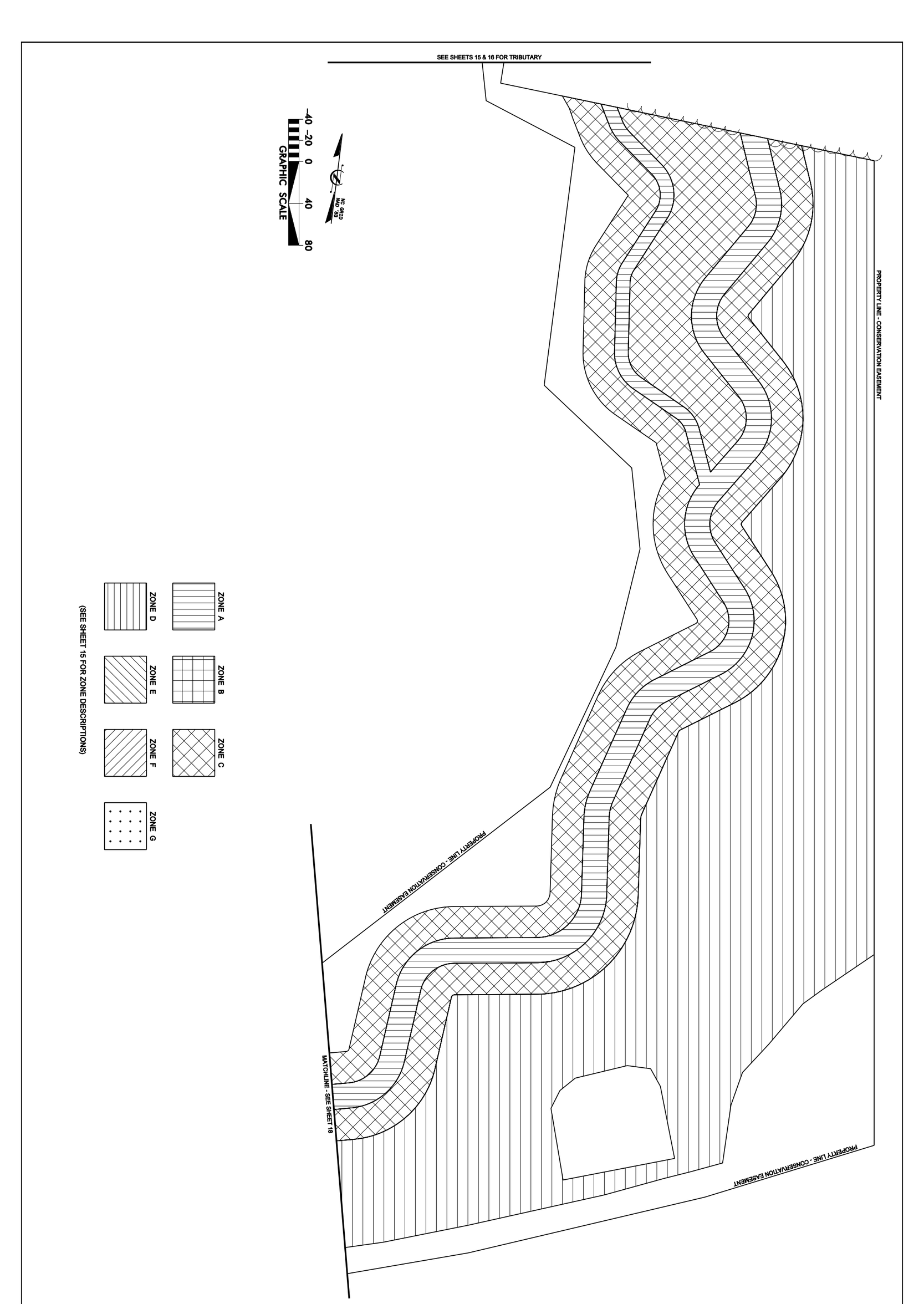
UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION
ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA
STATION 112+15 TO STATION 123+93

DATE: AUGUST 2007
SCALE: 1"=30'

PLANTING PLAN

SHEET 16 OF 28



PLANTING PLAN

SHEET 17 OF 28

DATE: AUGUST 2007

SCALE: 1"=30'

UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION

ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

STATION 10+00 TO STATION 22+13

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SYM.	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07	

REVISIONS

PROPERTY LINE - CONSERVATION EASEMENT

MATCHLINE - SEE SHEET 17

MATCHLINE - SEE SHEET 19

PROPERTY LINE - CONSERVATION EASEMENT

ZONE A

ZONE B

ZONE C

ZONE D

ZONE E

ZONE F

ZONE G

(SEE SHEET 15 FOR ZONE DESCRIPTIONS)

NO GRID AND NORTH

–40 –20 0 40 80

GRAPHIC SCALE

A	SUBMITTED WITH RESTORATION PLAN (60%)	SYM.	DESCRIPTION	DATE	APPROVED
				AUG 07	

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UT TO CRAB CREEK
STREAM AND WETLAND RESTORATION
ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA
STATION 22+13 TO STATION 34+05

DATE: AUGUST 2007
SCALE: 1"=30'

PLANTING PLAN

SHEET 18 OF 28

PROPERTY LINE - CONSERVATION EASEMENT

MATCHLINE - SEE SHEET 18

PROPERTY LINE - CONSERVATION EASEMENT

MATCHLINE - SEE SHEET 20

NC GRID NAD 83

–30 –15 0 30 60

GRAPHIC SCALE

ZONE A

ZONE B

ZONE C

ZONE D

ZONE E

ZONE F

ZONE G

(SEE SHEET 15 FOR ZONE DESCRIPTIONS)

A	SUBMITTED WITH RESTORATION PLAN (60%)	AUG 07		
SYM.	DESCRIPTION	DATE	APPROVED	

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UT TO CRAB CREEK STREAM AND WETLAND RESTORATION

ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

DATE: AUGUST 2007

SCALE: 1"=30'

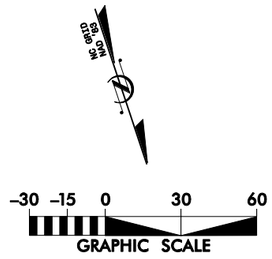
PLANTING PLAN

MATCHLINE - SEE SHEET 19

PROPERTY LINE- CONSERVATION EASEMENT

MATCHLINE - CONTINUED FROM THIS SHEET

MATCHLINE - CONTINUED ON THIS SHEET



ZONE A ZONE B ZONE C

ZONE D ZONE E ZONE F ZONE G

(SEE SHEET 15 FOR ZONE DESCRIPTIONS)

REVISIONS			
	DESCRIPTION	DATE	APPROVED
A	SUBMITTED WITH RESTORATION PLAN (80%)	AUG 07	

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UT TO CRAB CREEK STREAM AND WETLAND RESTORATION

ENNICE, ALLEGHANY COUNTY, NORTH CAROLINA

DATE: AUGUST 2007

SCALE: 1"=30'

PLANTING PLAN

SHEET 20 OF 28

Appendix A

NCNHP and SHPO Correspondence
NCHP Site Survey Report
Rare and Endangered Plant Survey

NCNHP and SHPO Correspondence

North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

January 12, 2007

April Helms
KCI Associates
Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609

Re: EEP, Crab Creek Stream and Wetland Restoration, East of Sparta, Alleghany County, ER 06-2971

Dear Ms. Helms:

Thank you for your letter of November 8, 2006, concerning the above project. We apologize for the delay in our response.

We have determined that the project as proposed will not affect any historic structures.

There are no known-recorded archaeological sites within the project boundaries. However, the project area has never been systematically surveyed to determine the location or significance of archaeological resources. Based on the topographic and hydrological situation, there is a very high probability for the presence of prehistoric or historic archaeological sites.

We recommend that a comprehensive survey be conducted by an experienced archaeologist to identify and evaluate the significance of archaeological remains that may be damaged or destroyed by the proposed project. Potential effects on unknown resources must be assessed prior to the initiation of construction activities.

Two copies of the resulting archaeological survey report, as well as one copy of the appropriate site forms, should be forwarded to us for review and comment as soon as they are available and well in advance of any construction activities.

A list of archaeological consultants who have conducted or expressed an interest in contract work in North Carolina is available at www.arch.dcr.state.nc.us/consults.htm. The archaeologists listed, or any other experienced archaeologist, may be contacted to conduct the recommended survey.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, contact Renee Gledhill-Earley, environmental review coordinator, at 919-733-4763, ext. 246. In all future communication concerning this project, please cite the above referenced tracking number.

Sincerely,

Renee Gledhill-Earley

Peter Sandbeck

NCDENR

North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor

William G. Ross Jr., Secretary

November 20, 2006

April Helms
KCI Associates of NC
Landmark Center II Suite 220
4601 Six Forks Road
Raleigh NC 27609

Subject: Natural Heritage Review Crab Creek Stream and Wetland Restoration Project, Project Number 12053743H

Dear Ms. Helms:

The Natural Heritage Program has records of rare plant and animal species and a significant natural heritage area within the project area shown on your map of 8 November 2006. The Ennice Meadow Bog Significant Natural Heritage Area is known to support the following rare species:
American Speedwell (*Veronica americana*) - NC Significantly Rare
Bog Turtle (*Gleptyms muhlenbergii*) - US Fish and Wildlife Service Threatened (S/A), NC Threatened

Additional rare species are known from the Edmonds Meadow Bog and Savannah Church Bog and Seep Significant Natural Heritage Areas, less than one mile from the project site. These species, which may also occur at the project site if suitable habitat is present, are listed below:
Alder Flycatcher (*Empidonax alnorum*) - NC Significantly Rare
Fen Sedge (*Carex sp. 2*) - US Fish and Wildlife Service Federal Species of Concern, NC Significantly Rare
Gray's Lily (*Lilium grayi*) - US Fish and Wildlife Service Federal Species of Concern, NC Threatened-Special Concern
Marsh Bellflower (*Campanula aparinoides*) - NC Significantly Rare
Northern White Beaksedge (*Rhynchospora alba*) - NC Significantly Rare

Additional records of rare species have been reported from this general area, with vague directions. These species may occur at the project site if suitable habitat is present:
Eastern Small-footed Myotis (*Myotis leibii*) - US Fish and Wildlife Service Federal Species of Concern, NC Special Concern
Savanna Sparrow (*Passerculus sandwichensis*) - NC Significantly Rare

Because of the high potential for rare species and high quality natural areas to occur within your project site, a careful survey should be conducted during the growing season prior to project work. If rare species are located, extreme care should be used to avoid impacting the rare species as part of the restoration project. The use of Natural Heritage Program data should not be substituted for actual field surveys.

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-715-8700 \ FAX: 919-715-3085 \ Internet www.ncnhp.org

You may wish to check the Natural Heritage Program database website at www.ncnhp.org for a listing of rare plants and animals and significant natural communities in the county and on the topographic quad map.

Please do not hesitate to contact me at 919-715-8700 if you have questions or need further information.

Sincerely,

Misty Franklin

Misty Franklin, Botanist
NC Natural Heritage Program

One NorthCarolina *Naturally*

Significant Natural Heritage Area Report

03 August 2007

Name Ennice Meadow Bog

IDENTIFIERS

Site ID 545

Site Alias ENNICE MEADOW BOG/MARSH; THIS SITE HAD ONCE BEEN CALLED EDMONDS MEADOW BOG

Macro Site Name

Mega Site Name

Site Relations Edmonds Meadow Bog is approximately 1 mile to the east in the same watershed.

Owner Abbr.	Owner	Owner Comments
PRV	PRIVATE	

LOCATORS

County Alleghany (NC)

Latitude 363309N **Longitude** 0805822W

Quad Cumberland Knob **Watershed** Upper New

Directions North and south of NC 18; opposite its junction with SR 1508; 2 miles west of Edmonds; about 1.5 miles east of Ennice; and 0.8 mile south of the Virginia border.

SITE DESCRIPTION

Minimum Elevation: 2,850.00 **Feet** 869.00 **Meters** **Survey** R

Maximum Elevation: 2,860.00 **Feet** 872.00 **Meters**

Site Description A small marshy bog on a stream floodplain terrace. The bog is a mosaic of rush-dominated marsh and thickets of alder, with some red maple and willow along the creek. The community is degraded by clearing, grazing, and flood-deposited sediment. Rare species at the site include: Veronica americana, Sanguisorba canadensis, and Clemmys muhlenbergii.

Key Enviro Factors Soil saturation, flooding, sediment deposition

Climate Description

Land Use History

Cultural Features

Additional Topics W# BOG

SITE DESIGN

Site Mapped Y - Yes **Mapped Date**

Designer Alan Smith

Boundary Justification Boundary is limit of saturated soil

Primary and Secondary Area 33.10 **Acres** **Primary Area** 33.10 **Acres**

Site Comments

Last Visit 1989-07-31

SITE SIGNIFICANCE

Site Significance C

Site Significance Comments Small cluster of rare species and poor quality Southern Appalachian Bog (Northern Subtype).

Biodivsig rating B3 - High

Biodivsig Comments D-ranked Southern Appalachian Bog (Northern Subtype) (G1T1)

Other Values

Other Values Comments

Significant Natural Heritage Area Report

03 August 2007

Name Ennice Meadow Bog

Protection Urgency P3 - Definable threat/opportunity but not within 5 years

Protection Urgency Comments

Management Urgency M3 - Needed within 5 years to maintain quality

Management Urgency Comments

REAL ESTATE/PROTECTION

Conservation Intentions Registry

Number of Tracts

Designation

Protection Comments No protection status

MANAGEMENT

Land Use Comments The area has been heavily grazed.

Natural Hazard Comments

Exotics Comments

Offsite The surrounding area is old pasture and young forest.

Information Needs

Management Needs

Managed Area Relations

ELEMENT OCCURRENCES

Scientific Name	Common Name	G Rank	S Rank	EO Rank	EO ID
Glyptemys muhlenbergii	Bog Turtle	G3	S2	D	14799
Veronica americana	American Speedwell	G5	S2	B?	15671
Southern appalachian bog (northern subtype)		G1G2T1T2	S1S2	D	8685

REFERENCES

Reference Code	Full Citation
U93SMI02NCUS	Smith, A.B. 1993. A Survey of Mountain Wetland Communities. Report to NC Natural Heritage Program, Division of Parks and Recreation, Raleigh, NC.

VERSION

Version Date 1993-03-18

Version Author Smith

NCHP Site Survey Report

SITE SURVEY REPORT
-- N.C. Natural Heritage Program
P.O. Box 27687 / Raleigh NC 27611

Date: 7/21/89 7/30/89
Quad Name: Cumberland Knob
County: Alleghany

Name of Site: Ennice Meadow Bog ~~Forest~~
Surveyors: Alan Smith
Location & Directions: North of NC 18, two miles west of Edmonds across from intersection of SR 1508 and NC 18. Bog lies along both sides of stream

Size: 2 acres Province: Blue Ridge Watershed: Crab Crk → Little R → New R.
Owners and address: Not known

Owner contacted & attitude: not contacted

General Landscape Description:

the site occupies depressions adjacent to the sizeable creek. these are not in the immediate floodplain, but behind natural stream terraces. the appearance is generally of a marsh, rather than a bog, with evidence of flooding shrubs and small trees occupy the wetter areas near creek. Surrounding areas have

Physical Description: mostly been and are presently, cleared land.

Aspect:	Slope:	Topog. Position:	Hydrology:	Moisture:
___ N	✓ flat	___ crest	___ terrestrial	___ inundated
___ E	___ 0-5	___ upper slope	___ palustrine	___ freq. flooded
___ S	___ 5-10	___ mid slope	___ estuarine	✓ saturated
___ W	___ 10-35	___ lower slope	___ riverine	___ seasonally wet
✓ flat	___ 35 +	___ upland flat	___ lacustrine	___ moist (mesic)
___ all	___ vertical	✓ alluvial flat	✓ subterranean	___ dry (xeric)

Elevation: 2500'
Geology: no outcrops in site. general area underlain by • mica-gneiss of Ashe metamorphic suite
Soils (series if known, correlated with Natural Communities, p.2, if possible):
dark, muck soil. Mapped only as Alluvial land, wet.

Comments on Physical Description:

Biological Description:

Natural Communities. List communities and for each describe:
A) vegetation structure,
B) dominants & important spp. by strata,
C) position in landscape & relation to other communities,
D) quality & condition,
E) size

SOUTHERN APPALACHIAN BOG - (MEADOW BOG, MARSH-BOG COMPLEX)

A) Zones of shrubs & small trees, generally closer to stream, alternating with a zone of marshy cover, mostly of rushes, with only a few small shrubs within. On drier areas, also with thickets of invasive shrubs. Relatively low diversity layers.

B) Alnus serrulata (Acer rubrum, Salix nigra) / Cyperus strigosus, Juncus effusus, Scirpus expansus Carex scoparia, C. atlantica

C) occupies most of floodplain depressions along the creek, brushy pasture and cleared ~~as~~ residential and pasture land border the site. Substantial natural communities no longer nearby

D) a fairly low quality site, with evidence of long term clearing and grazing. Also quite likely altered by flooding, apparently has been severe in recent past, evidenced by large silt/mud deposits. presence of some rare species attest to fairly good stability of the site, at least in part.

E) 2 acres

Special Status Species present (attach forms):

Epilobium leptophyllum ~~-SR~~ (Watch List)

Veronica americana - SR

Potential for other Special Status Species:

low except for Bog Thistle

Other noteworthy species or features present:

none noted

Site Integrity: ___high ___good ✓fair ___poor

Average DBH of canopy trees: NA

Maximum DBH of canopy trees: NA

Fire regime (natural, suppression, date of most recent, etc.):

no fire in evidence

___logged (when, describe):

___even-aged canopy (successional stand from pasture or clearcut)

✓non-native or weedy spp. present (list and describe):

multiflora rose, Blackberry

___ditched/drained (describe):

___stream channelized

___dredging/filling

___understory cleared

✓grazing some evidence, little current effect.

___ORV damage (describe):

___other (describe):

Adjacent land use (describe): agricultural, residential

Significance of site: (high quality and/or rare communities, rare spp., etc.):

Discussion:

___national
___state
✓regional
✓county

Significance is due to presence of rare plant species and probable occurrence of a Box Turtle population. The site is also important in understanding relationships in bog, marsh ~~and~~ wetland community types. This one represents more of a disturbed marsh condition than other similar meadow sites, perhaps due to more frequent flooding or other unknown factors.

Protection Considerations and Management Needs: (discuss recommended protection for natural area, and management needed to maintain or improve quality of site, such as fire, ORV exclusion, fencing, blocking drainage, etc.)

The site should be protected for the rare species which occur here. This would be a good site for manipulation or study of wetland successional dynamics.

Documentation

Survey boundaries (describe why your survey stopped where it did):-

edge of wetland community is extent of survey, no interesting surrounding communities

Priority for further survey (why, for what, at what season):

low except for Box Turtles, especially in spring.

Specimens collected (plants, animals, soil, rock - of what and state repository):

Photographs (of what):

Others knowledgeable about site: Dennis Herman

✓TOPO MAP ATTACHED

___Sketch of site or part of site attached (as needed or appropriate, to show access, rare spp., relative positions of communities, etc., particularly if cannot be well-portrayed on attached topo map).

Ennis AL 9

PLANT SPECIES LIST

This list is: nearly complete ___ medium ✓ casual ___

TREES

- ✓ Acer rubrum
- Amelanchier arborea
- Betula lenta
- Carpinus caroliniana
- Liriodendron tulipifera
- Magnolia fraseri
- Nyssa sylvatica
- Pinus rigida
- P. strobus
- ✓ Platanus occidentalis
- ✓ Salix nigra
- Tsuga canadensis

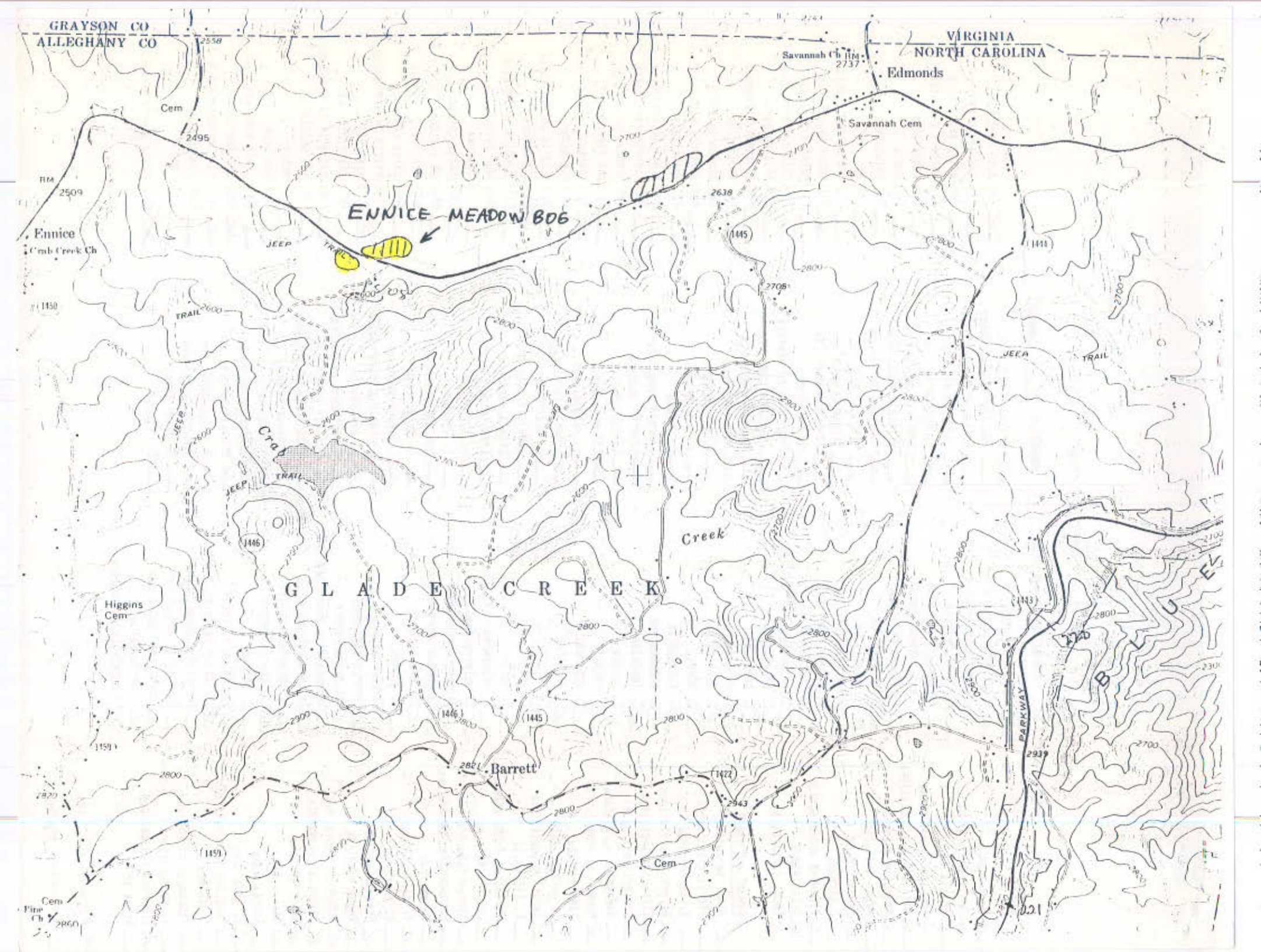
SHRUBS and VINES

- ✓ Alnus serrulata
- Aronia arbutifolia
- A. melanocarpa
- Calycanthus floridus
- Clematis virginiana
- Clethra acuminata
- Hamamelis virginiana
- ✓ Hypericum densiflorum
- Ilex montana
- I. verticillata
- Kalmia angustifolia
- K. latifolia
- Leucothoe fontanesiana
- Lindera benzoin
- Lyonia ligustrina
- Rhododendron catawbiense
- R. maximum
- R. calendulaceum
- R. viscosum
- ✓ Rosa palustris
- ✓ Rubus hispidus
- ✓ Rubus sp. canadensis?
- ✓ Sambucus canadensis
- ✓ Salix sericea
- ✓ Smilax spp.
- Spirea alba
- ✓ S. tomentosa
- Toxicodendron radicans
- T. vernix
- Vaccinium corymbosum
- V. macrocarpon
- ✓ Viburnum cassinoides
- Vitus sp

✓ Rosa multiflora
✓ Lonicera japonica

Herbs:

- Aletris farinosa
- ✓ Andropogon scoparium
- Anemone quinquefolia
- Arethusa bulbosa
- Arisaema triphyllum ssp. stewardsonii
- Asclepias incarnata
- ✓ Aster puniceus
- ✓ A. umbellatus
- Bertonia virginica
- Calopogon tuberosus
- Caltha palustris
- ✓ Carex ~~bullata~~ atlantica
- C. bromoides
- C. buxbaumii
- # C. crinita
- ✓ C. folliculata
- C. howei
- C. incomperta
- ✓ C. intumescens
- ✓ C. leptalea
- ✓ C. lurida
- C. ruthii
- C. scabrata
- ✓ C. scoparia
- C. stricta
- C. swanii
- C. torta
- C. trisperma
- ✓ C. vulpinoidea
- Calopogon tuberosus
- Campanula aparinoides
- Chelone cuthertii
- C. glabra
- Circaea alpina
- ✓ Cyperus strigosus
- Dalibarda repens
- Dennstaedtia punctilobula
- Drosera rotundifolia
- Dryopteris cristata
- ✓ Eleocharis tenuis
- E. obtusa
- Epilobium ciliatum
- ✓ Epilobium leptophyllum
- Eriocaulon decangulare
- Eriophorum virginicum
- Eupatorium fistulosum
- ✓ E. perfoliatum
- ✓ Fimbristylis autumnalis
- Galium tinctorium
- Gaultheria procumbens
- Gentiana quinquefolia
- Glyceria striata
- ✓ G. melicaria
- Goodyera pubescens
- Graticla viscidula
- ✓ Helenium autumnale
- Helonias bullata
- ✓ Holcus lanatus
- Houstonia caerulea
- H. purpurea
- ✓ Hypericum canadensis
- ✓ Impatiens capensis
- Isoetes engelmanni
- ✓ Juncus effusus
- J. gymnocarpus
- J. subcaudatus
- J. tenuis
- Leersia virginica
- Liatris spicata
- Lilium grayi
- ✓ Linum striatum
- L. virginianum
- ✓ Lobelia cardinalis
- L. puberula
- Ludwigia palustris
- Luzula echinata
- Lycopodium clavatum
- L. lucidulum
- L. obscurum
- ✓ Lycopus americanus
- L. virginicus
- Lygodium palmatum
- ✓ Lysimachia quadrifolia
- ✓ L. terrestris
- Maianthemum canadense
- Medeola virginiana
- Melanthium virginianum
- ✓ Mimulus ringens
- ✓ Mollugo verticillata
- Oenothera perennis
- ✓ Onoclea sensibilis
- Orontium aquaticum
- ✓ Osmunda cinnamomea
- O. claytoniana
- O. regalis
- ✓ Oxypolis ridigior
- Panicum dichotomum
- Parnassia asarifolia
- Platanthera clavellata
- P. grandiflora
- P. lacera
- Poa paludigena
- Poa sp.
- Pogonia ophioglossoides
- ✓ Polygonum sagittatum
- Polygonatum biflorum
- Potentilla simplex
- Prunella vulgaris
- Pycnanthemum flexuosum
- P. tenuifolium
- Ranunculus bulbosus
- Rhynchospora alba
- R. capitellata
- Rudbeckia laciniata
- Sanguisorba canadensis
- Sarracenia purpurea
- ✓ Scirpus cyperinus
- ✓ S. expansus
- Scleria minor
- Scutellaria integrifolia
- ✓ Senecio aureus
- ✓ Sisyrinchium mucronatum
- ✓ Solidago patula
- S. uliginosa
- Spiranthes cernua
- Stachys latidens
- S. nuttallii
- Thalictrum clavatum
- ✓ Thelypteris novaboracensis
- ✓ T. palustris
- Tofieldia glutinosa
- Trautvetteria caroliniana
- Trillium undulatum
- T. erectum
- T. surculosus
- Utriculata subulata
- ✓ Veronica americana
- ✓ Vernonia novaboracensis
- Viola cucullata
- Xyris torta
- ✓ Scirpus pursh[illegible]


GRAYSON CO
ALLEGHANY CO
VIRGINIA
NORTH CAROLINA
Savannah Ch
Edmonds
Savannah Cem
Cem
2495
RM
2509
ENNICE MEADOW BOG
Ennice
Crab Creek Ch
JEEP
TRAIL
2638
1445
1448
2705
1450
2600
2800
2700
JEEP
TRAIL
Crab
JEEP
TRAIL
1446
Creek
G L A D E C R E E K
Higgins
Cem
1443
BLUE
RIDGE
PARKWAY
1446
1445
1459
2821
Barrett
1472
2943
2939
1459
Cem
Pine
Ch
2860
021

Rare and Endangered Plant Survey

Rare and Endangered Plant Survey – UT to Crab Creek Restoration Site

Site Description

Location:	Directly north of NC 18 approximately 2 miles west of Edmonds, NC in NE Alleghany County (36.5528 degrees N, 80.9732 degrees W)
Community Type:	Southern Appalachian Bog (Northern Subtype)
Size:	Approximately 2.1 acres
Team:	K. Knight-Meng and C. Van Der Wiele, KCI Associates of NC
Date:	September 24, 2007
Temperature:	Warm - ~80 degrees F – sunny but hazy
Precipitation:	The site has been experiencing severe drought conditions since August 14, 2007. Last significant rainfall: 1.51 inches recorded on September 15, 2007 at Sparta 2 SE (318158) Weather Station
Growing Season:	May 2 - October 6

Survey Methods and Results

A site walk of the site was conducted using random GPS points created in GIS to ensure coverage of the area in question. The drier portions of the site, which were generally found in the northeastern third of the bog, were dominated by large thickets of goldenrod (*Solidago patula*) and purple-stemmed aster (*Symphyotrichum puniceum*) interspersed with swamp rose (*Rosa palustris*) and arrowleaf tearthumb (*Polygonum sagittatum*). A dispersed stream/seep system was still flowing despite the drought conditions and was bringing more water to the southwestern portion of the site. This area had standing water within six inches and consisted of a sedge community with many individuals of jewelweed (*Impatiens capensis*) and arrowleaf tearthumb.

The site was searched for the following rare and threatened species. None of these species were found during the site search.

Marsh bellflower (*Campanula aparinoides*)
Fen sedge (*Carex sp. 2*) (No identifying characteristics found for this species) Federal Species of Concern and NC Significantly Rare
Bog turtle (*Clemmys muhlenbergii*) Federally Threatened (S/A), NC Threatened
Alder flycatcher (*Empidonax alnorum*) NC Significantly Rare
Gray's lily (*Lilium grayi*) Federal Species of Concern, NC Significantly Rare
Eastern small-footed myotis (*Myotis leibii*) Federal Species of Concern, NC Threatened-Special Concern
Savannah sparrow (*Passerculus sandwichensis*) NC Significantly Rare
Northern white beaksedge (*Rhynchospora alba*) NC Significantly Rare
American Speedwell (*Veronica americana*) NC Significantly Rare

While looking for rare and threatened species listed above, the following plant species were noted at the site:

<u>Herbaceous Layer</u>
Agrimony (*Agrimonia parviflora*)
Jack-in-the-pulpit *(Arisaema triphyllum)*
Shallow sedge (*Carex lurida*)
Sedge species (*Carex spp*.)
White turtlehead (*Chelone glabra*)
Dayflower (*Commelina spp.)*
Linear-leaf willowherb, bog willowherb (*Epilobium leptophyllum*)
Swamp sunflower (*Helianthus angustifolius*)

Jewelweed / touch-me-not (*Impatiens capensis*)
Soft rush (*Juncus effusus*)
Wild mint (*Mentha arvensis*)
Monkey flower (*Mimulus ringens*)
Sensitive fern (*Onoclea sensibilis*)
Arrowleaf tearthumb (*Polygonum sagittatum*)
Cutleaf coneflower (*Rudbeckia laciniata*)
Bristle grass (*Setaria sp.)*
Rough-leaved goldenrod (*Solidago patula*)
Purple-stemmed aster (*Symphyotrichum puniceum [Aster puniceus])*
Skunk cabbage (*Symplocarpus foetidus*)
New York ironweed (*Vernonia noveboracensis*)

<u>Shrub and Vine Layer</u>
Red maple (*Acer rubrum*)
Tag alder (*Alnus serrulata*)
Virginia clematis (*Clematis virginia*)
Swamp rose (*Rosa palustris*)
Blackberry *(Rubus spp.)*
Silky willow (*Salix sericea*)

Appendix B

NCDWQ Stream Restoration Monitoring Plan

North Carolina Division of Water Quality
Surface Water Protection Section
Watershed Assessment Team (WAT)
July, 2007

Stream Restoration Monitoring Plan
Unnamed Tributary to Crab Creek (UTCC)

New River Basin
Subbasin 05-07-03

This document is a monitoring plan for a stream restoration project in a UTCC in Alleghany County. A conservation easement agreement was recently finalized between the landowner and the Ecosystem Enhancement Program (EEP) for approximately 6000 feet of stream length and associated riparian buffers. The conservation easement was the result of ongoing local watershed planning (LWP) by EEP within the larger Little River watershed. Several components of stream and wetland restoration are planned including wetland and stream buffer creation/enhancement and bog turtle habitat enhancement/preservation. Construction is scheduled to begin during the latter part of 2008.

The purpose of this plan is to provide details relative to baseline (pre restoration) and subsequent (post restoration) monitoring and data analyses. The objective of monitoring here is to provide evidence of a change or improvement in water quality, hydrology and habitat functions as a result of the restoration project. There is broad consensus that measuring success of restoration projects is essential, but methods to systematically and appropriately determine success remain elusive (Ryder et al., 2005) as well as which ecosystem-level processes can serve as good indicators of functional integrity (Gessner and Chauvet, 2002). Methods to measure watershed functions (or in this case, improved function or success due to a stream restoration project) using surrogate indicators were recommended by the Watershed Needs Assessment Team (WNAT, 2003). Penrose (2003) recommended the use of aquatic insect assemblages as evidence of improved ecological function as a measure of restoration success.

Monitoring Goals

1. Identify water quality problems that may exist relative to fungicide use on pumpkins. A fungicide and its residues may be entering the stream in storm water runoff affecting aquatic life. Benthic macroinvertebrates and storm water chemistry may provide evidence of toxic inputs. Details for monitoring are provided below.

2. Provide evidence of change in water quality, habitat and hydrologic function as a result of the restoration project in various indicators outlined below (compared to existing conditions).
   - Improved water quality functions may be evidenced by an increase in nutrient retention (i.e., total dissolved nitrogen), thermal regulation; TSS load reduction (in storm conditions) and, changes in benthic macroinvertebrate biotic indices that reflect improvements in water quality, or an increase or decrease of certain water quality indicator species;

- Improved habitat function may be evidenced by a favorable change in benthic assemblages as reflected by improved habitat conditions (e.g. certain keystone species or habitat specialists (Penrose, 2003); improvement of overall habitat and microhabitat heterogeneity (e.g., less riffle embeddedness, increased pool variety); and,
- Hydrologic function improvements may be evidenced by improved streambank stability (e.g., lower bank erosion hazard index (BEHI) and an increase in certain benthic species. The type of restoration design will dictate other post monitoring activities that may be conducted.

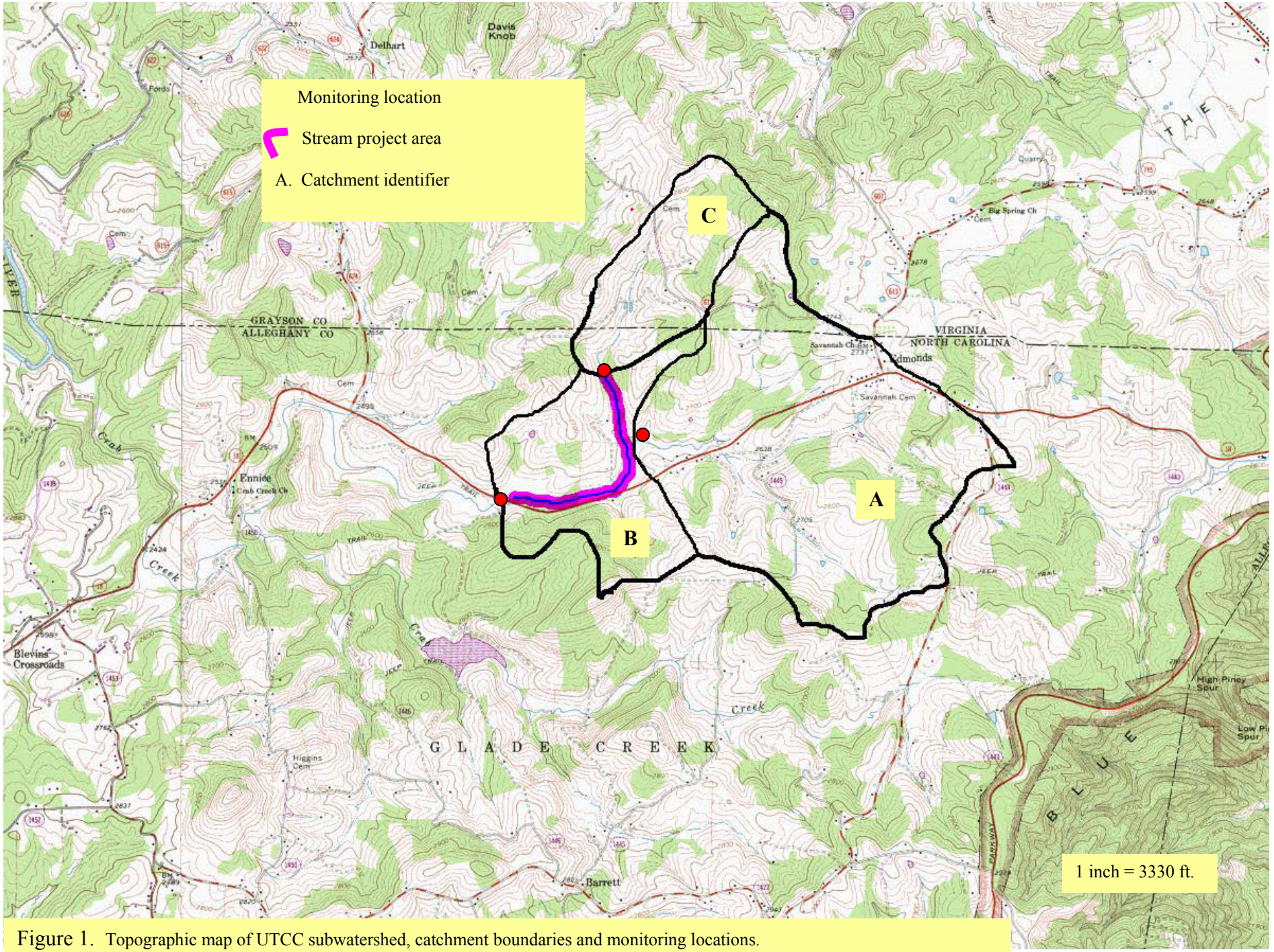


Figure 1. Topographic map of UTCC subwatershed, catchment boundaries and monitoring locations.

Monitoring Approach and Methods

General

According to the Environmental Resources Technical Report (ERTR) provided by KCI Associates of NC (KCI), several problems associated with the channel and riparian areas were identified including agricultural runoff, ditching, channelization, bed and bank instability, incision, and overwidened stream segments. They concluded there were functional losses related to habitat, water quality and hydrology. The goals of the restoration plan proposed by EEP are to restore terrestrial and aquatic diversity and improve water quality.

It is generally thought that wetlands (Jones et al., 1976; USEPA 1992) and riparian areas (USEPA, 2005; Wenger, 1999; Hill, 1996) provide a variety of water quality functions that maintain good water quality. Wetland soils and riparian area vegetation combine physical processes of filtering and biological processes of nutrient uptake and denitrification to transform, retain and remove sediment and chemical pollutants. Riparian vegetation and wetland areas can intercept surface runoff, subsurface flow and groundwater preventing pollutant discharges to surface waters (USEPA, 2005a). Riparian forests provide shading to moderate thermal pollution; improve aquatic habitat by providing cover; increase stream bank stability; supply large organic debris to increase channel heterogeneity and provide substrates for microflora to flourish increasing biological nutrient processing. In addition, small streams such as the UTCC are known to retain and transform important amounts of nutrients (Peterson et al., 2001; Sweeney et al., 2004) and provide other beneficial ecosystem services (Meyer et al., 2003).

Based on the brief literature review above, there is little doubt that a project such as the one proposed by KCI for the UTCC could not result in benefits to water quality and improved functions or ecological processes. Providing evidence of improvement would support an argument that restoration projects are worth the effort and could help to improve the nature of future restoration efforts within this type of landscape and the broader ecoregion.

Measuring water quality improvements due to a change in land management or installation of BMPs within a watershed presents a variety of challenges due to the time and resources necessary to factor out natural and other variability (climate, season, sampling and lab error, upstream land use changes) and to account for those improvements that may take several years to reveal themselves (NCSU, 1995). This is most likely true regarding assessment and measurement of improved ecologic function related to a stream restoration projects. Penrose et al., (2003) developed a monitoring strategy to assess ecosystem functions of restored streams and to define success criteria in North Carolina using benthic macroinvertebrate assemblages. He found that some taxa recolonized certain restored habitats relatively soon after construction (two years). It was unclear as of this writing whether additional important taxa would recolonize other specific restored habitats. A method to assess ecological condition of streams using shifts in functional feeding group ratios (FFG) was presented by Hauer and Lamberti (2007). Applying of a version of this method may help to detect improvements associated with stream restoration.

There are techniques to measure key in-stream ecological processes or functions directly, of which some version of may have practical applications within a restoration or watershed assessment setting. Sweeney et al. (2004) conducted a study in 16 streams in Piedmont

watersheds in Pennsylvania and Maryland to show that riparian deforestation reduces stream habitat and compromises in-stream processing of pollutants. They measured in-stream nutrient processing, respiration rates, pesticide degradation and other processes to support their hypothesis. Litter breakdown rates as Gessner and Chauvet suggested (2002) would be a good candidate for assessing functional integrity because of its central role in stream ecosystem functioning and relative ease of implementation. Currently however, resource limitations and other reasons preclude direct measurements of processes in the context of watershed assessments at this time. The monitoring we undertake for this project may help to develop better assessment methods and techniques for evaluating in-stream processes relative to stream restoration projects and watershed assessments in the future.

Approach

The UT to Crab Creek is a small catchment draining an area of 2.7 square miles (Table 1). The restoration project is within a smaller catchment (Figure 1, catchment B) draining 0.6 square miles that is "nested" in the larger catchment. A complicating factor is the relatively large headwater drainage areas upstream of the project (Figure 1, catchments A and C) that when combined contribute 75% of total drainage area. Water quality from these two catchments will obscure downstream water quality. Monitoring locations are located in close proximity to the restoration project minimizing downstream input interference. Initial data evaluations will portend potential problems related to monitoring sensitivity. Loads would be calculated for each pollutant or parameter on a sub-catchment basis using flow data and pollutant concentration. Loads from upstream catchments will be subtracted from the total catchment load to obtain the load from the "nested catchment". Load data would then be normalized by upstream catchment drainage area and stream length. A similar approach was used by NCDWQ (2007) as a method to rank catchments in a synoptic nutrient survey conducted for the Little River LWP in 2006. Schilling and Spooner (2006) used this technique (among others) as a method to study the effects of land use change on subwatershed nitrate loads.

A paired watershed design will be used for chemical/physical data analyses (NCSU, 1995). In terms of data analysis the pre-construction baseline data collection period is referred to as the calibration period and is meant to discern a predictable interrelationship between data from the upstream (control) catchments and the downstream (treatment) catchment. Once the treatment (restoration project) is in place, subsequent data and analyses will attempt to understand the new interrelationship between the upstream (control) catchments and the downstream (treatment) catchment (NRCS, 2003). Non-parametric test(s) could be used to determine differences between parameter loads as explained above.

Functional indicator data could also be analyzed using correlation and recursive partitioning analyses to elucidate interrelationships between benthic assemblages, habitat, microhabitat and water quality data. These analyses could help develop other methods for measuring certain ecosystem functions.

A nearby "reference" subwatershed will not be needed for this monitoring design. The two upstream catchments will serve as control catchments in a paired watershed design where no restoration work will occur. We generally know water quality conditions in this planning area. There are recent data available (benthic and water quality) collected in 2006 from several

catchments in the planning area that will be used for comparison purposes to provide insights on overall watershed functions as they currently exist in the UTCC. Several of these streams could be revisited to conduct a more in depth assessment related to indicators of water quality, habitat and hydrologic functions for this purpose if resources allow. Obviously, the stream restoration project design, however, needs to be based on nearby reference conditions.

Monitoring Methods and Locations

Proposed monitoring locations and catchment descriptions are summarized in Table 1. Figure 1 provides a topographic view of the subwatershed and catchment delineations. The Division of Water Quality Watershed Assessment Team (WAT) would conduct the monitoring in collaboration with EEP staff (monitoring and others), consultants and local stakeholders.

Table 1. UT to Crab Creek (UTCC) monitoring locations and catchment descriptions.

Catchment	Drainage Area (Square miles)	Monitoring Location	
		Latitude	Longitude
A	1.66	36.55560	-80.96381
B	0.62	36.55218	-80.97362
C	0.44	36.56052	-80.96592
Total	2.72		

Chemical and Physical Analyses

Field parameters (dissolved oxygen, specific conductance, pH, and temperature) nutrients (total phosphorus, ammonia, TKN and nitrite-nitrate), residue (suspended, fixed and volatile), sulfate, chloride, calcium, magnesium and potassium will be collected at each location in baseflow conditions. The chemistry parameters listed above are indicators of important ecosystem functions that may provide evidence of elemental cycling and retention that occurs in baseflow conditions. They will also provide evidence of existing water quality conditions related to past and present landuse that may change as a result of the restoration project. Table 2 provides a list of parameters and analytical methods.

Water temperature will be monitored hourly during the months of April through November at each location (in all conditions) using data loggers.

Nutrients and residue only will be collected during storm events. The degree of elemental cycling occurring during storm events is of lesser concern than the amount of sediment and nutrients leaving the catchments (i.e., retained on site). However, following fungicide applications in the fall, samples for mancozeb will also be conducted at each location.

Water temperature, dissolved oxygen, pH and specific conductance will be measured in-situ with handheld field instrumentation (YSI Model 85 and Accumet AP61) during each monitoring event. Samples for other parameters will be submitted to the DWQ Laboratory Section for

analysis with one exception as noted below. Chemical and physical monitoring will be conducted according to the procedures described in NCDWQ's Standard Operation Procedure

Sample analyses will be performed by NCDWQ's Laboratory except for fungicide analysis (mancozeb), which will be conducted by North Carolina Department of Agriculture (at no cost). DWQ's lab has not developed a lab procedure to test for mancozeb. Results are usually available from the laboratory approximately one month following sample collection. Results will be evaluated upon receipt from the laboratory and made available to interested parties soon thereafter.

Velocity measurements will be conducted using a hand held portable flowmeter (FLO-MATE Model 2000) as part of each baseflow-monitoring event. Stream velocity times cross sectional area will provide flow measurements to use in pollutant load calculations for comparisons normalized by catchment area and stream length. Measurements of velocity during storm events will be conducted if personal safety permits. Otherwise, storm flows can be estimated from the flood frequency curves developed by W.K. Dickson during the Phase I assessment activities for the Little River LWP in 2004 or by other methods. Staff gauges may be deployed at each location to assist with stormflow estimates. Flow data estimates collected by KCI may also be used for these purposes. On site rainfall amounts are currently monitored by KCI.

Frequency of sampling and conditions.

Each location will be sampled during baseflow conditions, which is defined as a period of time required for storm impacts to subside (i.e. turbidity); based on past experience, it requires 24 - 48 hours after the rainfall event depending on intensity of the storm. Professional judgment will be exercised here to make this call. Baseflow grab samples will be collected twice per month.

Storm samples will be collected at each location for every storm event that occurs, if possible. Logistical constraints and variability of many storm events make it difficult to collect storm samples. The goal of storm sampling is to collect samples during the rising stage of the storm hydrograph. The intent is to estimate nutrient and sediment concentrations (and loads) for each catchment during storm events that occur throughout the monitoring period. Storm samples will be collected manually (one grab sample) if present during the storm event. Automatic battery powered sampling equipment will be deployed to assist with storms that occur during off duty periods. Samplers will be programmed to begin sampling after a stream rise of 6 inches collecting four grab samples in 15-minute increments for a time weighted composite sample of nine liters. Upon retrieval, individual samples will be poured from the well-mixed nine-liter composite sample, preserved and shipped to the lab for analysis.

Biological Surveys

Biological assessment involves the collection and identification of benthic macroinvertebrates to determine and evaluate community structure and diversity that result from water quality and habitat conditions. Benthic community composition with respect to species richness, abundance and pollution intolerance integrates upstream water quality and in-stream habitat conditions. Benthic surveys will be conducted at the three locations described in Table 1 pre/post restoration.

Biological monitoring (benthic communities and habitat) will be conducted according to procedures described in the Biological Assessment Unit's (BAU) SOP (NCDWQ 2003). Details of the protocol can be reviewed at http://www.esb.enr.state.nc.us/BAU.htm].

Stream Channel Assessments

Monitoring to establish baseline information related to indicators of hydrologic and habitat functions may be conducted if EEP or its consultants are not planning to provide it. These may include channel cross sections, qualitative and quantitative methods to analyze riffle and pool substrates (pebble size), stream bank stability via bank erosion hazard index (BEHI), in-stream habitats and riffle embeddedness within segments of each catchment.

Toxicity Bioassays

Water column and sediment toxicity testing may or may not be conducted. A fungicide (mancozeb) is applied in catchment B in the fall for pumpkin production. It has low mobility and due to its high adsorption capacity will tend to adsorb to sediment. It has a moderate to high acute toxicity range for fish (Orme, 2006). Ethylenethiourea (ETU), mancozebs metabolite, is not acutely toxic but is a concern in that is persists in the environment for 5 – 10 weeks and is water-soluble. It is currently unknown whether existing land use practices will continue into the foreseeable future. The decision to conduct toxicity testing will be finalized after the benthic macroinvertebrate assessments are conducted.

Table 2. NCDWQ Laboratory Section – Water Methods and Practical Quantitation Limits (PQL).

Parameter	EPA Method[1]	APHA Method[2]	Other Method	PQL	Revision Date
Susp. residue	160.2	2540D		2 mg/L	3/13/01
Susp. volatile residue	160.4			2 mg/L	3/13/01
Susp. fixed residue	160.4			2 mg/L	3/13/01
NH_3 as N	350.1 and 350.2		QUIK CHEM 10-107-06-1-J	0.01 mg/L	7/24/01
TKN as N	350.1 and 351.2		QUIK CHEM 10-107-06-2-H	0.20 mg/L	7/24/01
NO_2+ NO_3 as N	353.2		QUIK CHEM 10-107-04-1-C	0.01 mg/L	7/24/01
P total as P	365.1		QUIK CHEM 10-115-01-1-EF	0.02 mg/L	7/24/01
Sulfate	375.4			5 mg/L	3/13/01
Chloride	325.3			5 mg/L	2/20/03
Potassium	200.7			0.10 mg/L	7/24/01
Calcium (Ca)	200.7			0.10 mg/L	3/13/01
Magnesium (Mg)	200.7			0.10 mg/L	3/13/01

1. Information on EPA methods available at http://h2o.ehnr.state.nc.us./lab/qa/epamethods/epamethods.htm
2. APHA reference: Standard Methods for the Examination of Water and Wastewater, 18th edition.

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Appendix C

Categorical Exclusion Checklist

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Submitted: May 29, 2007

Part 1: General Project Information	
Project Name:	UT to Crab Creek Stream/Wetland Restoration Project
County Name:	Alleghany County
EEP Number:	N/A
Project Sponsor:	KCI Technologies, Inc
Project Contact Name:	April Davis
Project Contact Address:	4601 Six Forks Rd., Suite 220, Raleigh, NC 27609
Project Contact E-mail:	adavis@kci.com
EEP Project Manager:	Harry Tsomides

Project Description

Restoration of approximately 3,197 linear feet and enhancement of 2,853 linear feet of an Unnamed Tributary to Crab Creek (UTCC) and its tributary (UT1). In addition, there are approximately 16.7 acres of wetland preservation opportunities, 12.4 acres of upland buffer, 11.5 acres of wetland bog restoration, and 3.3 acres of bog preservation.

For Official Use Only

Reviewed By:

Date	**EEP Project Manager**

Conditional Approved By:

Date	**For Division Administrator FHWA**

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

Final Approval By:

Date	**For Division Administrator FHWA**

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

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☒ Yes ☐ No
2. Is the site of religious importance to American Indians? *I have contacted the EBCI (Tyler Howe) several times and still have not received a response letter. Still waiting for concurrence from EBCI*	☐ Yes ☐ No ☐ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☒ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☒ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☒ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☒ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☒ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species? *Southern Appalachian bog wetland habitat is present on the site. No designated critical habitat is present on the site according to USFWS Critical Habitat Portal.*	☒ Yes ☐ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☒ Yes ☐ No ☐ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☒ No ☐ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes

USFWS has not responded to my letter in request to review the project site.	☐ No ☒ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☒ N/A
Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☒ Yes ☐ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project? *The EBCI has not responded to my letter in request to review the project site. Still waiting on concurrence from EBCI.*	☐ Yes ☐ No ☒ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☒ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☒ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☐ Yes ☒ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☒ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☒ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☒ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☒ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☒ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☒ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☒ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☒ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☒ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☒ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☒ No
2. Have the USFWS recommendations been incorporated?	☐ Yes

	☐ No ☒ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☒ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☒ N/A

Appendix D

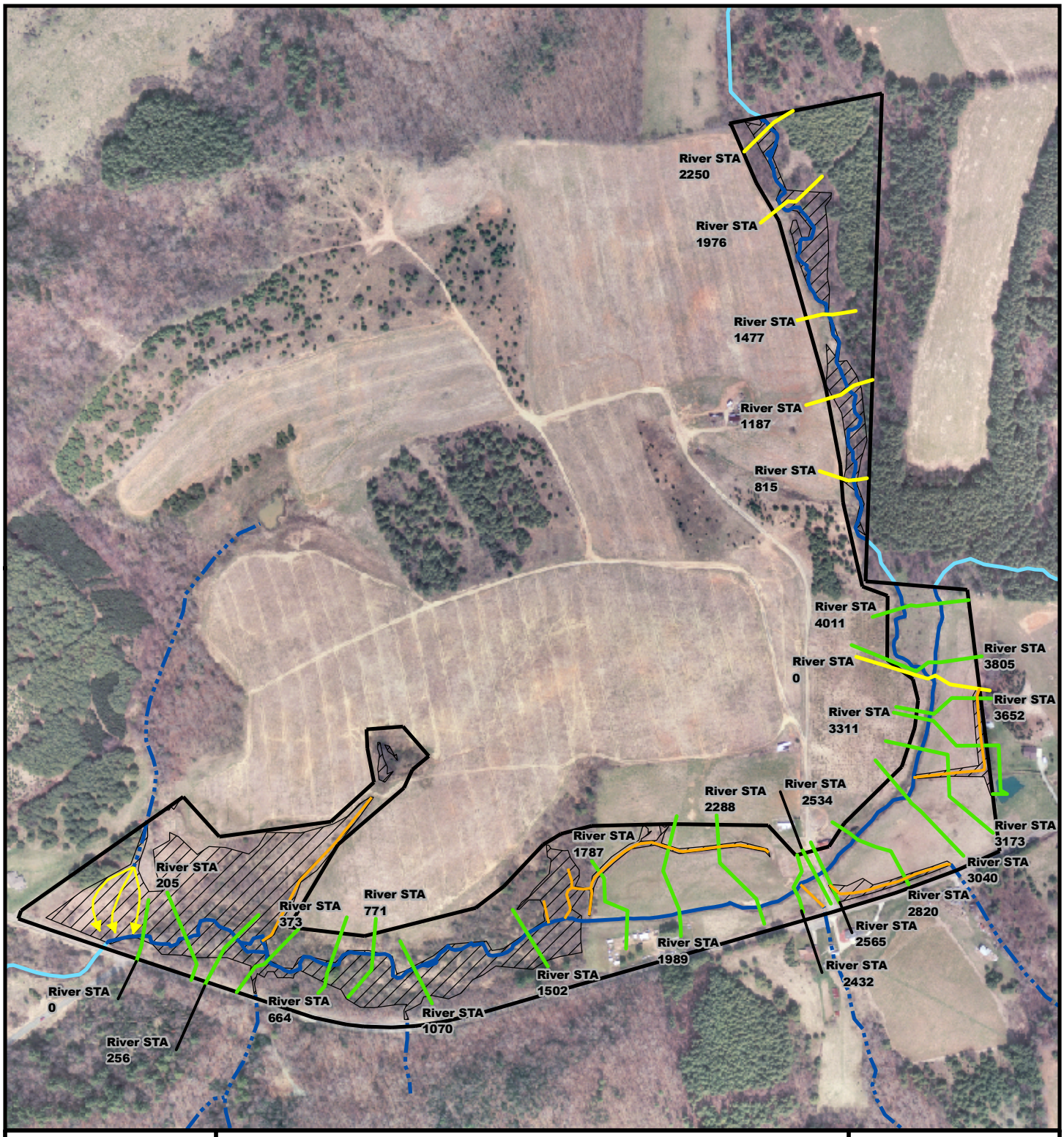
HEC-RAS Analysis

HEC-RAS Results for UT1										
River	Reach	River Sta	Proposed Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Elevation Rise	Top Width
						(cfs)	(ft)	(ft)		(ft)
UTCC_Trib 1	Trib_1	2250.391	100+45	2-YR	PROPOSED	74	2616.58	2618.3	0.41	50.71
UTCC_Trib 1	Trib_1	2250.391	100+45	2-YR	Exist	74	2616.77	2617.89		28.29
UTCC_Trib 1	Trib_1	2250.391	100+45	25-YR	PROPOSED	276	2616.58	2619.04	0.15	79.74
UTCC_Trib 1	Trib_1	2250.391	100+45	25-YR	Exist	276	2616.77	2618.89		66.27
UTCC_Trib 1	Trib_1	2250.391	100+45	100-YR	PROPOSED	439	2616.58	2619.37	0.06	81.79
UTCC_Trib 1	Trib_1	2250.391	100+45	100-YR	Exist	439	2616.77	2619.31		75.21
UTCC_Trib 1	Trib_1	1976.391	103+65	2-YR	PROPOSED	74	2608.03	2610.73	0.35	12.77
UTCC_Trib 1	Trib_1	1976.391	103+65	2-YR	Exist	74	2608.28	2610.38		11.9
UTCC_Trib 1	Trib_1	1976.391	103+65	25-YR	PROPOSED	276	2608.03	2611.95	0.02	50.41
UTCC_Trib 1	Trib_1	1976.391	103+65	25-YR	Exist	276	2608.28	2611.93		95.2
UTCC_Trib 1	Trib_1	1976.391	103+65	100-YR	PROPOSED	439	2608.03	2612.63	0.22	86.56
UTCC_Trib 1	Trib_1	1976.391	103+65	100-YR	Exist	439	2608.28	2612.41		117.3
UTCC_Trib 1	Trib_1	1477.351	108+57	2-YR	PROPOSED	86	2597.91	2599.83	0.65	12.51
UTCC_Trib 1	Trib_1	1477.351	108+57	2-YR	Exist	86	2597.53	2599.18		9.15
UTCC_Trib 1	Trib_1	1477.351	108+57	25-YR	PROPOSED	314	2597.91	2601.15	0.04	42.59
UTCC_Trib 1	Trib_1	1477.351	108+57	25-YR	Exist	314	2597.53	2601.11		12.57
UTCC_Trib 1	Trib_1	1477.351	108+57	100-YR	PROPOSED	498	2597.91	2601.7		51.95
UTCC_Trib 1	Trib_1	1477.351	108+57	100-YR	Exist	498	2597.53	2602.69		83.67
UTCC_Trib 1	Trib_1	1187.119		2-YR	PROPOSED	86	2590.02	2592.22		33.65
UTCC_Trib 1	Trib_1	1187.119		2-YR	Exist	86	2590.02	2592.54		18.75
UTCC_Trib 1	Trib_1	1187.119		25-YR	PROPOSED	314	2590.02	2593.42		60.59
UTCC_Trib 1	Trib_1	1187.119		25-YR	Exist	314	2590.02	2594.01		70.67
UTCC_Trib 1	Trib_1	1187.119		100-YR	PROPOSED	498	2590.02	2594.07		71.82
UTCC_Trib 1	Trib_1	1187.119		100-YR	Exist	498	2590.02	2594.52		82.85
UTCC_Trib 1	Trib_1	814.582		2-YR	PROPOSED	86	2582.21	2584.65		11.32
UTCC_Trib 1	Trib_1	814.582		2-YR	Exist	86	2583.26	2584.82		14.41
UTCC_Trib 1	Trib_1	814.582		25-YR	PROPOSED	314	2582.21	2586.25		19.69
UTCC_Trib 1	Trib_1	814.582		25-YR	Exist	314	2583.26	2586.48		50.62
UTCC_Trib 1	Trib_1	814.582		100-YR	PROPOSED	498	2582.21	2587.08		23.86
UTCC_Trib 1	Trib_1	814.582		100-YR	Exist	498	2583.26	2587.15		62.94
UTCC_Trib 1	Trib_1	0.016	123+70	2-YR	PROPOSED	86	2566.75	2568.59	1.23	39.29
UTCC_Trib 1	Trib_1	0.016	123+70	2-YR	Exist	86	2565.54	2567.3		20.6
UTCC_Trib 1	Trib_1	0.016	123+70	25-YR	PROPOSED	314	2566.75	2570.07	0.91	112.82
UTCC_Trib 1	Trib_1	0.016	123+70	25-YR	Exist	314	2565.54	2568.82		36.64
UTCC_Trib 1	Trib_1	0.016	123+70	100-YR	PROPOSED	498	2566.75	2570.83	0.78	225.36
UTCC_Trib 1	Trib_1	0.016	123+70	100-YR	Exist	498	2565.54	2569.58		62.11

HEC-RAS Results for UTCC										
River	Reach	River Sta	Proposed Statio	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Elevation Rise	Top Width
						(cfs)	(ft)	(ft)		(ft)
CrabCreek	UTCC_Upper	4011.013	10+60	2-YR	PROPOSED	192	2568.62	2572.93	0.68	64.43
CrabCreek	UTCC_Upper	4011.013	10+60	2-YR	Exist	192	2569.83	2572.25		14.83
CrabCreek	UTCC_Upper	4011.013		25-YR	PROPOSED	658	2568.62	2574.23		182.53
CrabCreek	UTCC_Upper	4011.013		25-YR	Exist	658	2569.83	2574.66		198.69
CrabCreek	UTCC_Upper	4011.013		100-YR	PROPOSED	1019	2568.62	2574.83		226.47
CrabCreek	UTCC_Upper	4011.013		100-YR	Exist	1019	2569.83	2575.18		227.36
CrabCreek	UTCC_Upper	3805.204		2-YR	PROPOSED	192	2565.71	2568.62		25.91
CrabCreek	UTCC_Upper	3805.204		2-YR	Exist	192	2566.37	2569		25.73
CrabCreek	UTCC_Upper	3805.204		25-YR	PROPOSED	658	2565.71	2570.32		126.16
CrabCreek	UTCC_Upper	3805.204		25-YR	Exist	658	2566.37	2570.71		58.49
CrabCreek	UTCC_Upper	3805.204		100-YR	PROPOSED	1019	2565.71	2570.86		141.59
CrabCreek	UTCC_Upper	3805.204		100-YR	Exist	1019	2566.37	2571.64		164.54
CrabCreek	UTCC_Lower	3651.849	14+87	2-YR	PROPOSED	233	2565.51	2568.46	0.8	114.96
CrabCreek	UTCC_Lower	3651.849	14+87	2-YR	Exist	233	2563.78	2567.66		22.81
CrabCreek	UTCC_Lower	3651.849	14+87	25-YR	PROPOSED	786	2565.51	2569.74	0.65	213.93
CrabCreek	UTCC_Lower	3651.849	14+87	25-YR	Exist	786	2563.78	2569.09		70.84
CrabCreek	UTCC_Lower	3651.849		100-YR	PROPOSED	1212	2565.51	2570.39		309.74
CrabCreek	UTCC_Lower	3651.849		100-YR	Exist	1212	2563.78	2570.62		313.7
CrabCreek	UTCC_Lower	3311		2-YR	PROPOSED	233	2565.11	2567.65	0.06	65.52
CrabCreek	UTCC_Lower	3311		2-YR	Exist	233	2563.67	2567.59		23.67
CrabCreek	UTCC_Lower	3311		25-YR	PROPOSED	786	2565.11	2569.26		255.01
CrabCreek	UTCC_Lower	3311		25-YR	Exist	786	2563.67	2569.3		259.03
CrabCreek	UTCC_Lower	3311		100-YR	PROPOSED	1212	2565.11	2569.75		344.12
CrabCreek	UTCC_Lower	3311		100-YR	Exist	1212	2563.67	2569.87		350.45
CrabCreek	UTCC_Lower	3172.717		2-YR	PROPOSED	233	2563.93	2566.29		54.44
CrabCreek	UTCC_Lower	3172.717		2-YR	Exist	233	2563.83	2566.53		46.65
CrabCreek	UTCC_Lower	3172.717		25-YR	PROPOSED	786	2563.93	2567.87		230.26
CrabCreek	UTCC_Lower	3172.717		25-YR	Exist	786	2563.83	2568.45		377.2
CrabCreek	UTCC_Lower	3172.717		100-YR	PROPOSED	1212	2563.93	2568.83		410.54
CrabCreek	UTCC_Lower	3172.717		100-YR	Exist	1212	2563.83	2569.17		427.22
CrabCreek	UTCC_Lower	3039.657		2-YR	PROPOSED	233	2560.26	2564.19		58.94
CrabCreek	UTCC_Lower	3039.657		2-YR	Exist	233	2561.12	2564.67		25.57
CrabCreek	UTCC_Lower	3039.657		25-YR	PROPOSED	786	2560.26	2565.43		91.38
CrabCreek	UTCC_Lower	3039.657		25-YR	Exist	786	2561.12	2567.18		238.93
CrabCreek	UTCC_Lower	3039.657		100-YR	PROPOSED	1212	2560.26	2566.43		159.23
CrabCreek	UTCC_Lower	3039.657		100-YR	Exist	1212	2561.12	2567.65		258.49
CrabCreek	UTCC_Lower	2819.94	21+40	2-YR	PROPOSED	233	2559.4	2561.76	0.16	57.38
CrabCreek	UTCC_Lower	2819.94	21+40	2-YR	Exist	233	2559.41	2561.6		16.1
CrabCreek	UTCC_Lower	2819.94		25-YR	PROPOSED	786	2559.4	2565		183.27
CrabCreek	UTCC_Lower	2819.94		25-YR	Exist	786	2559.41	2565.31		221.99
CrabCreek	UTCC_Lower	2819.94		100-YR	PROPOSED	1212	2559.4	2566		271.55
CrabCreek	UTCC_Lower	2819.94		100-YR	Exist	1212	2559.41	2566.16		282.83
CrabCreek	UTCC_Lower	2565		2-YR	PROPOSED	233	2557.62	2560.95		60.37
CrabCreek	UTCC_Lower	2565		2-YR	Exist	233	2556.34	2561.56		32.04
CrabCreek	UTCC_Lower	2565		25-YR	PROPOSED	786	2557.62	2564.91		153.29
CrabCreek	UTCC_Lower	2565		25-YR	Exist	786	2556.34	2565.31		178.89
CrabCreek	UTCC_Lower	2565		100-YR	PROPOSED	1212	2557.62	2565.84		286.44
CrabCreek	UTCC_Lower	2565		100-YR	Exist	1212	2556.34	2566.04		319.21

CrabCreek	UTCC_Lower	2548				Culvert				
CrabCreek	UTCC_Lower	2534.314		2-YR	PROPOSED	240	2557.15	2560.09		57.35
CrabCreek	UTCC_Lower	2534.314		2-YR	Exist	240	2556.34	2560.49		28.02
CrabCreek	UTCC_Lower	2534.314		25-YR	PROPOSED	807	2557.15	2561.29		64.53
CrabCreek	UTCC_Lower	2534.314		25-YR	Exist	807	2556.34	2562.99		76.48
CrabCreek	UTCC_Lower	2534.314		100-YR	PROPOSED	1243	2557.15	2561.93		68.36
CrabCreek	UTCC_Lower	2534.314		100-YR	Exist	1243	2556.34	2563.67		97.5
CrabCreek	UTCC_Lower	2432.459		2-YR	PROPOSED	240	2556.72	2559.14		60.84
CrabCreek	UTCC_Lower	2432.459		2-YR	Exist	240	2556.25	2559.96		24.78
CrabCreek	UTCC_Lower	2432.459		25-YR	PROPOSED	807	2556.72	2560.64		98.03
CrabCreek	UTCC_Lower	2432.459		25-YR	Exist	807	2556.25	2561.42		69.88
CrabCreek	UTCC_Lower	2432.459		100-YR	PROPOSED	1243	2556.72	2561.31		105.41
CrabCreek	UTCC_Lower	2432.459		100-YR	Exist	1243	2556.25	2562.88		196.41
CrabCreek	UTCC_Lower	2287.743		2-YR	PROPOSED	240	2554.15	2557.08		74.31
CrabCreek	UTCC_Lower	2287.743		2-YR	Exist	240	2556.44	2559.3		120.73
CrabCreek	UTCC_Lower	2287.743		25-YR	PROPOSED	807	2554.15	2558.67		111.16
CrabCreek	UTCC_Lower	2287.743		25-YR	Exist	807	2556.44	2560.56		315.58
CrabCreek	UTCC_Lower	2287.743		100-YR	PROPOSED	1243	2554.15	2559.68		256.31
CrabCreek	UTCC_Lower	2287.743		100-YR	Exist	1243	2556.44	2561.04		324.95
CrabCreek	UTCC_Lower	1988.554		2-YR	PROPOSED	240	2551.32	2555.25		64.51
CrabCreek	UTCC_Lower	1988.554		2-YR	Exist	240	2553.77	2556.68		45.84
CrabCreek	UTCC_Lower	1988.554		25-YR	PROPOSED	807	2551.32	2557.22		230.64
CrabCreek	UTCC_Lower	1988.554		25-YR	Exist	807	2553.77	2558.01		282.36
CrabCreek	UTCC_Lower	1988.554		100-YR	PROPOSED	1243	2551.32	2557.39		259.04
CrabCreek	UTCC_Lower	1988.554		100-YR	Exist	1243	2553.77	2558.48		291.05
CrabCreek	UTCC_Lower	1787.145		2-YR	PROPOSED	240	2551.02	2553.57		83.64
CrabCreek	UTCC_Lower	1787.145		2-YR	Exist	240	2552.09	2554.44		104.16
CrabCreek	UTCC_Lower	1787.145		25-YR	PROPOSED	807	2551.02	2554.47		185.79
CrabCreek	UTCC_Lower	1787.145		25-YR	Exist	807	2552.09	2555.4		197.08
CrabCreek	UTCC_Lower	1787.145		100-YR	PROPOSED	1243	2551.02	2555.39		260.43
CrabCreek	UTCC_Lower	1787.145		100-YR	Exist	1243	2552.09	2556.12		274.88
CrabCreek	UTCC_Lower	1501.529		2-YR	PROPOSED	251	2548.68	2551.33		16.75
CrabCreek	UTCC_Lower	1501.529		2-YR	Exist	251	2548.68	2551.33		16.75
CrabCreek	UTCC_Lower	1501.529		25-YR	PROPOSED	840	2548.68	2553.23		198.46
CrabCreek	UTCC_Lower	1501.529		25-YR	Exist	840	2548.68	2553.23		198.46
CrabCreek	UTCC_Lower	1501.529		100-YR	PROPOSED	1292	2548.68	2553.71		203.99
CrabCreek	UTCC_Lower	1501.529		100-YR	Exist	1292	2548.68	2553.71		203.99
CrabCreek	UTCC_Lower	1069.826		2-YR	PROPOSED	251	2544.37	2547.78		81.11
CrabCreek	UTCC_Lower	1069.826		2-YR	Exist	251	2544.37	2547.78		81.11
CrabCreek	UTCC_Lower	1069.826		25-YR	PROPOSED	840	2544.37	2549.4		291.5
CrabCreek	UTCC_Lower	1069.826		25-YR	Exist	840	2544.37	2549.4		291.5
CrabCreek	UTCC_Lower	1069.826		100-YR	PROPOSED	1292	2544.37	2550.13		327.8
CrabCreek	UTCC_Lower	1069.826		100-YR	Exist	1292	2544.37	2550.13		327.8
CrabCreek	UTCC_Lower	770.938		2-YR	PROPOSED	251	2543.17	2545.15		24.79
CrabCreek	UTCC_Lower	770.938		2-YR	Exist	251	2543.17	2545.15		24.79
CrabCreek	UTCC_Lower	770.938		25-YR	PROPOSED	840	2543.17	2547.18		211.27
CrabCreek	UTCC_Lower	770.938		25-YR	Exist	840	2543.17	2547.18		211.27
CrabCreek	UTCC_Lower	770.938		100-YR	PROPOSED	1292	2543.17	2547.65		257.41
CrabCreek	UTCC_Lower	770.938		100-YR	Exist	1292	2543.17	2547.65		257.41
CrabCreek	UTCC_Lower	663.874		2-YR	PROPOSED	251	2541.35	2544.03		31.42
CrabCreek	UTCC_Lower	663.874		2-YR	Exist	251	2541.35	2544.03		31.42
CrabCreek	UTCC_Lower	663.874		25-YR	PROPOSED	840	2541.35	2546.45		152.54
CrabCreek	UTCC_Lower	663.874		25-YR	Exist	840	2541.35	2546.45		152.54
CrabCreek	UTCC_Lower	663.874		100-YR	PROPOSED	1292	2541.35	2547.15		204.07
CrabCreek	UTCC_Lower	663.874		100-YR	Exist	1292	2541.35	2547.15		204.07

CrabCreek	UTCC_Lower	373.16		2-YR	PROPOSED	251	2539.75	2542.47		21.89
CrabCreek	UTCC_Lower	373.16		2-YR	Exist	251	2539.75	2542.47		21.89
CrabCreek	UTCC_Lower	373.16		25-YR	PROPOSED	840	2539.75	2544.35		141.73
CrabCreek	UTCC_Lower	373.16		25-YR	Exist	840	2539.75	2544.35		141.73
CrabCreek	UTCC_Lower	373.16		100-YR	PROPOSED	1292	2539.75	2545.32		211.6
CrabCreek	UTCC_Lower	373.16		100-YR	Exist	1292	2539.75	2545.32		211.6
CrabCreek	UTCC_Lower	255.833		2-YR	PROPOSED	267	2538.28	2540.91		28.83
CrabCreek	UTCC_Lower	255.833		2-YR	Exist	267	2538.28	2540.91		28.83
CrabCreek	UTCC_Lower	255.833		25-YR	PROPOSED	889	2538.28	2543.18		163.57
CrabCreek	UTCC_Lower	255.833		25-YR	Exist	889	2538.28	2543.18		163.57
CrabCreek	UTCC_Lower	255.833		100-YR	PROPOSED	1365	2538.28	2544.06		230.59
CrabCreek	UTCC_Lower	255.833		100-YR	Exist	1365	2538.28	2544.06		230.59
CrabCreek	UTCC_Lower	205		2-YR	PROPOSED	267	2536.21	2538.85		34.22
CrabCreek	UTCC_Lower	205		2-YR	Exist	267	2536.21	2538.85		34.23
CrabCreek	UTCC_Lower	205		25-YR	PROPOSED	889	2536.21	2541.07		236.95
CrabCreek	UTCC_Lower	205		25-YR	Exist	889	2536.21	2541.07		236.94
CrabCreek	UTCC_Lower	205		100-YR	PROPOSED	1365	2536.21	2541.92		251.79
CrabCreek	UTCC_Lower	205		100-YR	Exist	1365	2536.21	2541.92		251.79
CrabCreek	UTCC_Lower	0		2-YR	PROPOSED	267	2534.12	2536.9		20.29
CrabCreek	UTCC_Lower	0		2-YR	Exist	267	2534.12	2536.9		20.29
CrabCreek	UTCC_Lower	0		25-YR	PROPOSED	889	2534.12	2539		98.58
CrabCreek	UTCC_Lower	0		25-YR	Exist	889	2534.12	2539		98.58
CrabCreek	UTCC_Lower	0		100-YR	PROPOSED	1365	2534.12	2540.11		154.01
CrabCreek	UTCC_Lower	0		100-YR	Exist	1365	2534.12	2540.11		154.01



HEC-RAS Model at the Crab Creek Site

- Project Boundary
- HEC-RAS Cross-Sections (UT1)
- HEC-RAS Cross-Sections (UTCC)
- Project Streams
- Other Streams
- Other Streams (Intermittent)
- Diffuse Channel
- Existing Wetland
- Ditches

1:6,000
1 inch equals 500 feet

500 250 0 500 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

Appendix E

Existing Site Photographs

Existing Photos Crab Creek (UT1)

All pictures were taken December 12, 2006.

Photo 01: Start of project reach looking downstream.

Photo 02: Start of project reach looking downstream.

Photo 03: Looking downstream at debris jam.

Photo 04, 05, 06, 07: Looking downstream.

Photo 08: Old rusty car located on the right bank.

Photo 09: Wagon wheel located on the right bank.

Photo 10: Looking downstream.

Photo 11: Culvert in use for a crossing.

Photo 12: Looking downstream at UT1 where the stream exits the property briefly.

Existing Photos Crab Creek (Upstream UTCC)

Photo 01: Looking downstream at the project start of the upstream portion of UTCC.

Photo 02, 03, 04: Looking downstream in the upstream section of UTCC.

Photo 05: Looking downstream at the culvert road crossing at the entrance of the property.

Photo 06: Looking downstream at the middle section of UTCC.

Photo 07: Looking upstream at the 3-way culvert pipe.

Photo 08, 09: Looking downstream where UTCC enters the forested area (downstream section of UTCC) on the project site.

Existing Photos Crab Creek (Downstream UTCC)

Photo 01: Looking downstream at the downstream portion of UTCC when the stream enters the forested area.

Photo 02-12: Looking downstream at the downstream portion of UTCC.

Photo 13: Looking at the project end for UTCC.

Existing Photos Crab Creek (Bog Preservation)

Photo 01: Looking east in the bog preservation area.

Photo 02: Looking southeast in the bog preservation area.

Photo 03: Looking southwest in the bog preservation area, toward NC-18.

Photo 04: Looking southwest in the bog preservation area, toward the utility line.

Photo 05: Looking northeast in the bog preservation area..

Crab Creek-UT1 Existing Photographs

PHOTO 01.JPG

PHOTO 02.JPG

PHOTO 03.JPG

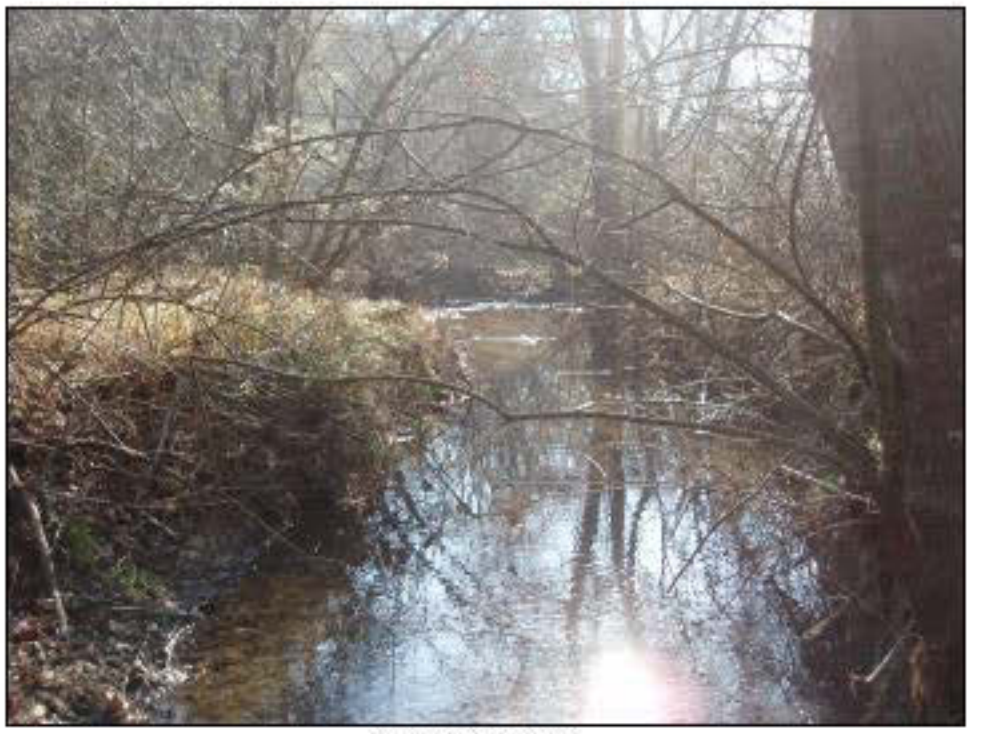


PHOTO 04.JPG

PHOTO 05.JPG

PHOTO 06.JPG

Crab Creek-UT1 Existing Photographs

PHOTO 07.JPG

PHOTO 08.JPG

PHOTO 09.JPG

PHOTO 10.JPG

PHOTO 11.JPG

PHOTO 12.JPG

Crab Creek-UT1 Existing Photographs

PHOTO 13.JPG

Crab Creek-(Upstream- UTCC) Existing Photographs

PHOTO 01.JPG

PHOTO 02.JPG

PHOTO 03.JPG

PHOTO 04.JPG

PHOTO 05.JPG

PHOTO 06.JPG

Crab Creek-(Upstream- UTCC) Existing Photographs

PHOTO 07.JPG

PHOTO 08.JPG

PHOTO 09.JPG

Crab Creek-(Downstream- UTCC) Existing Photographs

PHOTO 01.JPG

PHOTO 02.JPG

PHOTO 03.JPG

PHOTO 04.JPG

PHOTO 05.JPG

PHOTO 06.JPG

Crab Creek-(Downstream- UTCC) Existing Photographs

PHOTO 07.JPG

PHOTO 08.JPG

PHOTO 09.JPG

PHOTO 10.JPG

PHOTO 11.JPG

PHOTO 12.JPG

Crab Creek-(Downstream- UTCC) Existing Photographs

PHOTO 13.JPG

Crab Creek-(Bog Preservation) Existing Photographs

PHOTO 01.JPG

PHOTO 02.JPG

PHOTO 03.JPG

PHOTO 04.JPG

PHOTO 05.JPG

PHOTO 06.JPG

Crab Creek-(Bog Preservation) Existing Photographs

PHOTO 07.JPG

Appendix F

NCDWQ Stream Classification Forms
&
Routine Wetland Determination Data Forms

NCDWQ Stream Classification Forms

NCDWQ Stream Classification Form

Project Name: **Crab Creek (Existing Wetland 2)**
River Basin: **New River** County: **Alleghany** Evaluator: **BH, KK**
DWQ Project Number: Nearest Named Stream: Latitude: Signature:
Date: **January 11, 2007** USGSQUAD: **Cumberland Knob** Longitude: Location/Directions:

Please Note:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	(0)	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	(1)	2	3
3) Are Natural Levees Present?	(0)	1	2	3
4) Is The Channel Sinuous?	(0)	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	(0)	1	2	3
6) Is The Channel Braided?	0	(1)	2	3
7) Are Recent Alluvial Deposits Present?	0	(1)	2	3
8) Is There A Bankfull Bench Present?	(0)	1	2	3
9) Is A Continuous Bed & Bank Present?	0	(1)	2	3

*(*NOTE: If Bed & Bank Caused By Ditching And **WITHOUT** Sinuosity Then Score=0*)*

10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map ***And/Or*** In Field) Present? *Yes* = 3 *No* = (0)

Primary Geomorphology Indicator Points:__4__

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	(3)

Primary Hydrology Indicator Points:__3__

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	3	(2)	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	(0)
3) Is Periphyton Present?	0	1	(2)	3
4) Are Bivalves Present?	(0)	1	2	3

Primary Biology Indicator Points:__4__

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	(0)	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	(1.5)
3) Does Topography Indicate A Natural Drainage Way?	0	.5	(1)	1.5

Secondary Geomorphology Indicator Points:__2.5__

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	1	(.5)	0
2) Is Sediment On Plants (Or Debris) Present?	(0)	.5	1	1.5
3) Are Wrack Lines Present?	(0)	.5	1	1.5
4) Is Water In Channel ***And*** >48 Hrs. Since Last ***Known*** Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	(1.5)
5) Is There Water In Channel During Dry Conditions ***Or*** In Growing Season)?	0	.5	1	(1.5)

6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)? *Yes* = (1.5) *No* = 0

Secondary Hydrology Indicator Points:__3.5__

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fish Present?	(0)	.5	1	1.5
2) Are Amphibians Present?	(0)	.5	1	1.5
3) Are Aquatic Turtles Present?	(0)	.5	1	1.5
4) Are Crayfish Present?	(0)	.5	1	1.5
5) Are Macro benthos Present?	(0)	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	(.5)	1	1.5
7) Is Filamentous Algae Present?	0	.5	(1)	1.5

8) Are Wetland Plants In Streambed?	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	(.75)	.5	0	0

Secondary Biology Indicator Points:__2.25__

TOTAL POINTS *(Primary + Secondary)* = *__19.25__ (If ≥ 19 points the stream is at least intermittent)*

NCDWQ Stream Classification Form

Project Name: **Crab Creek (Existing Wetland 3)**
River Basin: **New River** County: **Alleghany** Evaluator: **BH, KK**
DWQ Project Number: Nearest Named Stream: Latitude: Signature:
Date: **January 11, 2007** USGSQUAD: **Cumberland Knob** Longitude: Location/Directions:

Please Note:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	(0)	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	(1)	2	3
3) Are Natural Levees Present?	(0)	1	2	3
4) Is The Channel Sinuous?	0	1	(2)	3
5) Is There An Active (Or Relic) Floodplain Present?	(0)	1	2	3
6) Is The Channel Braided?	(0)	1	2	3
7) Are Recent Alluvial Deposits Present?	(0)	1	2	3
8) Is There A Bankfull Bench Present?	(0)	1	2	3
9) Is A Continuous Bed & Bank Present? *(*NOTE: If Bed & Bank Caused By Ditching And **WITHOUT** Sinuosity Then Score=0*)*	0	(1)	2	3
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map ***And/Or*** In Field) Present?		*Yes* = 3	*No* = (0)	

Primary Geomorphology Indicator Points:__4__

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	0	(1)	2	3

Primary Hydrology Indicator Points:__1__

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	3	2	(1)	0
2) Are Rooted Plants Present In Streambed?	3	2	(1)	0
3) Is Periphyton Present?	(0)	1	2	3
4) Are Bivalves Present?	(0)	1	2	3

Primary Biology Indicator Points:__2__

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	(0)	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	(.5)	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	(.5)	1	1.5

Secondary Geomorphology Indicator Points:__1__

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	(1)	.5	0
2) Is Sediment On Plants (Or Debris) Present?	(0)	.5	1	1.5
3) Are Wrack Lines Present?	(0)	.5	1	1.5
4) Is Water In Channel ***And*** >48 Hrs. Since Last ***Known*** Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	(1)	1.5
5) Is There Water In Channel During Dry Conditions ***Or*** In Growing Season)?	(0)	.5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?		*Yes* = (1.5)	*No* = 0	

Secondary Hydrology Indicator Points:__3.5__

III. Biology	Absent	Weak	Moderate	Strong		
1) Are Fish Present?	(0)	.5	1	1.5		
2) Are Amphibians Present?	(0)	.5	1	1.5		
3) Are Aquatic Turtles Present?	(0)	.5	1	1.5		
4) Are Crayfish Present?	(0)	.5	1	1.5		
5) Are Macro benthos Present?	(0)	.5	1	1.5		
6) Are Iron Oxidizing Bacteria/Fungus Present?	(0)	.5	1	1.5		
7) Is Filamentous Algae Present?	(0)	.5	1	1.5		
8) Are Wetland Plants In Streambed?	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	(.75)	.5	0	0

Secondary Biology Indicator Points:__.75__

TOTAL POINTS *(Primary + Secondary)* = *__12.25__ (If ≥ 19 points the stream is at least intermittent)*

NCDWQ Stream Classification Form

Project Name: **Crab Creek (Existing Wetland 7)**
River Basin: **New River** County: **Alleghany** Evaluator: **BH, KK**
DWQ Project Number: Nearest Named Stream: Latitude: Signature:
Date: **January 11, 2007** USGSQUAD: **Cumberland Knob** Longitude: Location/Directions:

Please Note:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	0	(1)	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	(1)	2	3
3) Are Natural Levees Present?	(0)	1	2	3
4) Is The Channel Sinuous?	0	(1)	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	(2)	3
6) Is The Channel Braided?	0	(1)	2	3
7) Are Recent Alluvial Deposits Present?	(0)	1	2	3
8) Is There A Bankfull Bench Present?	0	(1)	2	3
9) Is A Continuous Bed & Bank Present?	0	(1)	2	3
*(*NOTE: If Bed & Bank Caused By Ditching And **WITHOUT** Sinuosity Then Score=0*)*				
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map ***And/Or*** In Field) Present?		*Yes* = 3	*No* = (0)	

Primary Geomorphology Indicator Points:__8__

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	0	1	(2)	3

Primary Hydrology Indicator Points:__2__

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	3	(2)	1	0
2) Are Rooted Plants Present In Streambed?	3	2	(1)	0
3) Is Periphyton Present?	(0)	1	2	3
4) Are Bivalves Present?	(0)	1	2	3

Primary Biology Indicator Points:__3__

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	(0)	.5	1	1.5
2) Is There A Grade Control Point In Channel?	(0)	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	(1)	1.5

Secondary Geomorphology Indicator Points:__1__

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	(1)	.5	0
2) Is Sediment On Plants (Or Debris) Present?	(0)	.5	1	1.5
3) Are Wrack Lines Present?	(0)	.5	1	1.5
4) Is Water In Channel ***And*** >48 Hrs. Since Last ***Known*** Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	(.5)	1	1.5
5) Is There Water In Channel During Dry Conditions ***Or*** In Growing Season)?	(0)	.5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?		*Yes* = (1.5)	*No* = 0	

Secondary Hydrology Indicator Points:__3__

III. Biology	Absent	Weak	Moderate	Strong		
1) Are Fish Present?	(0)	.5	1	1.5		
2) Are Amphibians Present?	(0)	.5	1	1.5		
3) Are Aquatic Turtles Present?	(0)	.5	1	1.5		
4) Are Crayfish Present?	(0)	.5	1	1.5		
5) Are Macro benthos Present?	(0)	.5	1	1.5		
6) Are Iron Oxidizing Bacteria/Fungus Present?	(0)	.5	1	1.5		
7) Is Filamentous Algae Present?	(0)	.5	1	1.5		
8) Are Wetland Plants In Streambed?	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	.75	(.5)	0	0

Secondary Biology Indicator Points:__.5__

TOTAL POINTS *(Primary + Secondary)* = *__17.5__* *(If ≥ 19 points the stream is at least intermittent)*

Routine Wetland Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Crab Creek **Applicant / Owner:** **Investigator:** SFS	**Date:** 12-16-06 **County:** Alleghany **State:**
Do normal circumstances exist on the site? Yes X No **Is the site significantly disturbed (Atypical situation)?** Yes No X **Is the area a potential problem area?** Yes No X **(explain on reverse if needed)**	**Community ID:** **Transect ID:** **Plot ID:** DP#1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Acer rubrum	1	FAC	9.		
2. Symplocarpus foetidus	3	OBL	10.		
3. Unknown Shrub	2	--	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 100%

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- **___ Stream, Lake, or Tide Gauge**
- **___ Aerial Photographs**
- **___ Other**

X No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ **(in.)**

Depth to Free Water in Pit: 6 **(in.)**

Depth to Saturated Soil: _____ **(in.)**

Wetland Hydrology Indicators

Primary Indicators:
- **___ Inundated**
- **X Saturated in Upper 12”**
- **___ Water Marks**
- **___ Drift Lines**
- **___ Sediment Deposits**
- **X Drainage Patterns in Wetlands**

Secondary Indicators:
- **___ Oxidized Roots Channels in Upper 12”**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC-Neutral Test**
- **___ Other (Explain in Remarks)**

Remarks:

SOILS

Map Unit Name
(Series and Phase): Nikwasi **Drainage Class:** Poorly Drained

Taxonomy (Subgroup): Cumulic Humaquepts **Confirm Mapped Type? Yes** ___ **No** X

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	A1	10YR 4/2			l, 1fgr
3-6	A2	10YR 4/2	5YR 3/4 c2p		l, 1fgr
6-10	A3	10YR 4/2			sl, 1fgr
10-18	A4	10YR 3/1			fsl, 1fgr

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- X Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- X Listed On Local Hydric Soils List
- X Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is the Sampling Point Within a Wetland? Yes X No ___

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Crab Creek **Applicant / Owner:** **Investigator:** SFS	**Date:** 12-16-06 **County:** Alleghany **State:** NC
Do normal circumstances exist on the site? Yes X No **Is the site significantly disturbed (Atypical situation)?** Yes No X **Is the area a potential problem area?** Yes No X **(explain on reverse if needed)**	**Community ID:** **Transect ID:** **Plot ID:** DP#2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Pinus strobus	1	FACU	9.		
2. Polystichum acrostichoides	3	FAC	10.		
3. Lindera benzoin	2	FACW	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 66%

Remarks:

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ **Stream, Lake, or Tide Gauge**
- ___ **Aerial Photographs**
- ___ **Other**

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: _____ **(in.)**

Depth to Free Water in Pit: >18 **(in.)**

Depth to Saturated Soil: _____ **(in.)**

Wetland Hydrology Indicators

Primary Indicators:
- ___ **Inundated**
- ___ **Saturated in Upper 12”**
- ___ **Water Marks**
- ___ **Drift Lines**
- ___ **Sediment Deposits**
- ___ **Drainage Patterns in Wetlands**

Secondary Indicators:
- ___ **Oxidized Roots Channels in Upper 12”**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC-Neutral Test**
- ___ **Other (Explain in Remarks)**

Remarks:

SOILS

Map Unit Name
(Series and Phase): Chandler **Drainage Class:** Well Drained

Taxonomy (Subgroup): Typic Dystrudepts **Confirm Mapped Type? Yes** ___ **No** X

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-8	A1	10YR 4/4			sl, 1fgr
8-12	Bw1	7.5YR 4/6			sl, 1fsbk
12-18	Bw2	7.5YR 4/6			scl, 1msbk

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ___ Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed On Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes ___ No X
Hydric Soils Present? Yes ___ No X

Is the Sampling Point Within a Wetland? Yes ___ No X

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Crab Creek
Applicant / Owner:
Investigator: SFS

Date: 12-19-06
County: Alleghany
State: NC

Do normal circumstances exist on the site? Yes X No
Is the site significantly disturbed (Atypical situation)? Yes No X
Is the area a potential problem area? Yes No X
(explain on reverse if needed)

Community ID:
Transect ID:
Plot ID: DP#3

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Cornus amomum FACW+	2	
2. Symplocarpus foetidus	3	OBL
3. Sphagnum	3	OBL
4. Rosa multiflora	2	UPL
5. Acer rubrum	2	FAC
6.		
7.		
8.		

Dominant Plant Species	Stratum	Indicator
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-): 80%

Remarks:

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ **Stream, Lake, or Tide Gauge**
- ___ **Aerial Photographs**
- ___ **Other**

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: _____ **(in.)**

Depth to Free Water in Pit: 10 **(in.)**

Depth to Saturated Soil: 8 **(in.)**

Wetland Hydrology Indicators

Primary Indicators:
- ___ **Inundated**
- X **Saturated in Upper 12"**
- ___ **Water Marks**
- ___ **Drift Lines**
- ___ **Sediment Deposits**
- ___ **Drainage Patterns in Wetlands**

Secondary Indicators:
- X **Oxidized Roots Channels in Upper 12"**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- X **FAC-Neutral Test**
- ___ **Other (Explain in Remarks)**

Remarks:

SOILS

Map Unit Name
(Series and Phase): Nikwasi **Drainage Class:** Poorly Drained

Taxonomy (Subgroup): Cumulic Humaquepts **Confirm**
Mapped Type? Yes _____ **No** X

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-8	A1	10YR 3/2	5YR 4/4 c2p		fsl
8-30	A2	10YR 3/1			fsl
30	Cg	10YR 3/2			Gravelly Coarse sand

Hydric Soil Indicators:

___ Histosol	___ Concretions
___ Histic Epipedon	___ High Organic Content in Surface Layer in Sandy Soils
___ Sulfidic Odor	___ Organic Streaking in Sandy Soils
___ Aquic Moisture Regime	X Listed On Local Hydric Soils List
___ Reducing Conditions	X Listed on National Hydric Soils List
X Gleyed or Low-Chroma Colors	___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___
Hydric Soils Present? Yes X No ___

Is the Sampling Point Within a Wetland? Yes X No ___

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Crab Creek **Applicant / Owner:** **Investigator:** SFS	**Date:** 12-19-06 **County:** Alleghany **State:** NC
Do normal circumstances exist on the site? Yes X No **Is the site significantly disturbed (Atypical situation)?** Yes No X **Is the area a potential problem area?** Yes No X **(explain on reverse if needed)**	**Community ID:** **Transect ID:** **Plot ID:** DP#4

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Smilax spp.	4	
2. Magnolia acuminata	1	NI
3. Quercus coccinea	1	NI
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 0%

Remarks:

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ **Stream, Lake, or Tide Gauge**
- ___ **Aerial Photographs**
- ___ **Other**

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: _____ **(in.)**

Depth to Free Water in Pit: >18 **(in.)**

Depth to Saturated Soil: _____ **(in.)**

Wetland Hydrology Indicators

Primary Indicators:
- ___ **Inundated**
- ___ **Saturated in Upper 12”**
- ___ **Water Marks**
- ___ **Drift Lines**
- ___ **Sediment Deposits**
- ___ **Drainage Patterns in Wetlands**

Secondary Indicators:
- ___ **Oxidized Roots Channels in Upper 12”**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC-Neutral Test**
- ___ **Other (Explain in Remarks)**

Remarks:

SOILS

Map Unit Name
(Series and Phase): Chester **Drainage Class:** Moderately Well

Taxonomy (Subgroup): Typic Hapludults **Confirm Mapped Type? Yes** ___ **No** X

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	A	7.5YR 4/4			sl, 1fgr
4-18	Bt1	7.5YR 4/4			scl, 1fsbk

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ___ Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed On Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ___ No X
Wetland Hydrology Present? Yes ___ No X
Hydric Soils Present? Yes ___ No X

Is the Sampling Point Within a Wetland? Yes ___ No X

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Crab Creek **Applicant / Owner:** **Investigator:** SFS	**Date:** 12-19-06 **County:** Alleghany **State:** NC
Do normal circumstances exist on the site? Yes X No **Is the site significantly disturbed (Atypical situation)?** Yes No X **Is the area a potential problem area?** Yes No X **(explain on reverse if needed)**	**Community ID:** **Transect ID:** **Plot ID:** DP#5

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Alnus serrulata	2	FACW+	9.		
2. Scirpus cyperinus	3	OBL	10.		
3. Polygonium sagittatum	3	OBL	11.		
4. Juncus effusus	3	FACW+	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 100%

Remarks:

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ **Stream, Lake, or Tide Gauge**
- ___ **Aerial Photographs**
- ___ **Other**

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: 2 **(in.)**

Depth to Free Water in Pit: _____ **(in.)**

Depth to Saturated Soil: _____ **(in.)**

Wetland Hydrology Indicators

Primary Indicators:
- ___ **Inundated**
- X **Saturated in Upper 12”**
- ___ **Water Marks**
- ___ **Drift Lines**
- ___ **Sediment Deposits**
- X **Drainage Patterns in Wetlands**

Secondary Indicators:
- ___ **Oxidized Roots Channels in Upper 12”**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- X **FAC-Neutral Test**
- ___ **Other (Explain in Remarks)**

Remarks:

SOILS

Map Unit Name
(Series and Phase): Nikwasi **Drainage Class:** Poorly Drained

Taxonomy (Subgroup): Cumulic Humaquepts **Confirm Mapped Type? Yes** ___ **No** X

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6	A1	10YR 4/2			loam
6-48	A2	10YR 2/2			fsl

Hydric Soil Indicators:

___ Histosol	___ Concretions
___ Histic Epipedon	___ High Organic Content in Surface Layer in Sandy Soils
___ Sulfidic Odor	___ Organic Streaking in Sandy Soils
___ Aquic Moisture Regime	X Listed On Local Hydric Soils List
___ Reducing Conditions	X Listed on National Hydric Soils List
X Gleyed or Low-Chroma Colors	___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? **Yes** X **No** ___
Wetland Hydrology Present? **Yes** X **No** ___
Hydric Soils Present? **Yes** X **No** ___

Is the Sampling Point Within a Wetland? **Yes** X **No** ___

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Crab Creek **Applicant / Owner:** **Investigator:** SFS	**Date:** 12-19-06 **County:** Alleghany **State:** NC
Do normal circumstances exist on the site? Yes X No **Is the site significantly disturbed (Atypical situation)?** Yes No X **Is the area a potential problem area?** Yes No X **(explain on reverse if needed)**	**Community ID:** **Transect ID:** **Plot ID:** DP#6

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Rosa multiflora	2	UPL	9.		
2. Pinus strobus	2	FACU	10.		
3. Crataegus spp.	2	- -	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 0%

Remarks:

HYDROLOGY

___ **Recorded Data (Describe In Remarks):**
- ___ **Stream, Lake, or Tide Gauge**
- ___ **Aerial Photographs**
- ___ **Other**

X **No Recorded Data Available**

Field Observations:

Depth of Surface Water: _____ **(in.)**

Depth to Free Water in Pit: _____ **(in.)**

Depth to Saturated Soil: 18 **(in.)**

Wetland Hydrology Indicators

Primary Indicators:
- ___ **Inundated**
- ___ **Saturated in Upper 12”**
- ___ **Water Marks**
- ___ **Drift Lines**
- ___ **Sediment Deposits**
- ___ **Drainage Patterns in Wetlands**

Secondary Indicators:
- ___ **Oxidized Roots Channels in Upper 12”**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC-Neutral Test**
- ___ **Other (Explain in Remarks)**

Remarks:

SOILS

Map Unit Name
(Series and Phase): Chester **Drainage Class:** Moderately Well

Taxonomy (Subgroup): Typic Hapudults **Confirm Mapped Type? Yes** ___ **No** X

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	A	10YR 3/3			fsl, 1fgr
3-9	E	10YR 3/4			sl, 1fsbk
9-18	Bt1	10YR 5/4			scl, 2fsbk

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ___ Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed On Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ___ No X
Wetland Hydrology Present? Yes ___ No X
Hydric Soils Present? Yes ___ No X

Is the Sampling Point Within a Wetland? Yes ___ No X

Remarks:

Appendix G

Existing Conditions

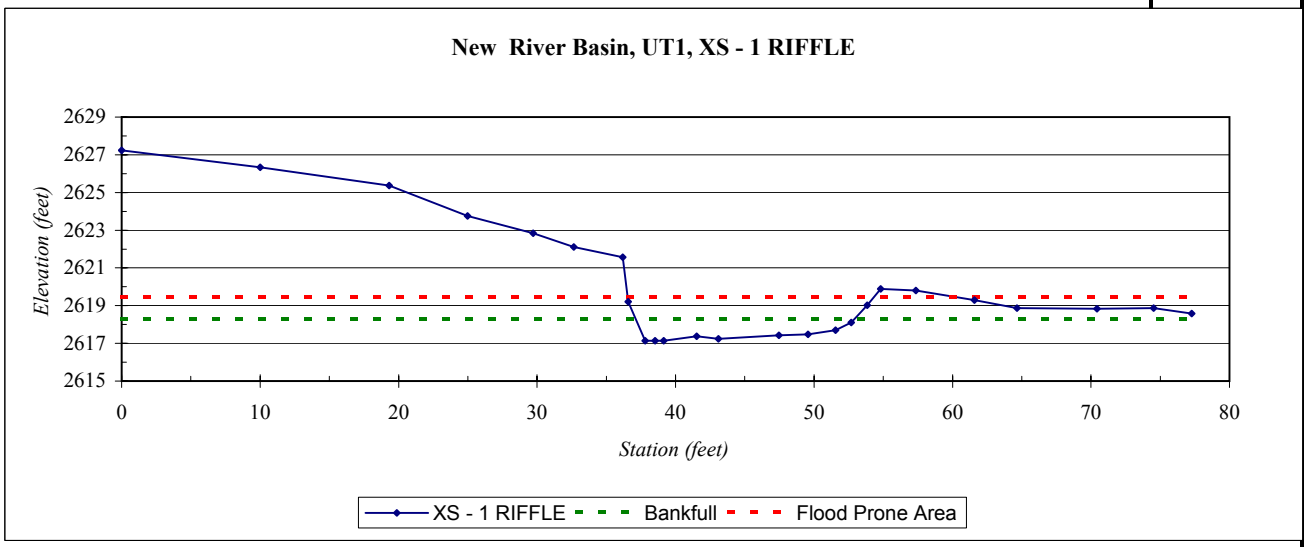
UT1

Existing Cross Sections

River Basin:	New
Watershed:	UT1
XS ID	XS - 1 RIFFLE
Drainage Area (sq mi):	0.53
Date:	4/24/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2627.24
10.0	2626.33
19.3	2625.37
25.0	2623.75
29.7	2622.84
32.6	2622.11
36.2	2621.57
36.6	2619.21
37.8	2617.14
38.5	2617.13
39.1	2617.13
41.5	2617.37
43.1	2617.24
47.5	2617.43
49.6	2617.48
51.6	2617.70
52.7	2618.10
53.8	2619.02
54.8	2619.88
57.4	2619.81
61.6	2619.29
64.6	2618.87
70.4	2618.84
74.5	2618.87
77.3	2618.58

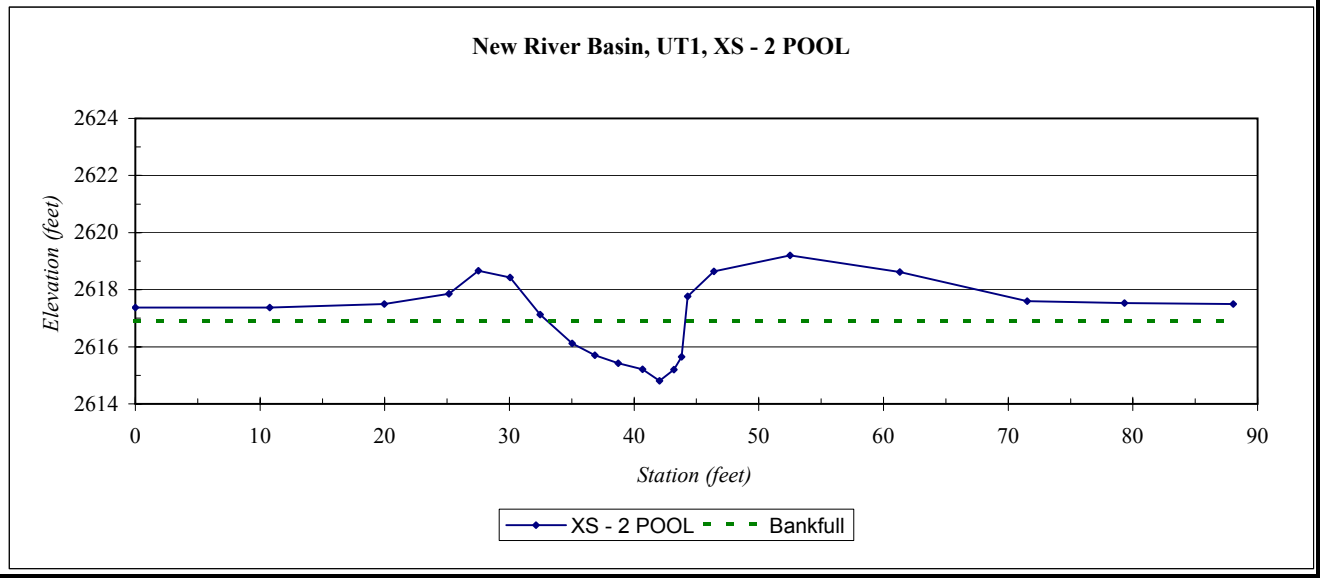
SUMMARY DATA	
Bankfull Elevation:	2618.30
Bankfull Cross-Sectional Area:	14.9
Bankfull Width:	15.8
Flood Prone Area Elevation:	2619.5
Flood Prone Width:	18.2
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.9
W / D Ratio:	16.7
Entrenchment Ratio:	1.2
Bank Height Ratio:	2.4
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 2 POOL
Drainage Area (sq mi):	0.53
Date:	4/24/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2617.38
10.8	2617.38
20.0	2617.50
25.2	2617.86
27.5	2618.66
30.1	2618.42
32.5	2617.13
35.0	2616.12
36.9	2615.71
38.7	2615.43
40.7	2615.21
42.0	2614.81
43.2	2615.20
43.8	2615.65
44.3	2617.76
46.4	2618.65
52.5	2619.20
61.3	2618.62
71.5	2617.60
79.3	2617.53
88.0	2617.50

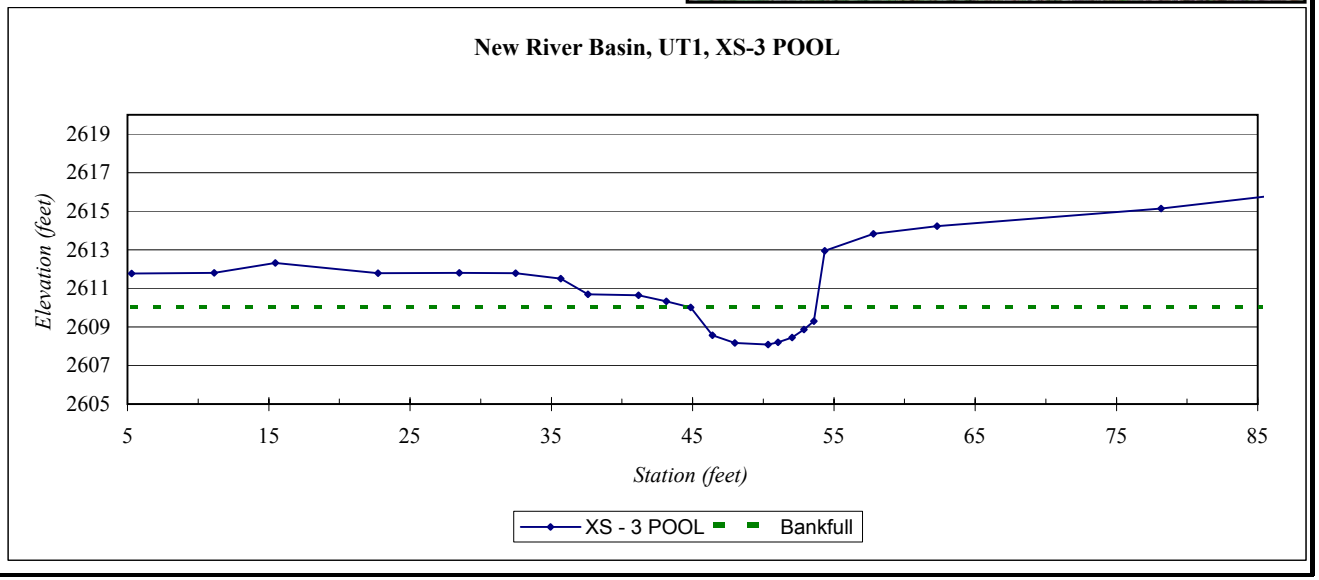
SUMMARY DATA	
Bankfull Elevation:	2616.9
Bankfull Cross-Sectional Area:	14.0
Bankfull Width:	11.0
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.1
Mean Depth at Bankfull:	1.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 3 POOL
Drainage Area (sq mi):	0.53
Date:	4/24/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
5.3	2611.78
11.1	2611.81
15.5	2612.31
22.7	2611.79
28.5	2611.80
32.5	2611.79
35.7	2611.50
37.6	2610.69
41.2	2610.64
43.1	2610.32
44.9	2610.01
46.4	2608.57
48.0	2608.17
50.3	2608.09
51.1	2608.20
52.0	2608.45
52.9	2608.87
53.6	2609.29
54.3	2612.95
57.8	2613.82
62.3	2614.22
78.2	2615.13
85.6	2615.77

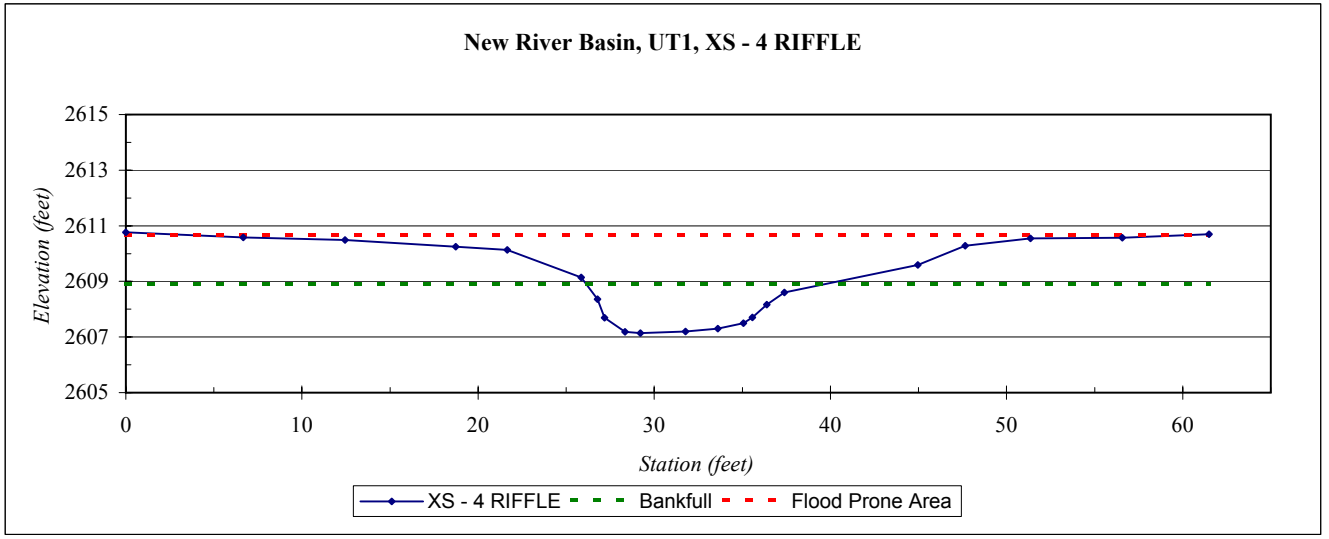
SUMMARY DATA	
Bankfull Elevation:	2610.0
Bankfull Cross-Sectional Area:	13.0
Bankfull Width:	8.8
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	1.9
Mean Depth at Bankfull:	1.5
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 4 RIFFLE
Drainage Area (sq mi):	0.53
Date:	4/24/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2610.77
6.7	2610.59
12.4	2610.49
18.7	2610.25
21.7	2610.13
25.8	2609.15
26.8	2608.37
27.2	2607.69
28.3	2607.18
29.2	2607.14
31.8	2607.20
33.6	2607.30
35.1	2607.50
35.6	2607.71
36.4	2608.16
37.4	2608.60
45.0	2609.59
47.7	2610.28
51.4	2610.54
56.6	2610.57
61.5	2610.70

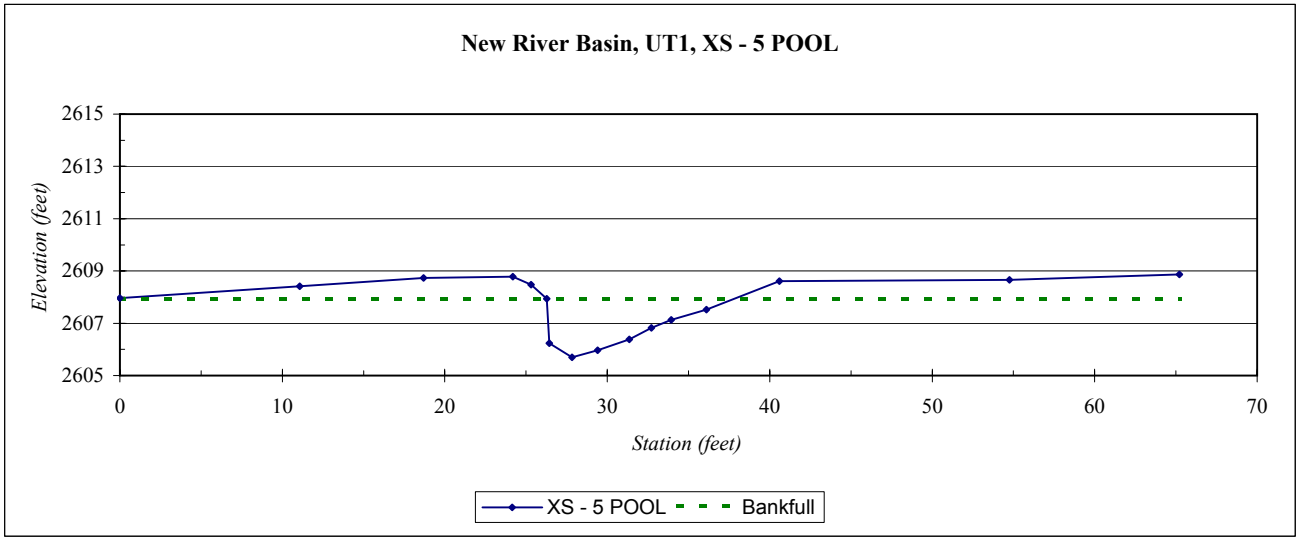
SUMMARY DATA	
Bankfull Elevation:	2608.90
Bankfull Cross-Sectional Area:	15.7
Bankfull Width:	13.6
Flood Prone Area Elevation:	2610.7
Flood Prone Width:	44.0
Max Depth at Bankfull:	1.8
Mean Depth at Bankfull:	1.2
W / D Ratio:	11.7
Entrenchment Ratio:	3.2
Bank Height Ratio:	1.7
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 5 POOL
Drainage Area (sq mi):	0.53
Date:	4/24/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2607.96
11.1	2608.42
18.7	2608.73
24.2	2608.78
25.3	2608.47
26.3	2607.94
26.4	2606.24
27.8	2605.70
29.4	2605.96
31.4	2606.38
32.7	2606.82
33.9	2607.13
36.1	2607.52
40.6	2608.61
54.7	2608.66
65.2	2608.87

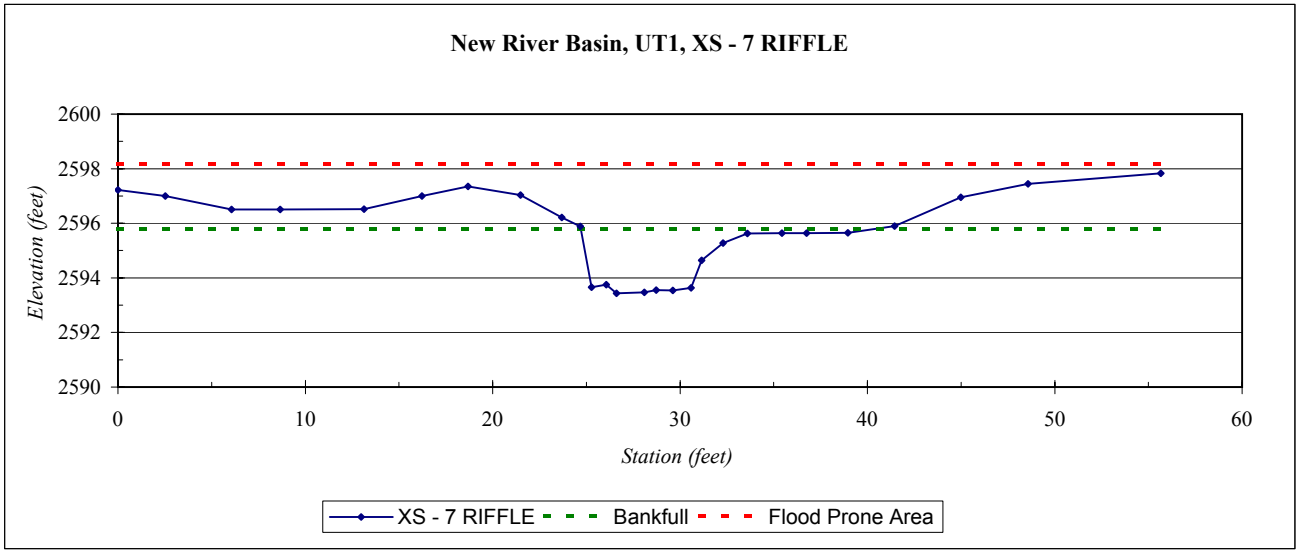
SUMMARY DATA	
Bankfull Elevation:	2607.9
Bankfull Cross-Sectional Area:	14.3
Bankfull Width:	11.5
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 7 RIFFLE
Drainage Area (sq mi):	0.53
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2597.22
2.5	2597.00
6.1	2596.50
8.7	2596.51
13.1	2596.51
16.2	2597.00
18.7	2597.35
21.5	2597.03
23.7	2596.22
24.7	2595.88
25.3	2593.65
26.1	2593.75
26.6	2593.44
28.1	2593.47
28.7	2593.55
29.6	2593.54
30.6	2593.64
31.2	2594.65
32.3	2595.28
33.6	2595.63
35.4	2595.64
36.7	2595.64
39.0	2595.65
41.5	2595.90
45.0	2596.95
48.6	2597.44
55.7	2597.83

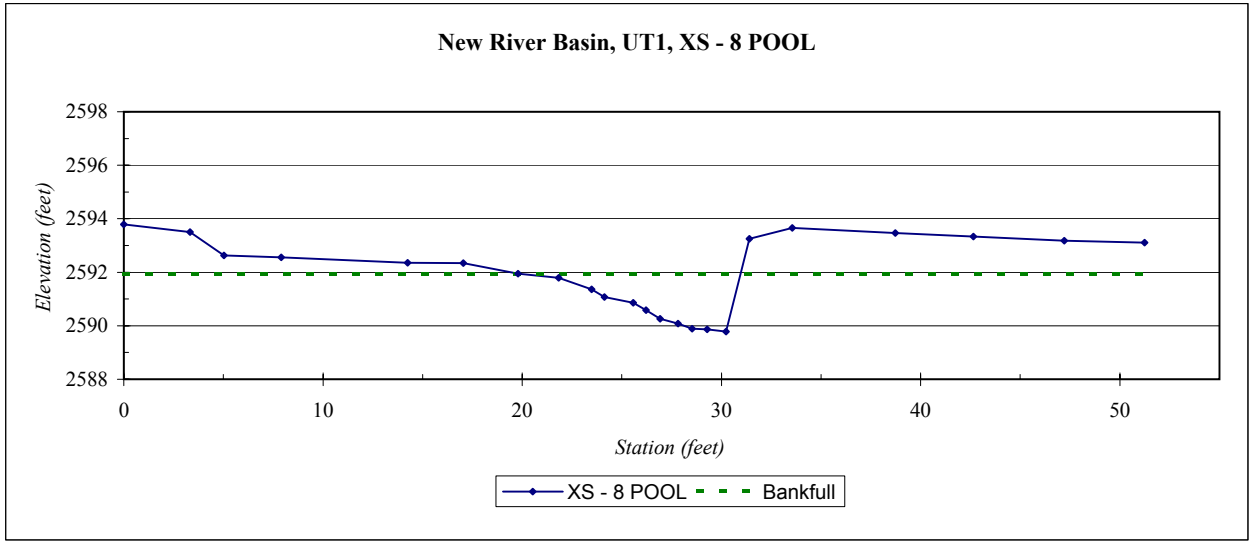
SUMMARY DATA	
Bankfull Elevation:	2595.80
Bankfull Cross-Sectional Area:	15.9
Bankfull Width:	15.8
Flood Prone Area Elevation:	2598.2
Flood Prone Width:	>55
Max Depth at Bankfull:	2.4
Mean Depth at Bankfull:	1.0
W / D Ratio:	15.7
Entrenchment Ratio:	3.5
Bank Height Ratio:	1.0
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 8 POOL
Drainage Area (sq mi):	0.53
Date:	4/24/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2593.79
3.3	2593.50
5.0	2592.63
7.9	2592.56
14.2	2592.36
17.0	2592.35
19.8	2591.95
21.8	2591.79
23.5	2591.36
24.1	2591.07
25.6	2590.86
26.2	2590.59
26.9	2590.26
27.8	2590.08
28.5	2589.89
29.3	2589.87
30.2	2589.79
31.4	2593.25
33.6	2593.66
38.7	2593.46
42.7	2593.34
47.2	2593.18
51.2	2593.11

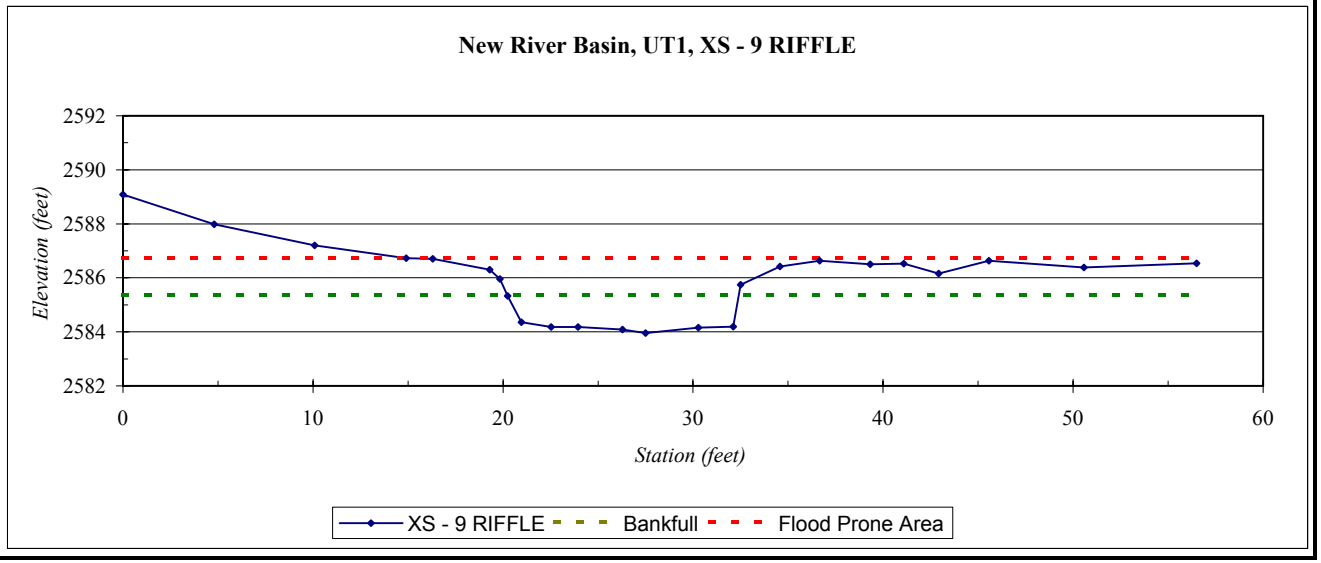
SUMMARY DATA	
Bankfull Elevation:	2591.9
Bankfull Cross-Sectional Area:	13.6
Bankfull Width:	11.1
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 9 RIFFLE
Drainage Area (sq mi):	0.53
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2589.09
4.8	2587.98
10.1	2587.20
14.9	2586.73
16.3	2586.70
19.3	2586.30
19.8	2585.95
20.2	2585.33
21.0	2584.35
22.5	2584.18
23.9	2584.19
26.3	2584.09
27.5	2583.95
30.3	2584.15
32.1	2584.20
32.5	2585.74
34.6	2586.42
36.7	2586.63
39.3	2586.50
41.1	2586.53
42.9	2586.16
45.6	2586.63
50.6	2586.39
56.5	2586.53

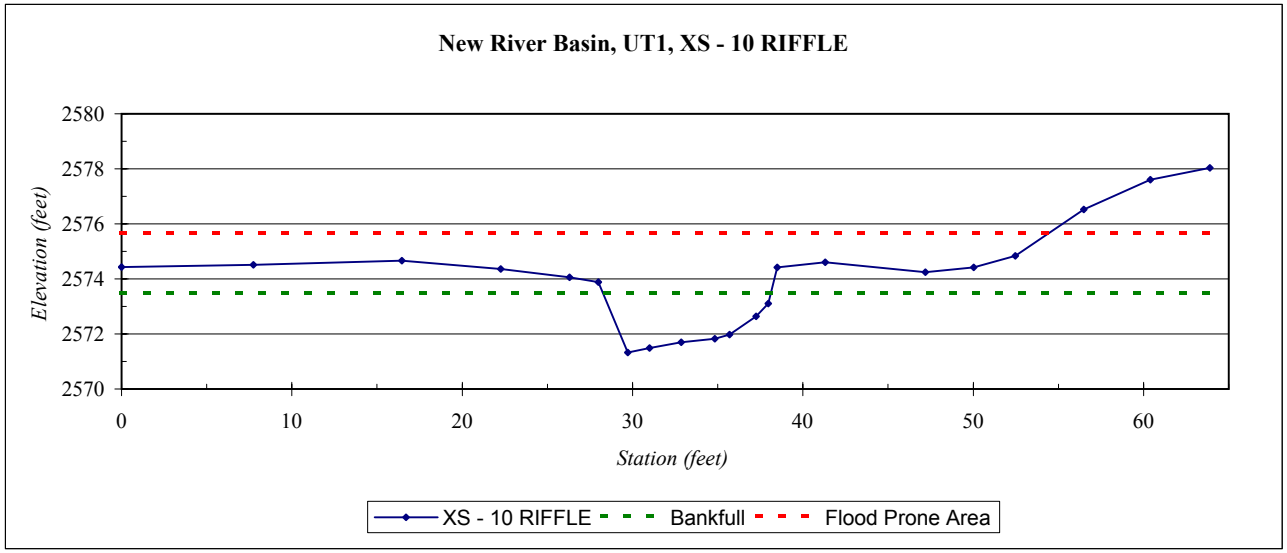
SUMMARY DATA	
Bankfull Elevation:	2585.35
Bankfull Cross-Sectional Area:	14.1
Bankfull Width:	12.2
Flood Prone Area Elevation:	2586.7
Flood Prone Width:	>40
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	1.2
W / D Ratio:	10.6
Entrenchment Ratio:	3.3
Bank Height Ratio:	1.7
Water Surface Slope (ft/ft):	0.021



River Basin:	New
Watershed:	UT1
XS ID	XS - 10 RIFFLE
Drainage Area (sq mi):	0.53
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2574.43
7.7	2574.51
16.5	2574.66
22.3	2574.37
26.3	2574.06
28.0	2573.88
29.7	2571.33
31.0	2571.48
32.9	2571.69
34.8	2571.82
35.7	2571.98
37.2	2572.63
38.0	2573.11
38.5	2574.42
41.3	2574.61
47.2	2574.24
50.0	2574.41
52.5	2574.83
56.5	2576.52
60.4	2577.60
63.9	2578.03

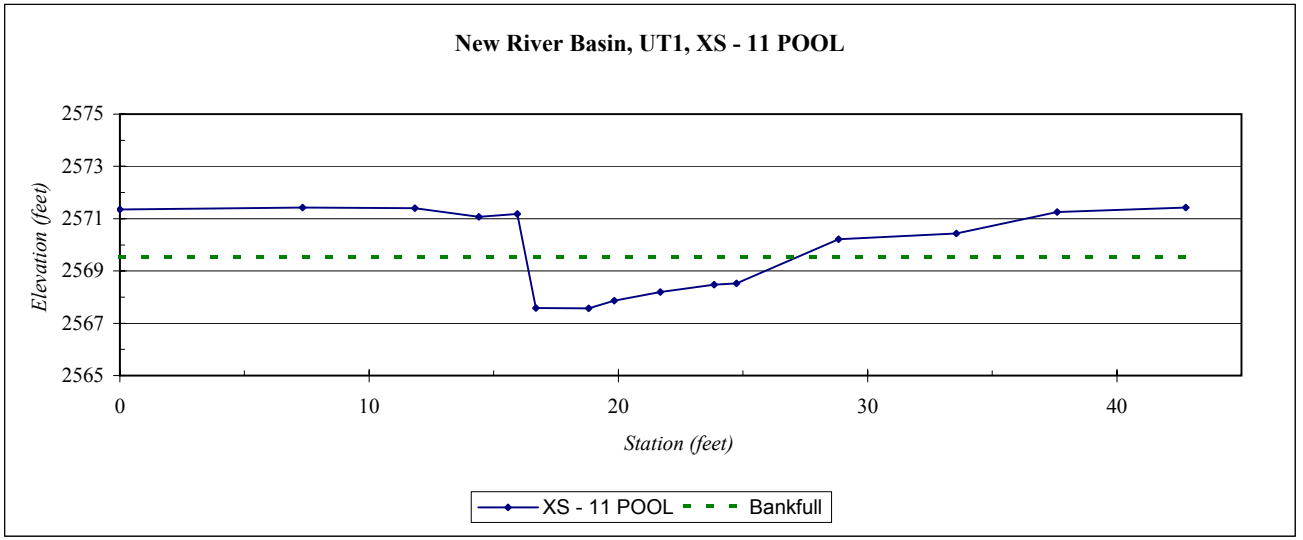
SUMMARY DATA	
Bankfull Elevation:	2573.50
Bankfull Cross-Sectional Area:	15.0
Bankfull Width:	9.9
Flood Prone Area Elevation:	2575.7
Flood Prone Width:	>55
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.5
W / D Ratio:	6.5
Entrenchment Ratio:	5.6
Bank Height Ratio:	1.2
Water Surface Slope (ft/ft):	0.018



River Basin:	New
Watershed:	UT1
XS ID	XS - 11 POOL
Drainage Area (sq mi):	0.53
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

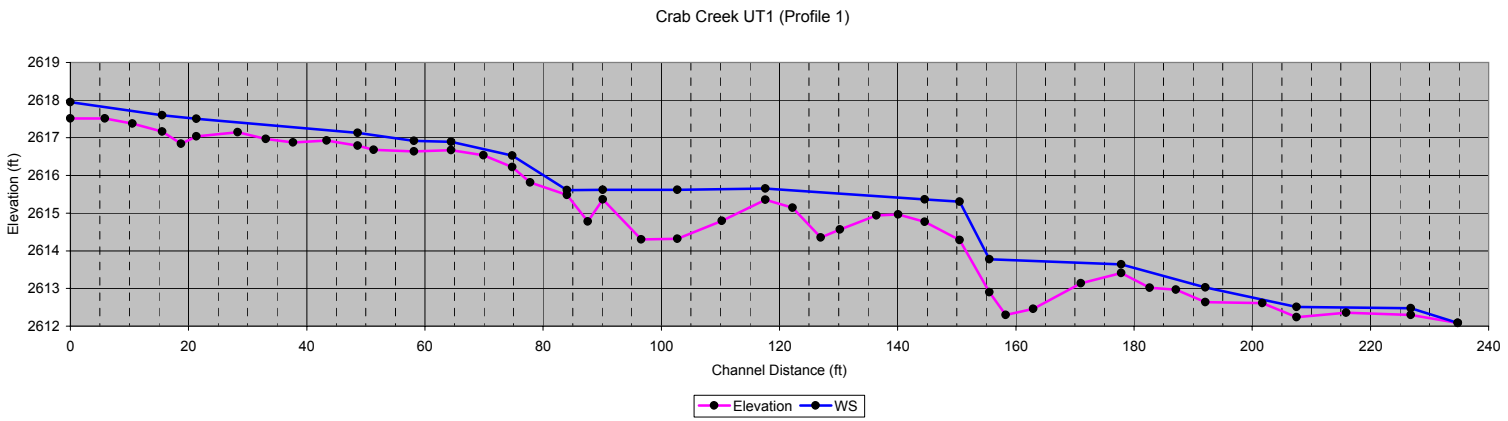
Station	Elevation
0.0	2571.35
7.3	2571.43
11.8	2571.40
14.4	2571.07
15.9	2571.18
16.7	2567.59
18.8	2567.57
19.8	2567.87
21.7	2568.20
23.8	2568.48
24.7	2568.52
28.8	2570.21
33.6	2570.43
37.6	2571.25
42.8	2571.42

SUMMARY DATA	
Bankfull Elevation:	2569.6
Bankfull Cross-Sectional Area:	14.1
Bankfull Width:	10.9
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.0
Mean Depth at Bankfull:	1.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.018



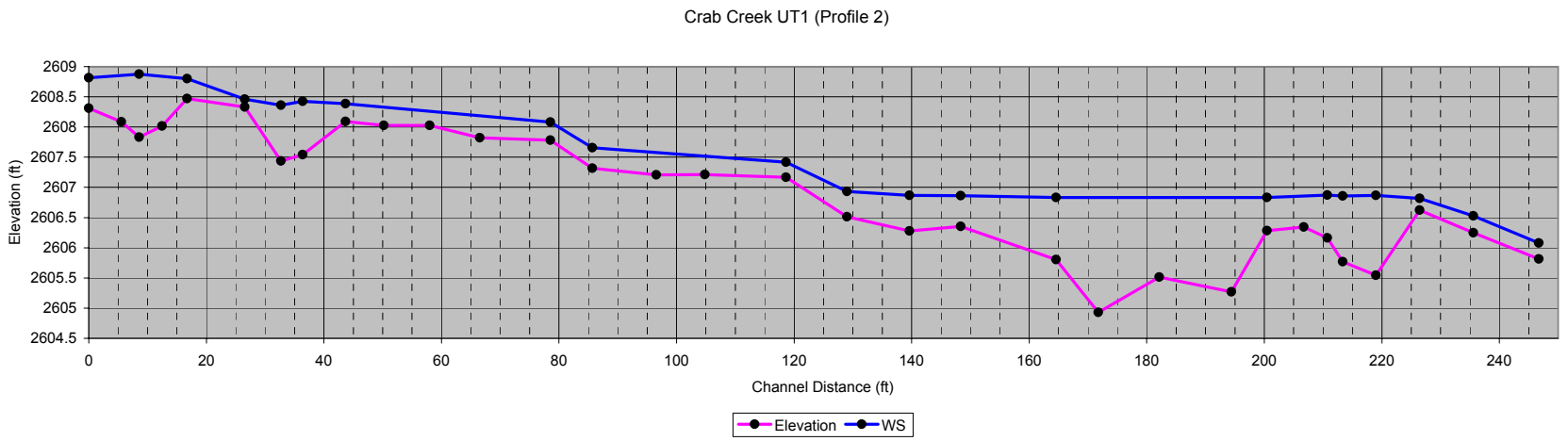
Existing Profiles

Slope Profile



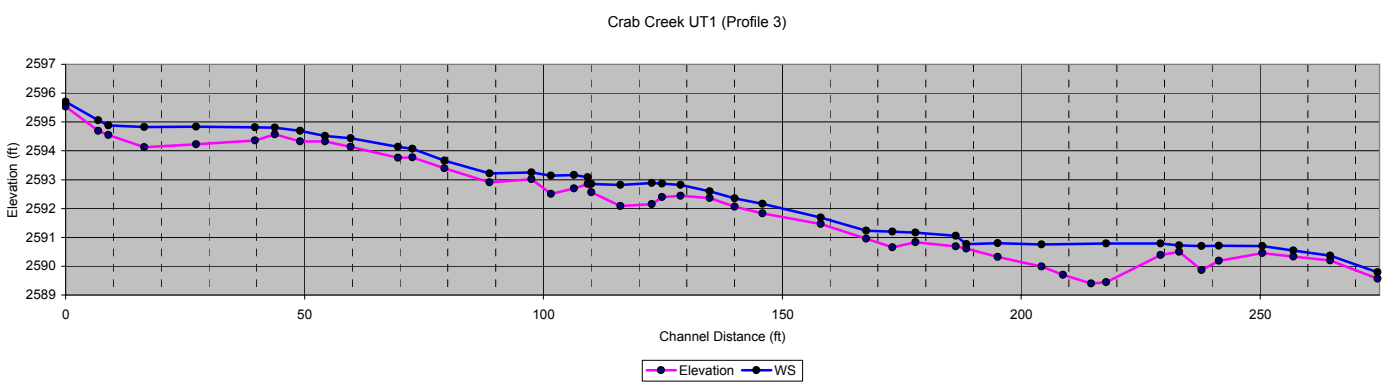
		Elevation BM:	100															
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
BRI		0.0		100									2617.51					2617.945
PRO1_RI	5.8	5.8		100									2617.51					
PRO1_RI	4.7	10.5		100									2617.38					
PRO1_RI	5.0	15.6		100									2617.17					2617.596
PRO1_RI	3.2	18.7		100									2616.85					
PRO1_RI	2.6	21.3		100									2617.03					2617.505
PRO1_RI	7.0	28.3		100									2617.15					
PRO1_RI	4.8	33.1		100									2616.97					
PRO1_RI	4.6	37.7		100									2616.87					
PRO1_RI	5.7	43.4		100									2616.92					
PRO1_RI	5.2	48.6		100									2616.79					2617.128
PRO1_RI	2.7	51.4		100									2616.68					
PRO1_RI	6.8	58.2		100									2616.64					2616.918
PRO1_RI	6.3	64.4		100									2616.67					2616.894
PRO1_RI	5.5	69.9		100									2616.53					
PRO1_RI	4.9	74.8		100									2616.22					2616.526
PRO1_RI	3.0	77.8		100									2615.81					
PRO1_ERI	6.2	84.0		100									2615.48					2615.614
PRO1_RU	3.5	87.6		100									2614.78					
PRO1_BPO	2.5	90.1		100									2615.37					2615.621
PRO1_PO	6.5	96.6		100									2614.31					
PRO1_EPO	6.1	102.7		100									2614.32					2615.618
PRO1_GL	7.5	110.3		100									2614.79					
PRO1_BRI	7.3	117.6		100									2615.36					2615.656
PRO1_ERI	4.6	122.2		100									2615.14					
PRO1_PO	4.8	127.0		100									2614.35					
PRO1_PO	3.2	130.2		100									2614.56					
PRO1_TW	6.2	136.4		100									2614.94					
PRO1_TW	3.7	140.1		100									2614.97					
PRO1_B-DEBRIS	4.5	144.6		100									2614.77					2615.364
PRO1_DEBRIS=TW	5.9	150.5		100									2614.29					2615.301
PRO1_E-DEBRIS	5.0	155.5		100									2612.90					2613.772
PRO1_BPO	2.8	158.3		100									2612.30					
PRO1_EPO	4.7	162.9		100									2612.46					
PRO1_GL	8.1	171.0		100									2613.14					
PRO1_BRI	6.9	177.9		100									2613.41					2613.643
PRO1_RI	4.8	182.7		100									2613.02					
PRO1_RI	4.4	187.1		100									2612.97					
PRO1_RI	5.0	192.1		100									2612.64					2613.024
PRO1_RI	9.7	201.7		100									2612.61					
PRO1_RI	5.8	207.5		100									2612.23					2612.512
PRO1_RI	8.4	215.9		100									2612.36					
PRO1_RI	11.0	226.8		100									2612.299					2612.474
PRO1_ERI=WS	8.0	234.8		100									2612.085					2612.085

Slope Profile



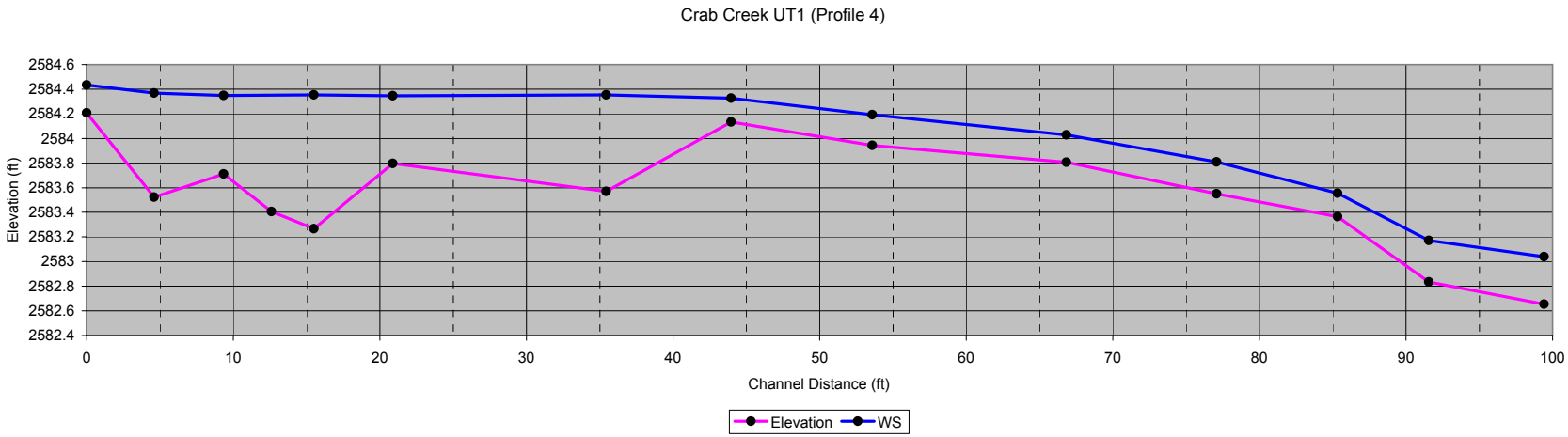
		Elevation BM:	100														
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO2_BRUN		0		100									2608.308					2608.815
PRO2_RUN	5.5	5.5		100									2608.084					
PRO2_BPO	3.0	8.6		100									2607.833					2608.876
PRO2_EPO	3.9	12.5		100									2608.016					
PRO2_BRI	4.3	16.7		100									2608.472					2608.802
PRO2_ERI	9.8	26.6		100									2608.332					2608.46
PRO2_BPO	6.1	32.7		100									2607.439					2608.358
PRO2_EPO	3.7	36.4		100									2607.543					2608.425
PRO2_BRI	7.3	43.7		100									2608.09					2608.388
PRO2_RI	6.5	50.2		100									2608.027					
PRO2_RI	7.8	58.0		100									2608.024					
PRO2_RI	8.6	66.5		100									2607.822					
PRO2_RI	12.0	78.5		100									2607.783					2608.081
PRO2_RI	7.2	85.7		100									2607.319					2607.658
PRO2_RI	10.9	96.6		100									2607.206					
PRO2_RI	8.3	104.8		100									2607.211					
PRO2_RI	13.8	118.6		100									2607.168					2607.418
PRO2_ERI	10.4	129.0		100									2606.513					2606.931
PRO2_RUN	10.6	139.6		100									2606.28					2606.867
PRO2_RUN	8.7	148.3		100									2606.352					2606.862
PRO2_BPO	16.2	164.6		100									2605.805					2606.834
PRO2_PO	7.2	171.7		100									2604.931					
PRO2_PO	10.4	182.1		100									2605.515					
PRO2_PO	12.2	194.4		100									2605.272					
PRO2_EPO	6.1	200.5		100									2606.285					2606.83
PRO2_TW	6.3	206.7		100									2606.343					
PRO2_TW	4.0	210.7		100									2606.164					2606.871
PRO2_BPO	2.6	213.4		100									2605.769					2606.858
PRO2_EPO	5.6	219.0		100									2605.546					2606.867
PRO2_BR	7.4	226.4		100									2606.625					2606.816
PRO2_RI	9.1	235.6		100									2606.249					2606.53
PRO2_ERI	11.2	246.7		100									2605.814					2606.078

Slope Profile



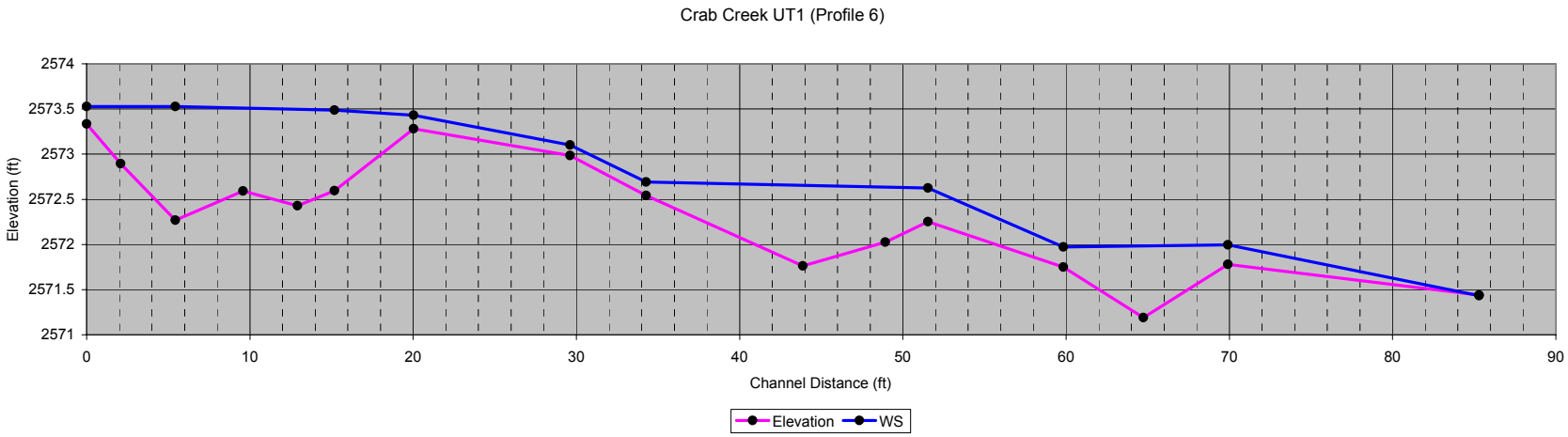
		Elevation BM:	100															
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO3_BRI		0.0		100									2595.54					2595.707
PRO3_RI	6.9	6.9		100									2594.688					2595.06
PRO3_ERI	2.1	9.0		100									2594.545					2594.881
PRO3_TW	7.5	16.5		100									2594.129					2594.821
PRO3_TW	10.9	27.3		100									2594.224					2594.838
PRO3_TW	12.4	39.7		100									2594.358					2594.811
PRO3_BRI	4.1	43.8		100									2594.572					2594.803
PRO3_RI	5.3	49.1		100									2594.33					2594.69
PRO3_RI	5.3	54.3		100									2594.327					2594.518
PRO3_RI	5.3	59.7		100									2594.132					2594.439
PRO3_RI	9.9	69.6		100									2593.755					2594.135
PRO3_RI	3.0	72.6		100									2593.771					2594.069
PRO3_RI	6.7	79.3		100									2593.398					2593.66
PRO3_ERI	9.5	88.8		100									2592.908					2593.213
PRO3_TW	8.7	97.5		100									2593.016					2593.254
PRO3_TW	4.1	101.6		100									2592.51					2593.14
PRO3_TW	4.8	106.4		100									2592.69					2593.158
PRO3_TW	2.8	109.3		100									2592.856					2593.083
PRO3_TW	0.8	110.0		100									2592.561					2592.854
PRO3_TW	6.1	116.1		100									2592.081					2592.822
PRO3_TW	6.6	122.7		100									2592.146					2592.885
PRO3_BRI	2.2	124.9		100									2592.393					2592.86
PRO3_RI	3.8	128.7		100									2592.436					2592.815
PRO3_RI	6.1	134.8		100									2592.365					2592.592
PRO3_RI	5.2	140.0		100									2592.066					2592.348
PRO3_RI	5.9	145.9		100									2591.832					2592.16
PRO3_RI	12.2	158.0		100									2591.461					2591.69
PRO3_RI	9.5	167.6		100									2590.958					2591.227
PRO3_TW	5.5	173.1		100									2590.656					2591.194
PRO3_RI	4.8	177.9		100									2590.833					2591.164
PRO3_RI	8.5	186.3		100									2590.687					2591.056
PRO3_RI	10.6	188.5		100									2590.608					2590.766
PRO3_ERI	6.6	195.1		100									2590.321					2590.794
PRO3_BPO	9.1	204.3		100									2589.984					2590.752
PRO3_PO	4.5	208.8		100									2589.704					
PRO3_PO	5.9	214.6		100									2589.402					
PRO3_EPO	3.2	217.8		100									2589.443					2590.785
PRO3_TW	11.4	229.2		100									2590.382					2590.781
PRO3_TW	3.9	233.1		100									2590.495					2590.723
PRO3_TW	4.6	237.7		100									2589.869					2590.703
PRO3_TW	3.6	241.4		100									2590.186					2590.705
PRO3_TW	9.1	250.5		100									2590.454					2590.703
PRO3_BRI	6.5	257.0		100									2590.329					2590.545
PRO3_RI	7.7	264.7		100									2590.202					2590.368
PRO3_RI	9.9	274.6		100									2589.57					2589.789

Slope Profile



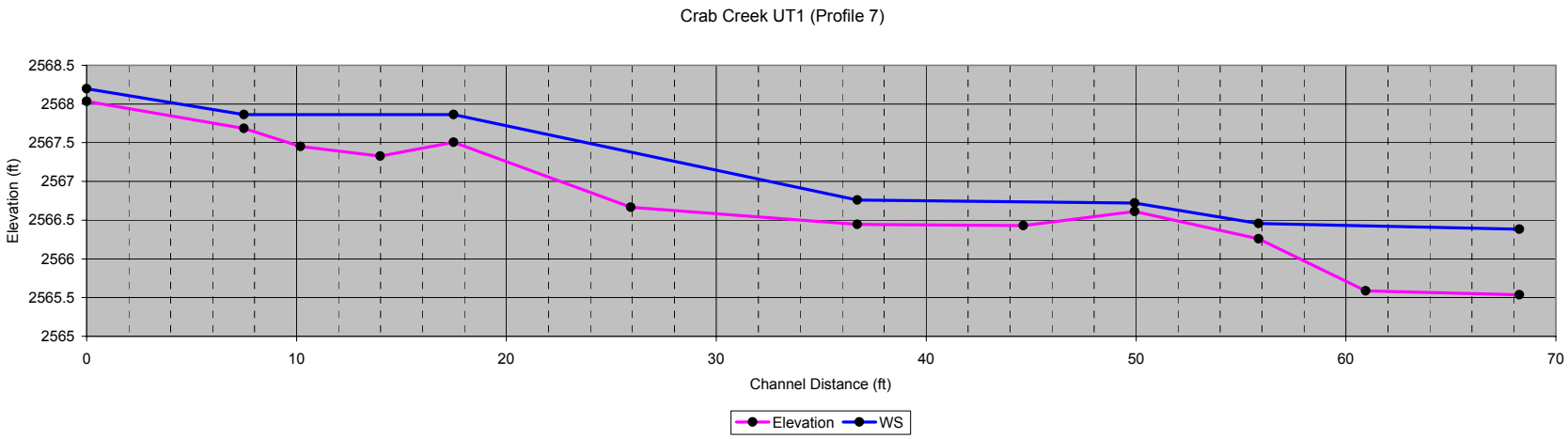
		Elevation BM:	100														
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO4_ERI		0		100									2584.208					2584.435
PRO4_TW	4.6	4.6		100									2583.524					2584.368
PRO4_TW	4.7	9.3		100									2583.712					2584.35
PRO4_BPO	3.3	12.6		100									2583.406					
PRO4_EPO	2.9	15.5		100									2583.267					2584.354
PRO4_TW	5.4	20.9		100									2583.796					2584.346
PRO4_TW	14.6	35.4		100									2583.57					2584.353
PRO4_BRI	8.5	44.0		100									2584.134					2584.327
PRO4_RI	9.6	53.6		100									2583.943					2584.193
PRO4_RI	13.2	66.8		100									2583.807					2584.028
PRO4_RI	10.3	77.1		100									2583.549					2583.81
PRO4_RI	8.3	85.3		100									2583.365					2583.555
PRO4_RI	6.2	91.6		100									2582.835					2583.171
PRO4_RI	7.9	99.4		100									2582.654					2583.041

Slope Profile



		Elevation BM:	100														
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO6_ERI		0.0		100									2573.335					2573.527
PRO6_RU	2.1	2.1		100									2572.894					
PRO6_BPO	3.4	5.4		100									2572.268					2573.527
PRO6_PO	4.1	9.6		100									2572.591					
PRO6_PO	3.3	12.9		100									2572.429					
PRO6_EPO	2.3	15.2		100									2572.595					2573.488
PRO6_BRI	4.9	20.0		100									2573.281					2573.431
PRO6_RI	9.6	29.6		100									2572.984					2573.1
PRO6_ERI=DEBRIS	4.7	34.3		100									2572.543					2572.692
PRO6_EDEBRIS	9.6	43.9		100									2571.762					
PRO6_TW	5.0	48.9		100									2572.024					
PRO6_BRI	2.6	51.5		100									2572.251					2572.624
PRO6_ERI	8.3	59.8		100									2571.75					2571.971
PRO6_TW	4.9	64.7		100									2571.189					
PRO6_BRI	5.2	69.9		100									2571.778					2571.995
PRO6_ERI	15.4	85.3		100									2571.439					2571.434

Slope Profile



		Elevation BM:	100														
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO7_BRI		0		100									2568.034					2568.196
PRO7_ERI	7.5	7.5		100									2567.686					2567.862
PRO7_TW	2.7	10.2		100									2567.453					
PRO7_TW	3.8	14.0		100									2567.327					
PRO7_ERI	3.5	17.5		100									2567.505					2567.862
PRO7_RI	8.4	25.9		100									2566.668					
PRO7_ERI	10.8	36.7		100									2566.445					2566.76
PRO7_TW	7.9	44.6		100									2566.43					
PRO7_BRI	5.3	49.9		100									2566.613					2566.719
PRO7_ERI	5.9	55.8		100									2566.26					2566.458
PRO7_TW	5.1	60.9		100									2565.585					
PRO7_TWTR=TWMC	7.3	68.3		100									2565.536					2566.384

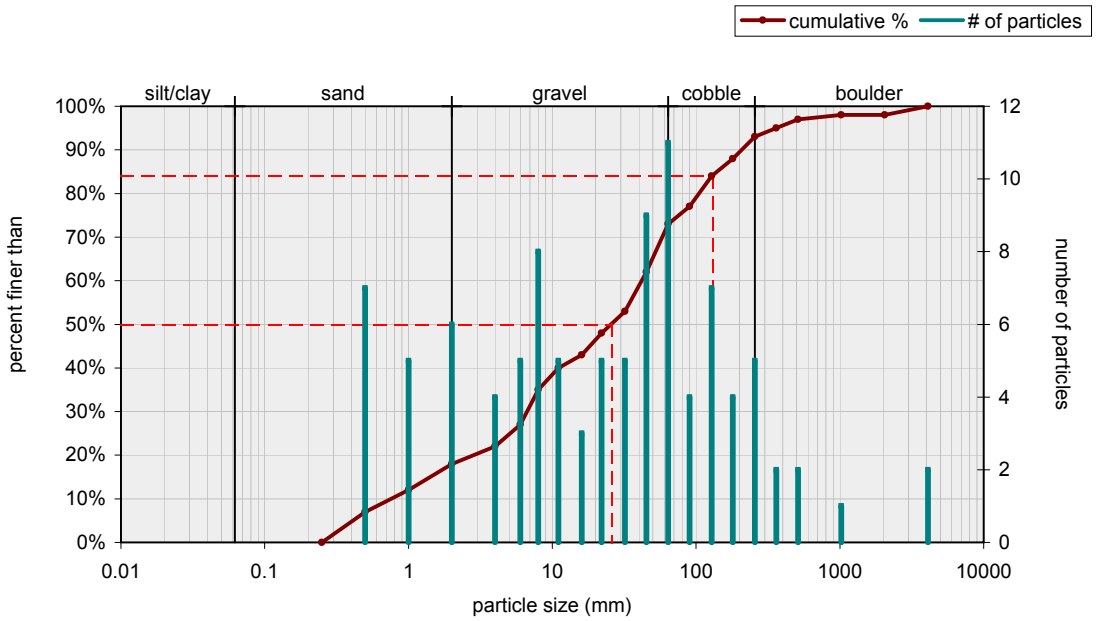
Sediment

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**7**
coarse sand	0.5 - 1	**5**
very coarse sand	1 - 2	**6**
very fine gravel	2 - 4	**4**
fine gravel	4 - 6	**5**
fine gravel	6 - 8	**8**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**5**
coarse gravel	22 - 32	**5**
very coarse gravel	32 - 45	**9**
very coarse gravel	45 - 64	**11**
small cobble	64 - 90	**4**
medium cobble	90 - 128	**7**
large cobble	128 - 180	**4**
very large cobble	180 - 256	**5**
small boulder	256 - 362	**2**
small boulder	362 - 512	**2**
medium boulder	512 - 1024	**1**
large boulder	1024 - 2048	
very large boulder	2048 - 4096	**2**
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS1- Riffle (UT1)

Riffle Surface Pebble Count, ---



Size (mm)	
D16	1.6
D35	8
D50	26
D65	50
D84	130
D95	360

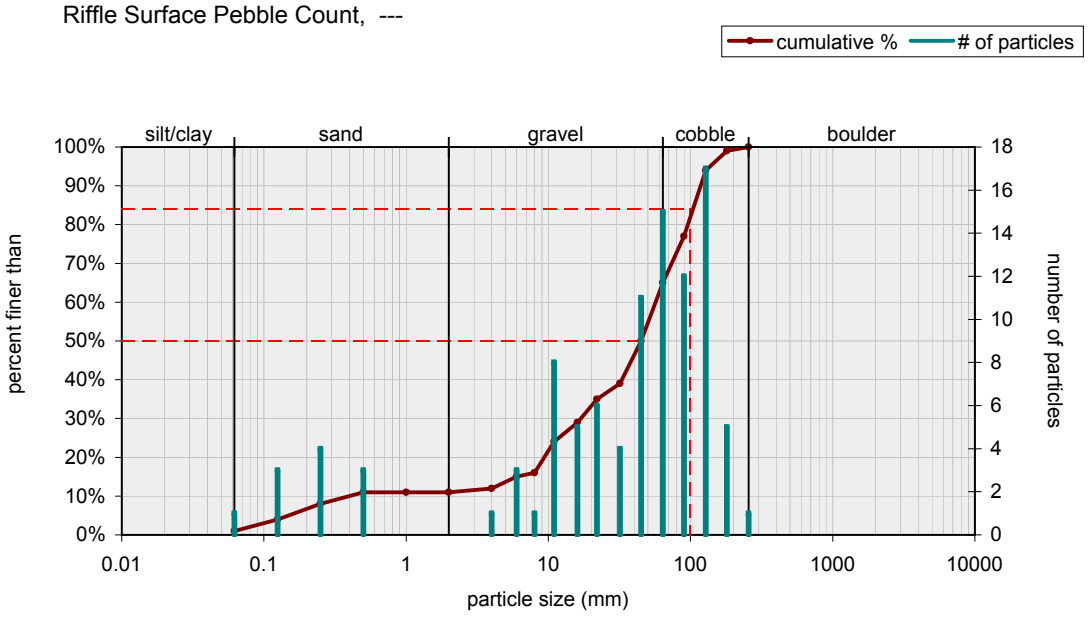
Size Distribution	
mean	14.4
dispersion	10.6
skewness	-0.19

Type	
silt/clay	0%
sand	18%
gravel	55%
cobble	20%
boulder	7%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**1**
very fine sand	0.062 - 0.125	**3**
fine sand	0.125 - 0.25	**4**
medium sand	0.25 - 0.5	**3**
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**8**
medium gravel	11 - 16	**5**
coarse gravel	16 - 22	**6**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**11**
very coarse gravel	45 - 64	**15**
small cobble	64 - 90	**12**
medium cobble	90 - 128	**17**
large cobble	128 - 180	**5**
very large cobble	180 - 256	**1**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS4- Riffle (UT1)



Size (mm)		
D16	8	3.4
D35	22	12
D50	45	17
D65	64	20
D84	100	29
D95	140	39

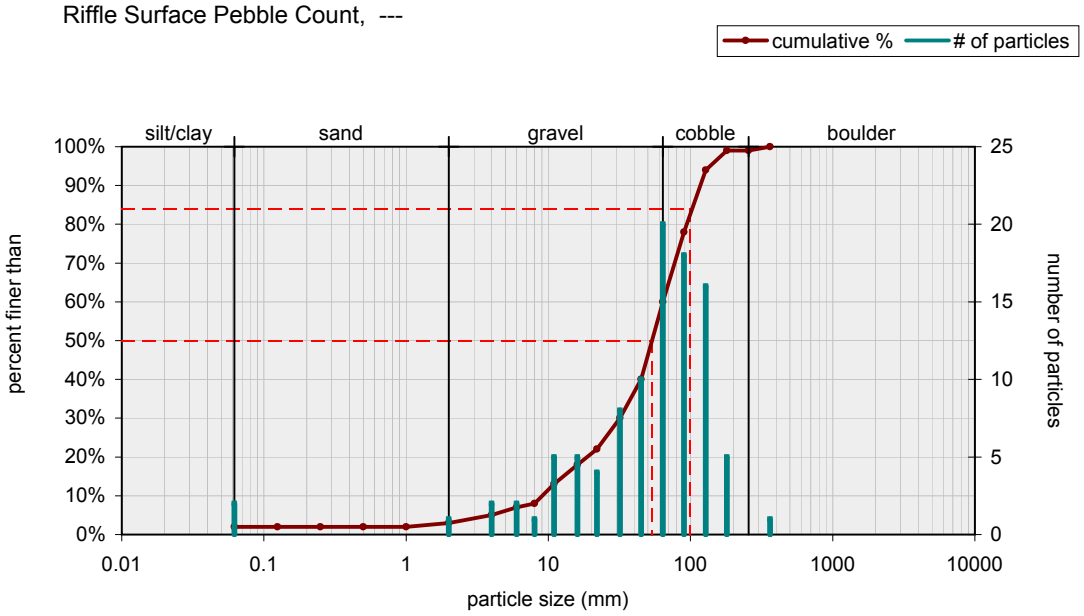
Size Distribution	
mean	28.3
dispersion	3.9
skewness	-0.19

Type	
silt/clay	1%
sand	10%
gravel	54%
cobble	35%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	**1**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**5**
coarse gravel	16 - 22	**4**
coarse gravel	22 - 32	**8**
very coarse gravel	32 - 45	**10**
very coarse gravel	45 - 64	**20**
small cobble	64 - 90	**18**
medium cobble	90 - 128	**16**
large cobble	128 - 180	**5**
very large cobble	180 - 256	
small boulder	256 - 362	**1**
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS7- Riffle (UT1)



Size (mm)		
D16	14	3.4
D35	38	12
D50	54	17
D65	70	20
D84	100	29
D95	140	39

Size Distribution	
mean	37.4
dispersion	2.9
skewness	-0.17

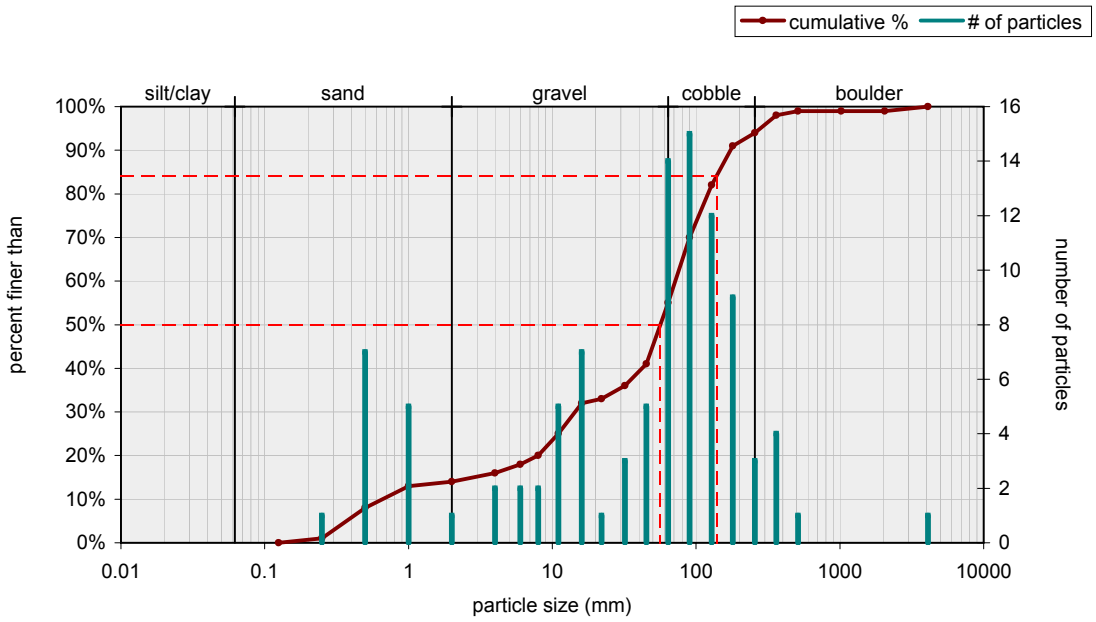
Type	
silt/clay	2%
sand	1%
gravel	57%
cobble	39%
boulder	1%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**1**
medium sand	0.25 - 0.5	**7**
coarse sand	0.5 - 1	**5**
very coarse sand	1 - 2	**1**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**1**
coarse gravel	22 - 32	**3**
very coarse gravel	32 - 45	**5**
very coarse gravel	45 - 64	**14**
small cobble	64 - 90	**15**
medium cobble	90 - 128	**12**
large cobble	128 - 180	**9**
very large cobble	180 - 256	**3**
small boulder	256 - 362	**4**
small boulder	362 - 512	**1**
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	**1**
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS9- Riffle (UT1)

Riffle Surface Pebble Count, ---



Size (mm)	
D16	4
D35	28
D50	56
D65	80
D84	140
D95	280

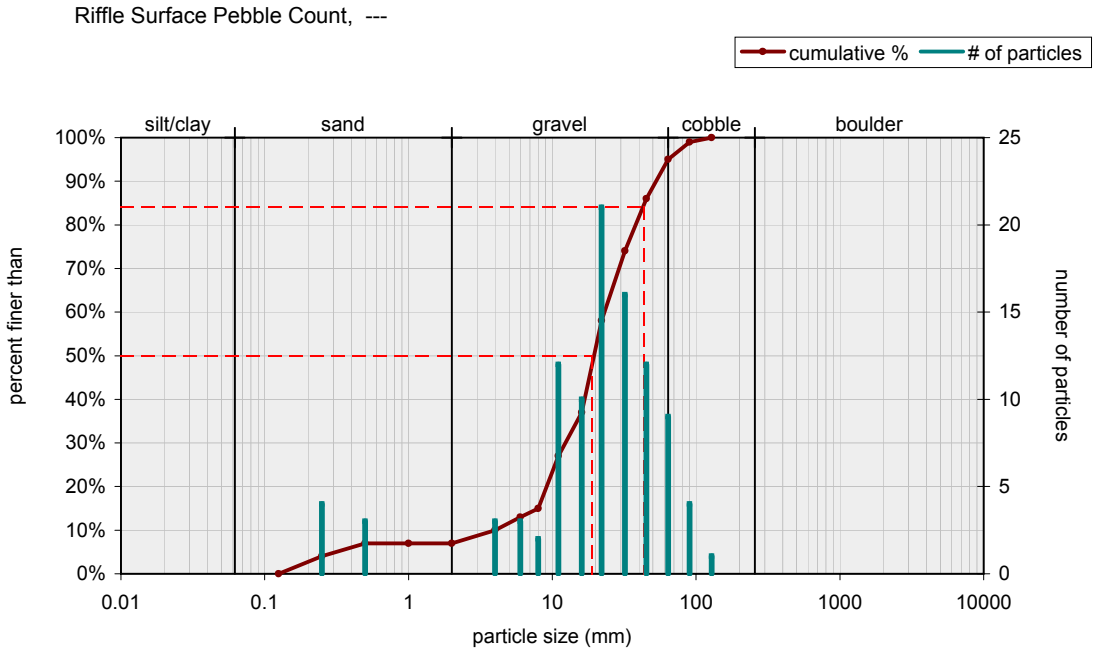
Size Distribution	
mean	23.7
dispersion	8.3
skewness	-0.30

Type	
silt/clay	0%
sand	14%
gravel	41%
cobble	39%
boulder	6%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**4**
medium sand	0.25 - 0.5	**3**
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**12**
medium gravel	11 - 16	**10**
coarse gravel	16 - 22	**21**
coarse gravel	22 - 32	**16**
very coarse gravel	32 - 45	**12**
very coarse gravel	45 - 64	**9**
small cobble	64 - 90	**4**
medium cobble	90 - 128	**1**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS10- Riffle (UT1)



Size (mm)	
D16	8.2
D35	15
D50	19
D65	26
D84	43
D95	64

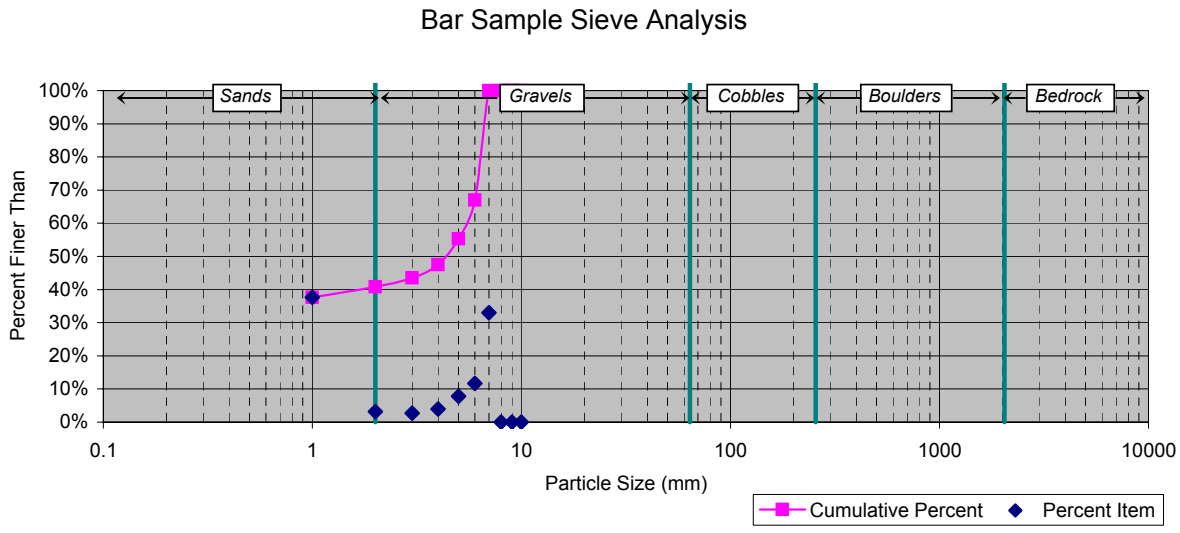
Size Distribution	
mean	18.8
dispersion	2.3
skewness	-0.01

Type	
silt/clay	0%
sand	7%
gravel	88%
cobble	5%
boulder	0%

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	134	37.6%	37.6%
1.0	11.5	3.2%	40.9%
2.0	9.5	2.7%	43.5%
4.0	14.0	3.9%	47.5%
8.0	28.0	7.9%	55.3%
16.0	41.5	11.7%	67.0%
31.5	117.5	33.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	356.0	100%	

Stream: Crab Creek UT1
Watershed:
Location: XS # 5 UT1
Note: Bar Sample # 1 (0-6 inches)

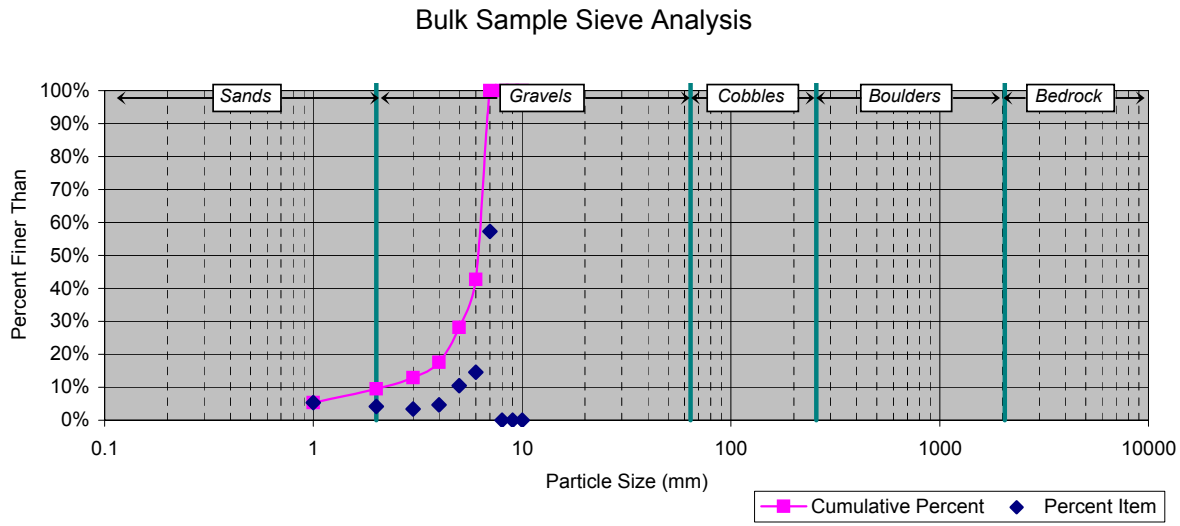


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
5.0	5.0	5.0	22.7	28.4	0%	44%	56%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	22	5.4%	5.4%
1.0	17.0	4.2%	9.5%
2.0	14.0	3.4%	13.0%
4.0	19.0	4.6%	17.6%
8.0	43.0	10.5%	28.1%
16.0	59.6	14.6%	42.7%
31.5	234.4	57.3%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	409.0	100%	

Stream: Crab Creek UT1
Watershed:
Location: XS # 1 UT1
Note: Bulk Sample # 1 (0-3.5 inches)

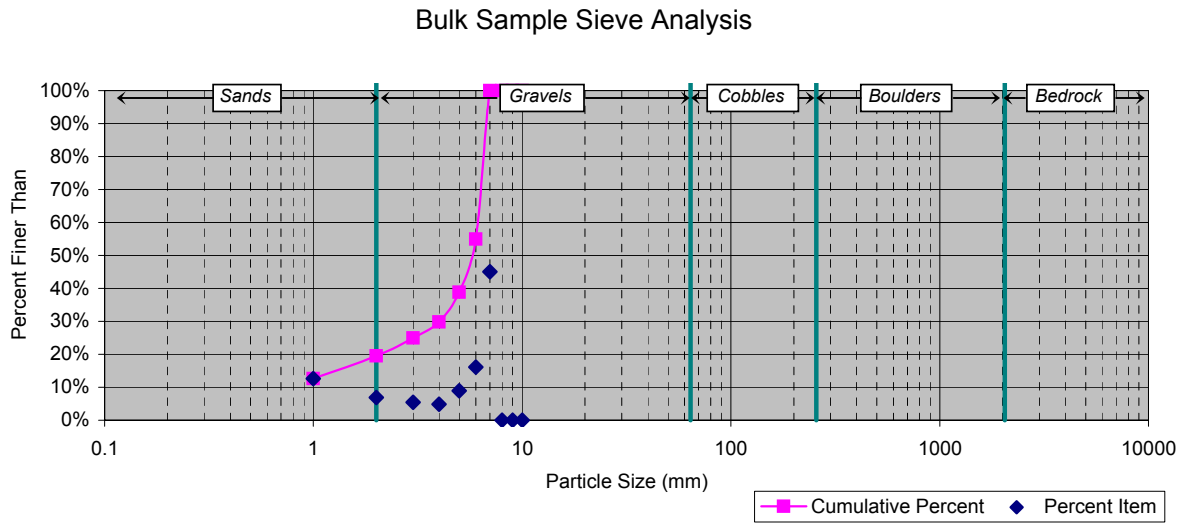


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
3.1	11.1	17.4	26.1	29.7	0%	13%	87%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	52	12.6%	12.6%
1.0	28.5	6.9%	19.5%
2.0	22.5	5.5%	25.0%
4.0	20.0	4.9%	29.9%
8.0	37.0	9.0%	38.8%
16.0	66.5	16.1%	55.0%
31.5	185.5	45.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	412.0	100%	

Stream: Crab Creek UT1
Watershed:
Location: XS # 1 UT1
Note: Bulk Sample # 1 (3.5-6.5 inches)

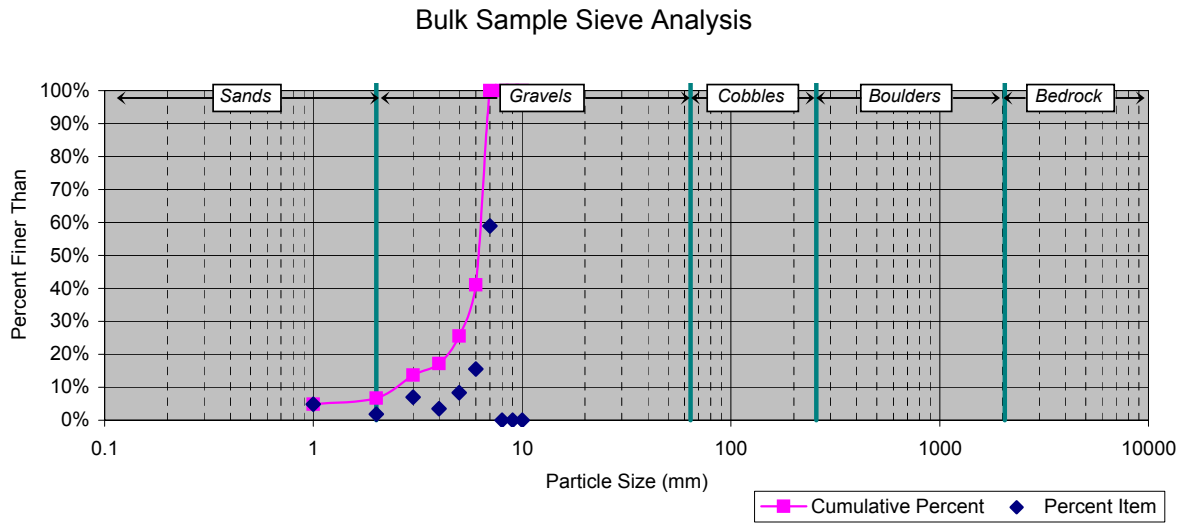


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
6.0	6.0	12.9	24.8	29.2	0%	25%	75%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	14.5	4.8%	4.8%
1.0	5.5	1.8%	6.7%
2.0	21.0	7.0%	13.7%
4.0	10.5	3.5%	17.2%
8.0	25.0	8.3%	25.5%
16.0	46.5	15.5%	41.1%
31.5	176.5	58.9%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	299.5	100%	

Stream: Crab Creek UT1
Watershed:
Location: XS # 9 UT1
Note: Bulk Sample # 2 (0-3.5 inches)

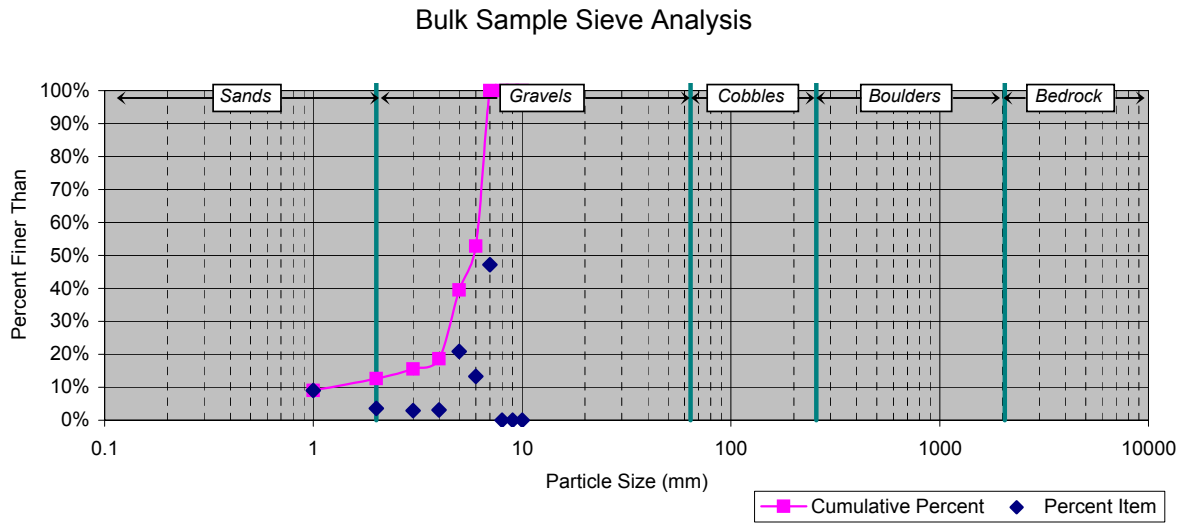


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
3.2	12.2	17.7	26.2	29.7	0%	14%	86%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	42	9.0%	9.0%
1.0	16.5	3.6%	12.6%
2.0	13.5	2.9%	15.5%
4.0	14.5	3.1%	18.6%
8.0	97.0	20.9%	39.5%
16.0	62.0	13.3%	52.9%
31.5	219.0	47.1%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	464.5	100%	

Stream:	Crab Creek UT1
Watershed:	
Location:	XS # 9 UT1
Note:	Bulk Sample # 2 (3.5-7 inches)



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.2	6.9	13.8	25.0	29.3	0%	16%	84%	0%	---	---

BEHI

Bank Erodibility Hazard Rating Guide

Stream: UT1 (Crab Creek Site) **Reach:** _____ **Date:** 4/24/07 **Crew:** AH

Bank Erosion Potential

Bank Height (ft): / Bankfull Height (ft):		Bank Height/ Bankfull Ht		Root Depth/ Bank Height		Root Density %		Bank Angle (Degrees)		Surface Protection%	
VERY LOW	Value Range	1.0	1.1	0.9	1.0	80	100	0.0	20.0	80	100
	Index Range	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V: 100.0**	**I: 1.0**
LOW	Value Range	1.11	1.19	0.5	0.89	55	79	21.0	60.0	55	79
	Index Range	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9
	Choice	**V:**	**I:**	**V: 0.80**	**I: 2.4**	**V: 75.0**	**I: 2.3**	**V:**	**I:**	**V:**	**I:**
MODERATE	Value Range	1.2	1.5	0.3	0.49	30	54	61.0	80.0	30	54
	Index Range	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9
	Choice	**V: 1.3**	**I: 4.6**	**V:**	**I:**	**V:**	**I:**	**V: 75.0**	**I: 5.4**	**V:**	**I:**
HIGH	Value Range	1.6	2.0	0.15	0.29	15	29	81.0	90.0	15	29
	Index Range	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
VERY HIGH	Value Range	2.1	2.8	0.05	0.14	5	14	91.0	119.0	10	14
	Index Range	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
EXTREME	Value Range	>2.8		<0.05		<5		>119		<10	
	Index Range	10		10		10		10		10	
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**

V = value, I = index

SUB-TOTAL (Sum one index from each column) 15.8

Bank Material Description:

Gravel and Sand Layers

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt Clay (+ 0: no adjustment)

Bank Sketch

BANK MATERIAL ADJUSTMENT 5

Stratification Comments:

_____

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT 5

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.9	10-19.9	20-29.9	30-39.9	40-45.9	46-50

Bank location description (check one)

GRAND TOTAL 25.8

BEHI RATING Moderate

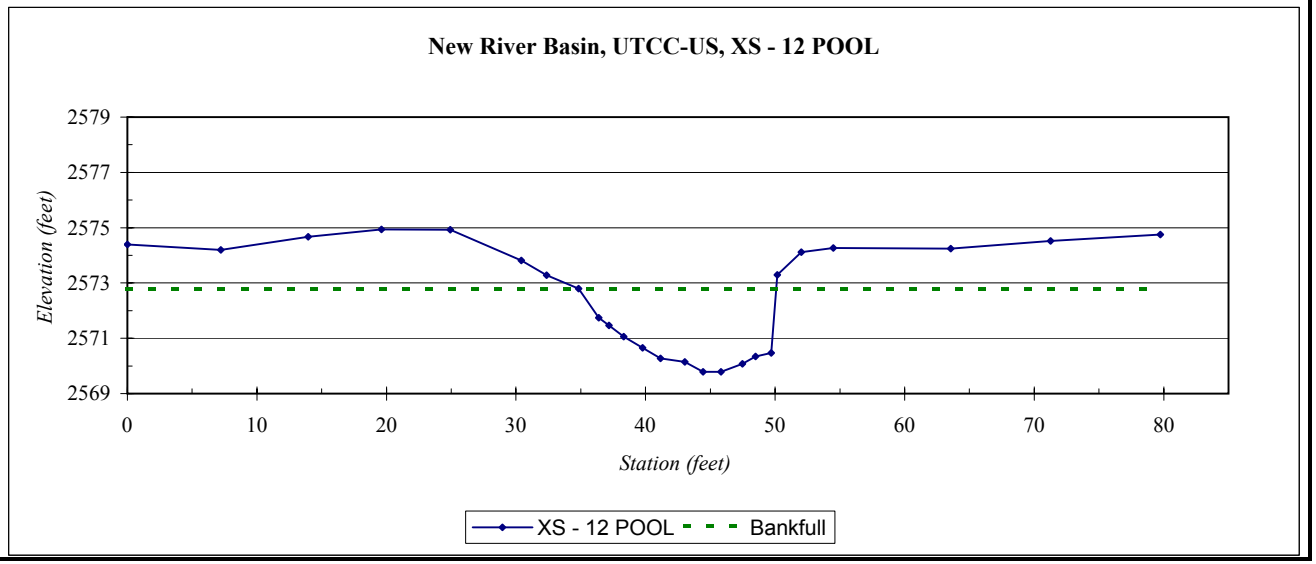
UTCC-US

Existing Cross Sections

River Basin:	New
Watershed:	UTCC-US
XS ID	XS - 12 POOL
Drainage Area (sq mi):	1.65
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2574.39
7.2	2574.20
14.0	2574.67
19.6	2574.93
24.9	2574.93
30.4	2573.81
32.3	2573.28
34.8	2572.79
36.4	2571.75
37.2	2571.47
38.3	2571.06
39.8	2570.66
41.1	2570.28
43.0	2570.14
44.4	2569.78
45.8	2569.79
47.5	2570.08
48.5	2570.35
49.7	2570.47
50.2	2573.29
52.0	2574.12
54.5	2574.26
63.6	2574.25
71.3	2574.52
79.7	2574.75

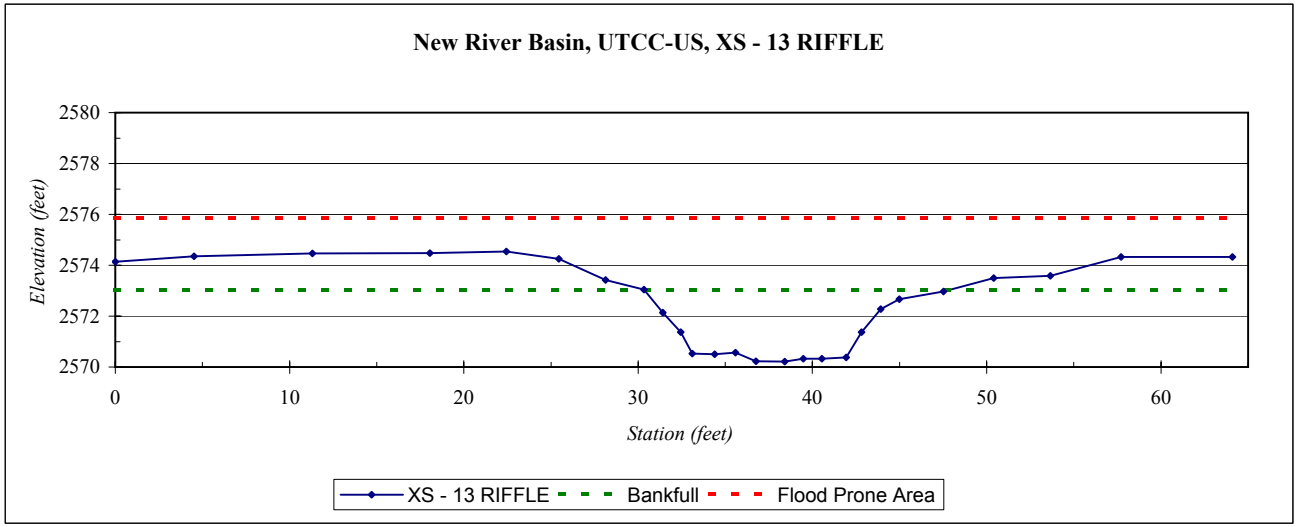
SUMMARY DATA	
Bankfull Elevation:	2572.8
Bankfull Cross-Sectional Area:	33.3
Bankfull Width:	15.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.0
Mean Depth at Bankfull:	2.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.009



River Basin:	New
Watershed:	UTCC-US
XS ID	XS - 13 RIFFLE
Drainage Area (sq mi):	1.65
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2574.14
4.5	2574.35
11.3	2574.46
18.1	2574.47
22.4	2574.55
25.4	2574.25
28.1	2573.42
30.3	2573.04
31.4	2572.14
32.4	2571.37
33.1	2570.53
34.4	2570.51
35.6	2570.56
36.8	2570.23
38.4	2570.21
39.5	2570.33
40.5	2570.33
41.9	2570.37
42.8	2571.37
43.9	2572.28
45.0	2572.66
47.5	2572.97
50.4	2573.49
53.7	2573.59
57.7	2574.32
64.1	2574.32

SUMMARY DATA	
Bankfull Elevation:	2573.04
Bankfull Cross-Sectional Area:	30.8
Bankfull Width:	17.6
Flood Prone Area Elevation:	2575.9
Flood Prone Width:	>65
Max Depth at Bankfull:	2.8
Mean Depth at Bankfull:	1.8
W / D Ratio:	10.0
Entrenchment Ratio:	>3.7
Bank Height Ratio:	1.0
Water Surface Slope (ft/ft):	0.009



River Basin:	New
Watershed:	UTCC-US
XS ID	XS - 14 RIFFLE
Drainage Area (sq mi):	2.12
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2568.30
6.7	2568.19
14.2	2568.26
20.2	2568.01
23.3	2567.38
25.5	2566.72
27.7	2566.14
29.3	2565.65
30.2	2565.04
31.0	2564.71
32.5	2564.29
34.3	2564.19
35.7	2564.22
37.5	2564.21
39.7	2564.20
41.7	2564.10
43.4	2564.43
45.0	2565.78
46.0	2566.43
47.8	2567.03
52.1	2566.93
58.2	2568.10
64.1	2568.83
71.2	2568.87

SUMMARY DATA	
Bankfull Elevation:	2566.50
Bankfull Cross-Sectional Area:	34.2
Bankfull Width:	19.9
Flood Prone Area Elevation:	2568.9
Flood Prone Width:	65.0
Max Depth at Bankfull:	2.4
Mean Depth at Bankfull:	1.7
W / D Ratio:	11.6
Entrenchment Ratio:	3.3
Bank Height Ratio:	1.2
Water Surface Slope (ft/ft):	0.009

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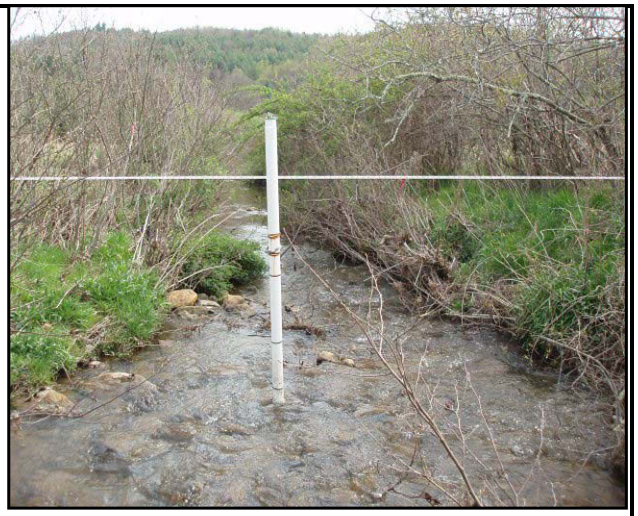
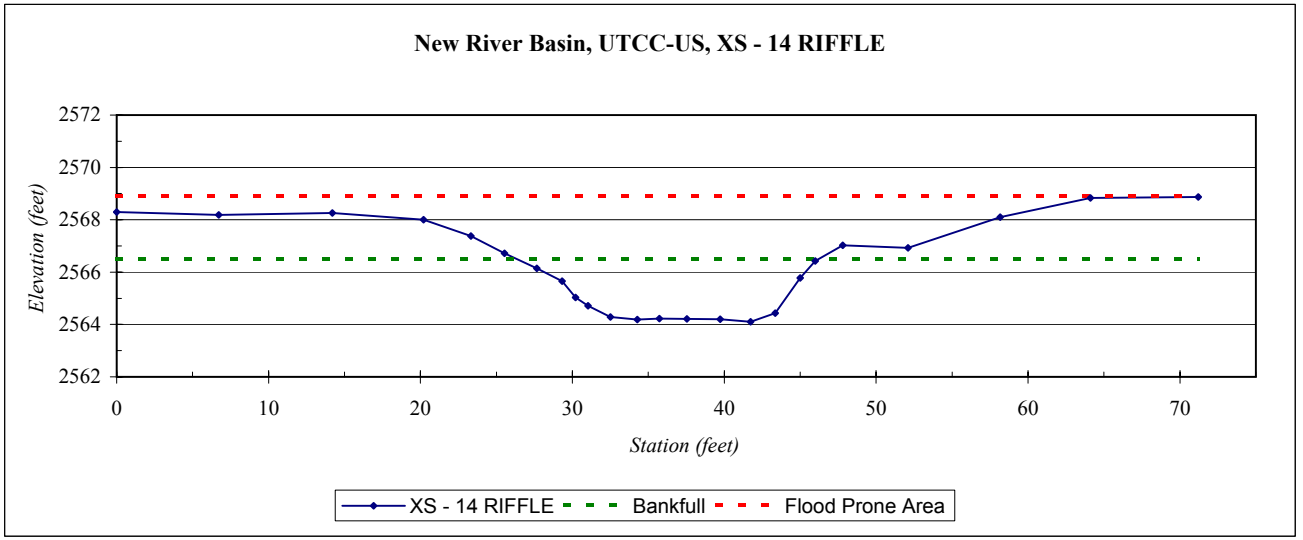
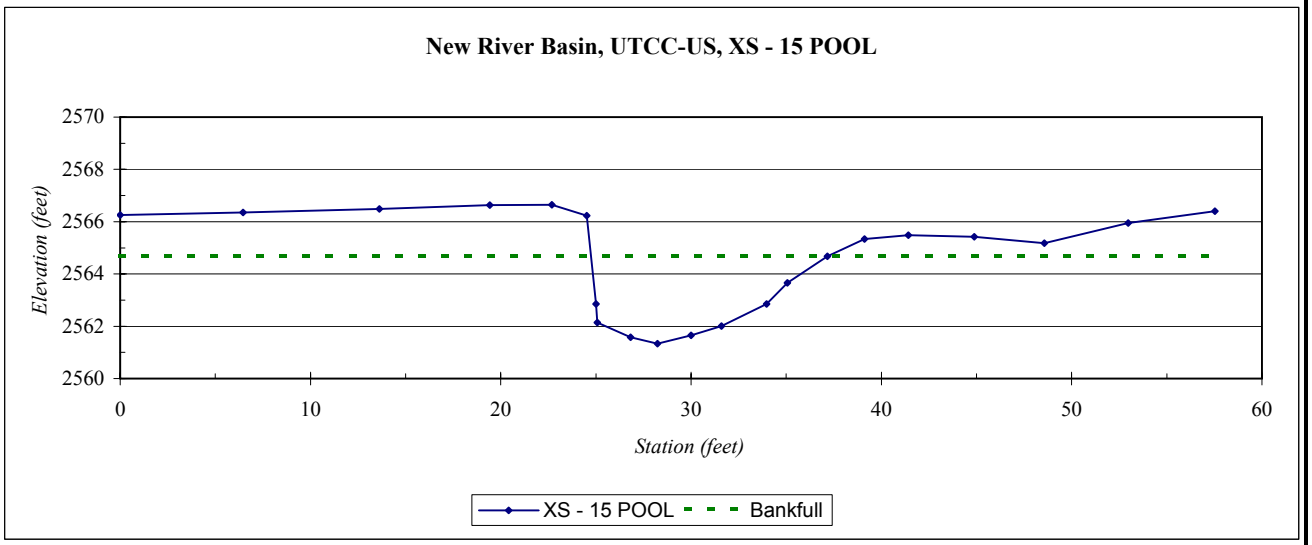




River Basin:	New
Watershed:	UTCC-US
XS ID	XS - 15 POOL
Drainage Area (sq mi):	2.12
Date:	4/25/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2566.25
6.5	2566.35
13.6	2566.48
19.4	2566.63
22.7	2566.65
24.5	2566.23
25.0	2562.86
25.1	2562.14
26.8	2561.57
28.2	2561.34
30.0	2561.65
31.6	2562.01
34.0	2562.85
35.1	2563.66
37.2	2564.68
39.1	2565.34
41.4	2565.48
44.9	2565.42
48.6	2565.17
53.0	2565.94
57.5	2566.40

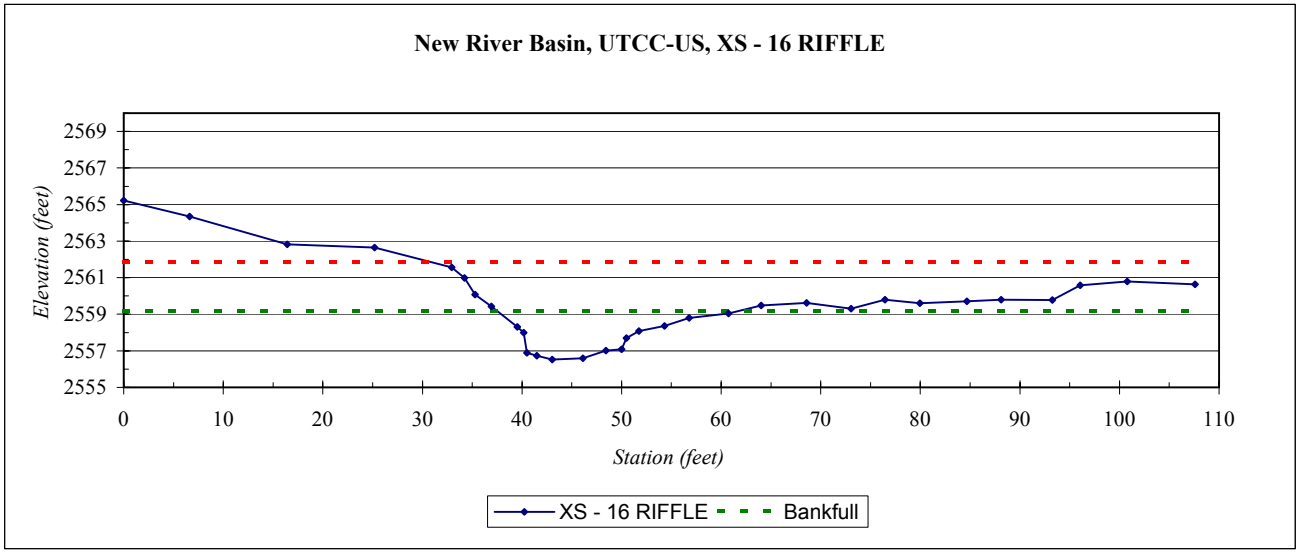
SUMMARY DATA	
Bankfull Elevation:	2564.7
Bankfull Cross-Sectional Area:	28.2
Bankfull Width:	12.5
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.3
Mean Depth at Bankfull:	2.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.009



River Basin:	New
Watershed:	UTCC-US
XS ID	XS - 16 RIFFLE
Drainage Area (sq mi):	2.42
Date:	4/26/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2565.22
6.6	2564.34
16.4	2562.83
25.2	2562.64
32.9	2561.57
34.2	2560.98
35.3	2560.07
36.9	2559.44
39.5	2558.31
40.2	2557.99
40.5	2556.88
41.5	2556.73
43.0	2556.52
46.1	2556.59
48.4	2557.02
50.0	2557.09
50.5	2557.70
51.7	2558.08
54.3	2558.36
56.8	2558.80
60.7	2559.05
64.0	2559.48
68.6	2559.63
73.0	2559.31
76.5	2559.80
80.0	2559.60
84.7	2559.72
88.1	2559.80
93.3	2559.78
96.1	2560.59
100.8	2560.79
107.6	2560.63

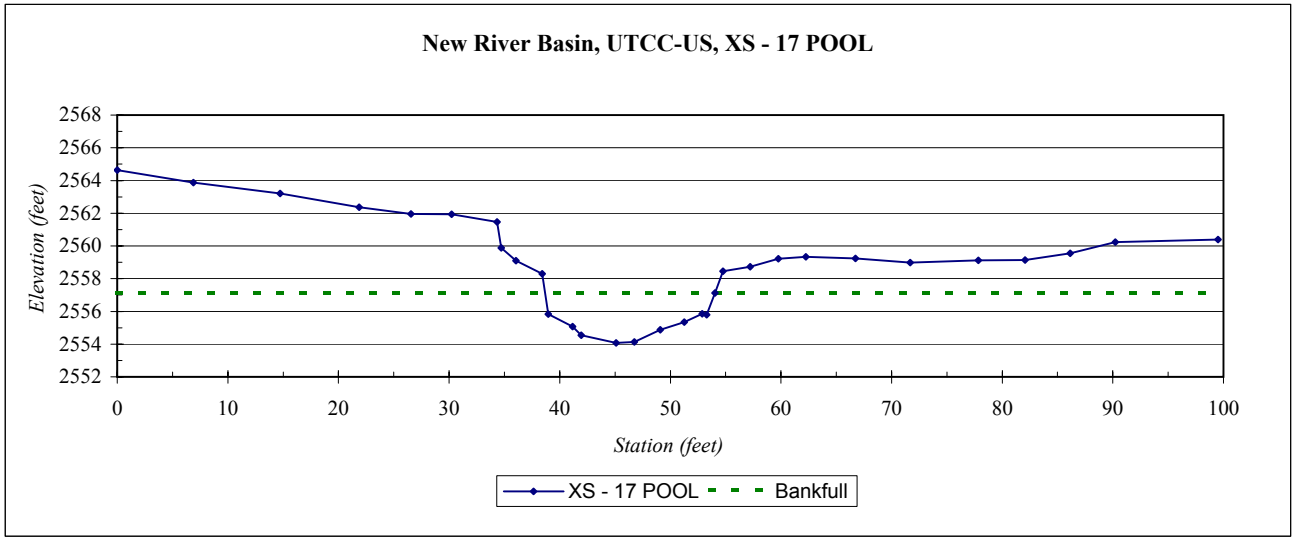
SUMMARY DATA	
Bankfull Elevation:	2559.2
Bankfull Cross-Sectional Area:	33.4
Bankfull Width:	24.5
Flood Prone Area Elevation:	2561.9
Flood Prone Width:	>75
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	1.4
W / D Ratio:	17.9
Entrenchment Ratio:	3.1
Bank Height Ratio:	1.0
Water Surface Slope (ft/ft):	0.009



River Basin:	New
Watershed:	UTCC-US
XS ID	XS - 17 POOL
Drainage Area (sq mi):	2.42
Date:	4/26/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2564.64
6.9	2563.88
14.7	2563.20
21.9	2562.37
26.5	2561.96
30.2	2561.94
34.3	2561.46
34.7	2559.88
36.0	2559.09
38.4	2558.30
39.0	2555.84
41.2	2555.08
41.9	2554.55
45.1	2554.07
46.8	2554.13
49.1	2554.87
51.3	2555.34
52.9	2555.86
53.3	2555.80
54.0	2557.13
54.8	2558.46
57.2	2558.73
59.8	2559.22
62.2	2559.34
66.7	2559.24
71.7	2558.98
77.8	2559.13
82.1	2559.13
86.1	2559.54
90.2	2560.23
99.5	2560.40

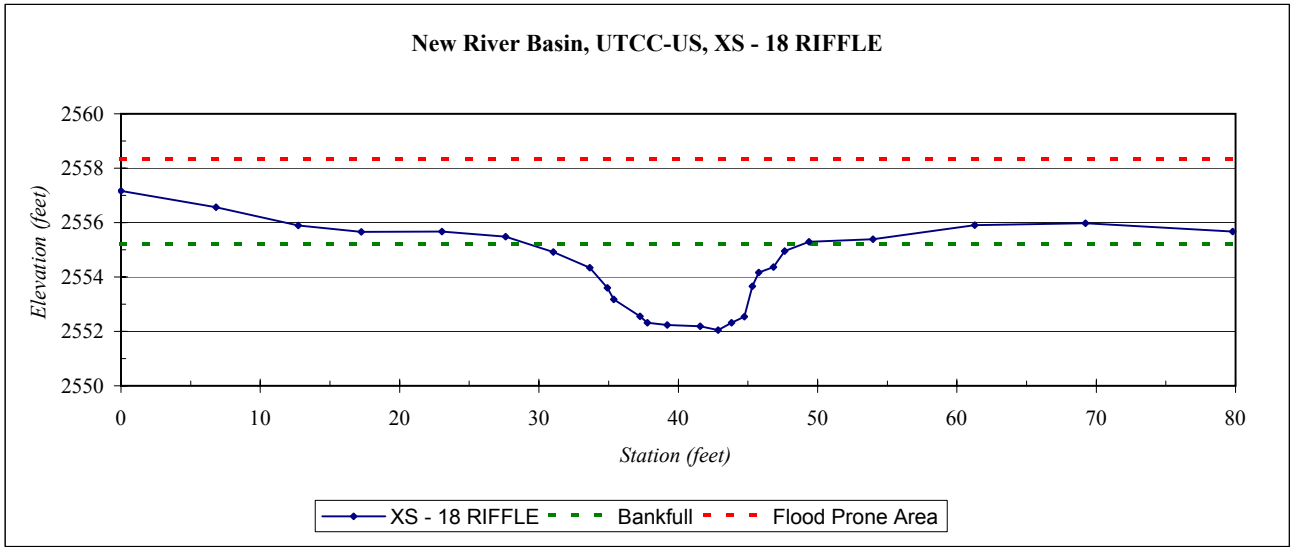
SUMMARY DATA	
Bankfull Elevation:	2557.13
Bankfull Cross-Sectional Area:	33.7
Bankfull Width:	15.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.1
Mean Depth at Bankfull:	2.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.009



River Basin:	New
Watershed:	UTCC-US
XS ID	XS - 18 RIFFLE
Drainage Area (sq mi):	2.42
Date:	4/26/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

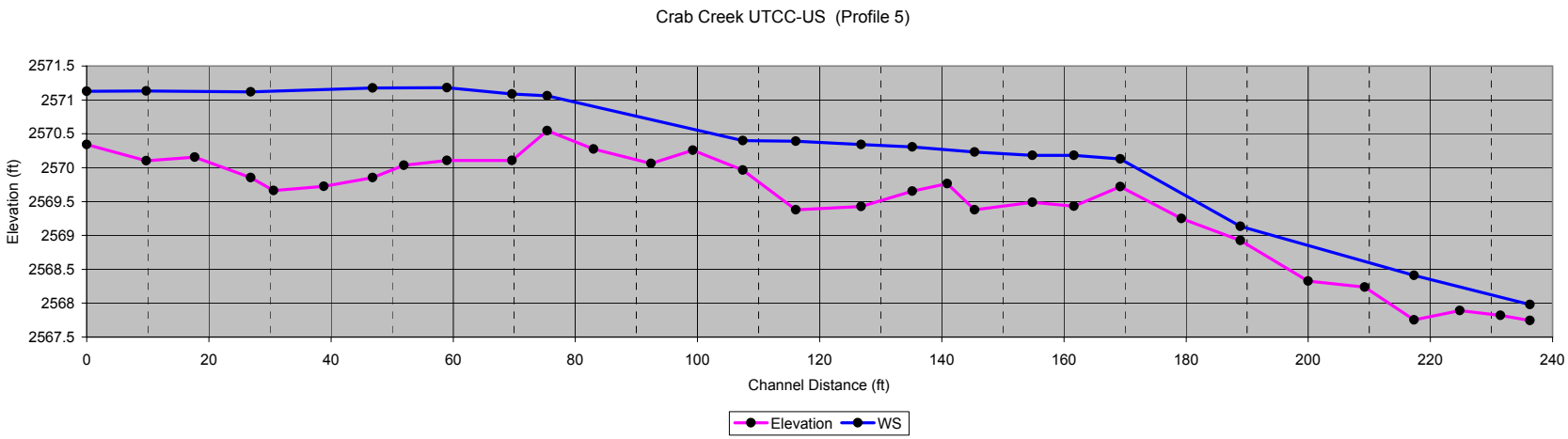
Station	Elevation
0.0	2557.16
6.8	2556.57
12.7	2555.90
17.3	2555.66
23.0	2555.67
27.6	2555.48
31.0	2554.92
33.6	2554.35
34.9	2553.61
35.4	2553.18
37.3	2552.55
37.8	2552.32
39.2	2552.24
41.6	2552.19
42.9	2552.04
43.8	2552.32
44.7	2552.54
45.3	2553.66
45.8	2554.17
46.8	2554.37
47.6	2554.96
49.4	2555.30
54.0	2555.39
61.3	2555.91
69.2	2555.98
79.8	2555.68

SUMMARY DATA	
Bankfull Elevation:	2555.20
Bankfull Cross-Sectional Area:	34.0
Bankfull Width:	19.7
Flood Prone Area Elevation:	2558.4
Flood Prone Width:	>80
Max Depth at Bankfull:	3.2
Mean Depth at Bankfull:	1.7
W / D Ratio:	11.4
Entrenchment Ratio:	>4.1
Bank Height Ratio:	1.0
Water Surface Slope (ft/ft):	0.009



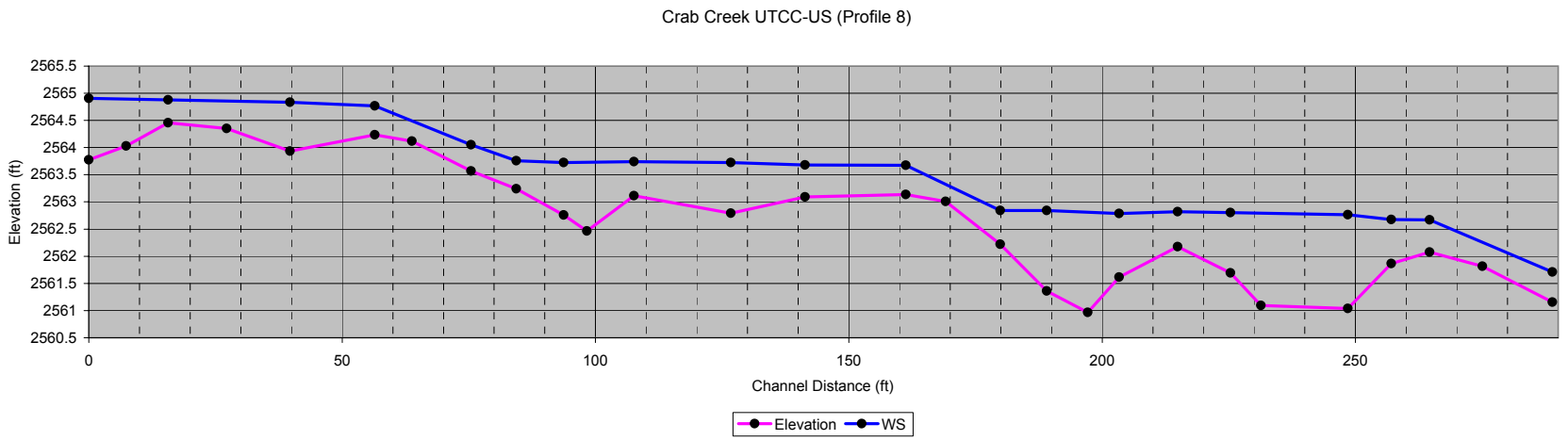
Existing Profiles

Slope Profile



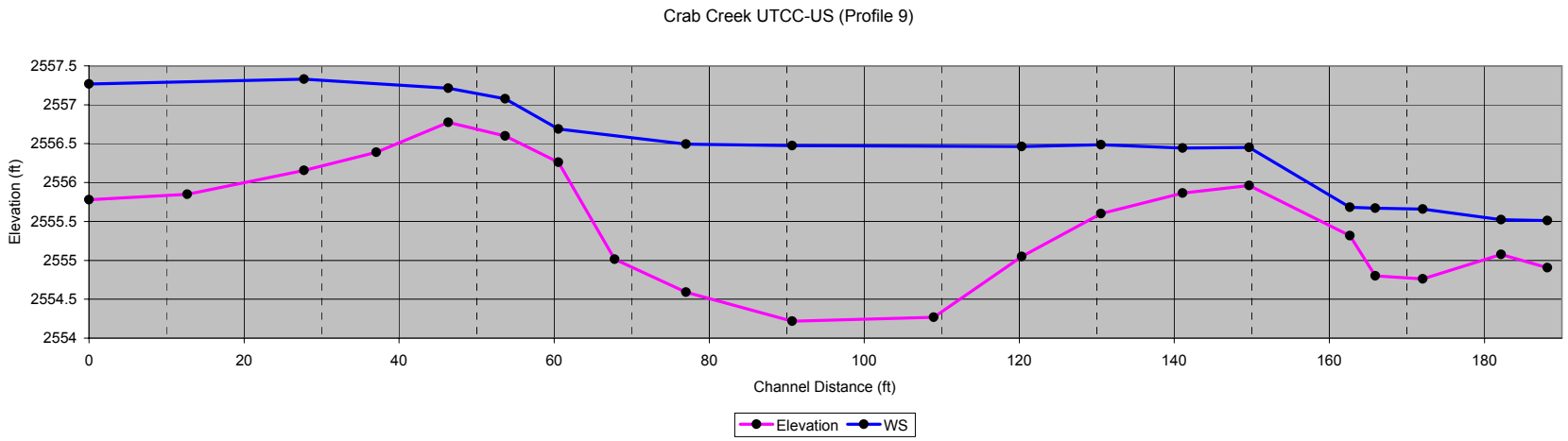
		Elevation BM:	100															
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO5-ERI		0		100									2570.341					2571.127
PRO5-TW	9.7	9.7		100									2570.103					2571.134
PRO5-TW	7.9	17.7		100									2570.156					
PRO5-BPO	9.2	26.9		100									2569.852					2571.118
PRO5-PO	3.7	30.6		100									2569.662					
PRO5-PO	8.2	38.8		100									2569.724					
PRO5-EPO	8.0	46.8		100									2569.852					2571.175
PRO5-TW	5.1	51.9		100									2570.036					
PRO5-TW	7.0	59.0		100									2570.105					2571.179
PRO5-TW	10.6	69.6		100									2570.106					2571.087
PRO5-BRI	5.8	75.4		100									2570.548					2571.059
PRO5-RI	7.6	83.0		100									2570.276					
PRO5-RI	9.4	92.4		100									2570.06					
PRO5-RI	6.9	99.3		100									2570.257					
PRO5-ERI	8.1	107.4		100									2569.964					2570.4
PRO5-TW	8.7	116.1		100									2569.378					2570.389
PRO5-TW	10.7	126.8254		100									2569.426					2570.343
PRO5-BRI	8.3	135.1563		100									2569.652					2570.306
PRO5-RI	5.7	140.8924		100									2569.766					
PRO5-ERI	4.5	145.3841		100									2569.379					2570.231
PRO5-TW	9.5	154.8583		100									2569.487					2570.18
PRO5-TW	6.8	161.6503		100									2569.433					2570.181
PRO5-BR	7.6	169.2123		100									2569.72					2570.129
PRO5-RI	10.0	179.2145		100									2569.25					
PRO5-RI	9.7	188.9082		100									2568.924					2569.134
PRO5-RI	11.1	200.006		100									2568.324					
PRO5-RI	9.2	209.2319		100									2568.236					
PRO5-RI	8.1	217.352		100									2567.755					2568.412
PRO5-RI	7.4	224.7972		100									2567.889					
PRO5-RI	6.7	231.4538		100									2567.819					
PRO5-ERI	4.8	236.2793		100									2567.746					2567.981

Slope Profile



		Elevation BM:		100														
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO8_TW		0		100									2563.773					2564.908
PRO8_TW	7.4	7.4		100									2564.03					
PRO8_TW=RI?	8.2	15.7		100									2564.459					2564.878
PRO8_TW	11.6	27.2		100									2564.352					
PRO8_TW	12.5	39.7		100									2563.936					2564.833
PRO8_BRI	16.7	56.5		100									2564.238					2564.765
PRO8_RI	7.3	63.8		100									2564.119					
PRO8_RI	11.6	75.4		100									2563.57					2564.051
PRO8_ERI	8.9	84.4		100									2563.242					2563.759
PRO8_BPO	9.4	93.8		100									2562.759					2563.726
PRO8_EPO	4.6	98.3		100									2562.463					
PRO8_TW	9.3	107.6		100									2563.115					2563.738
PRO8_TW	19.1	126.7		100									2562.79					2563.726
PRO8_TW	14.6	141.3		100									2563.09					2563.68
PRO8_BRI	19.9	161.3		100									2563.134					2563.673
PRO8_TW	7.8	169.1		100									2563.009					
PRO8_ERI	10.8	179.9103		100									2562.219					2562.844
PRO8_BPO	9.1	189.0509		100									2561.361					2562.844
PRO8_PO	8.1	197.1798		100									2560.966					
PRO8_EPO	6.2	203.3664		100									2561.615					2562.789
PRO8_TW	11.5	214.8929		100									2562.174					2562.82
PRO8_BPO	10.5	225.3525		100									2561.695					2562.801
PRO8_PO	6.0	231.3553		100									2561.094					
PRO8_EPO	17.1	248.4866		100									2561.04					2562.766
PRO8_TW	8.6	257.0693		100									2561.864					2562.675
PRO8_BRI	7.5	264.6103		100									2562.079					2562.67
PRO8_RI	10.4	275.0516		100									2561.814					
PRO8_ERI	13.8	288.8608		100									2561.154					2561.708

Slope Profile



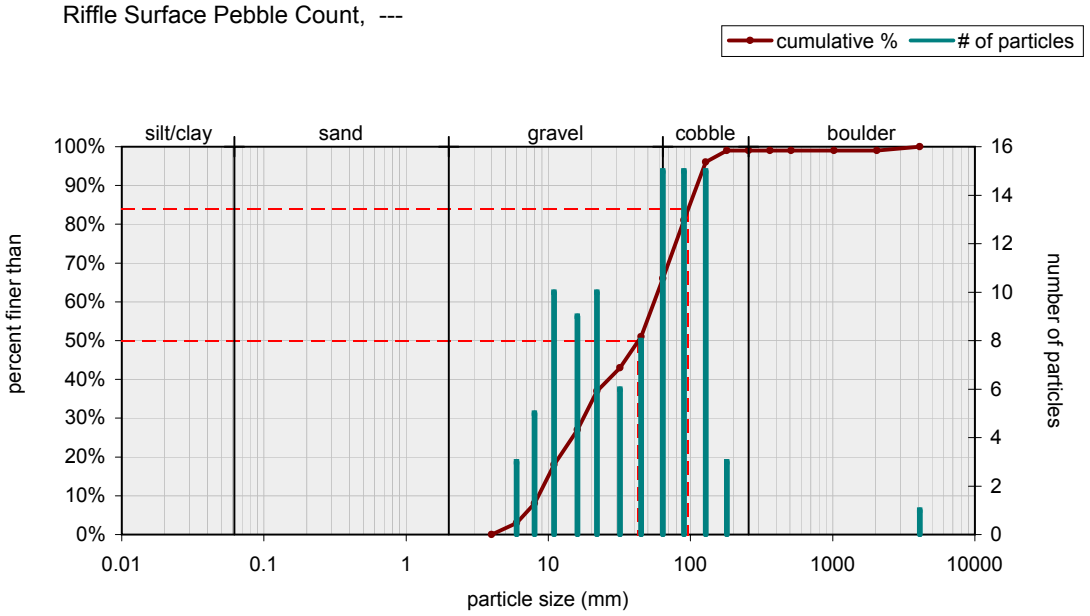
		Elevation BM:	100														
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO_9_TW		0		100									2555.78					2557.268
PRO_9_TW	12.7	12.7		100									2555.849					
PRO_9_TW	15.0	27.7		100									2556.156					2557.328
PRO_9_TW	9.3	37.1		100									2556.388					
PRO_9_BRI	9.3	46.3		100									2556.773					2557.214
PRO_9_RI	7.3	53.7		100									2556.599					2557.075
PRO_9_ERI	6.9	60.5		100									2556.261					2556.689
PRO_9_TW	7.2	67.8		100									2555.013					
PRO_9_BPO	9.2	77.0		100									2554.589					2556.493
PRO_9_PO	13.7	90.7		100									2554.217					2556.476
PRO_9_PO	18.3	109.0		100									2554.269					
PRO_9_EPO	11.3	120.3		100									2555.048					2556.462
PRO_9_TW	10.3	130.6		100									2555.601					2556.487
PRO_9_TW	10.5	141.1		100									2555.863					2556.444
PRO_9_BRI	8.6	149.6		100									2555.961					2556.451
PRO_9_ERI	13.0	162.6		100									2555.319					2555.682
PRO_9_TW	3.3	165.9256		100									2554.801					2555.67
PRO_9_TW	6.1	172.0471		100									2554.761					2555.66
PRO_9_TW	10.1	182.1762		100									2555.076					2555.524
PRO_9_TW	5.9	188.1107		100									2554.905					2555.511

Sediment

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**10**
medium gravel	11 - 16	**9**
coarse gravel	16 - 22	**10**
coarse gravel	22 - 32	**6**
very coarse gravel	32 - 45	**8**
very coarse gravel	45 - 64	**15**
small cobble	64 - 90	**15**
medium cobble	90 - 128	**15**
large cobble	128 - 180	**3**
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	**1**
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS13- Riffle (UTCC-US)



Size (mm)		
D16	10	3.4
D35	21	12
D50	43	17
D65	63	20
D84	97	29
D95	130	39

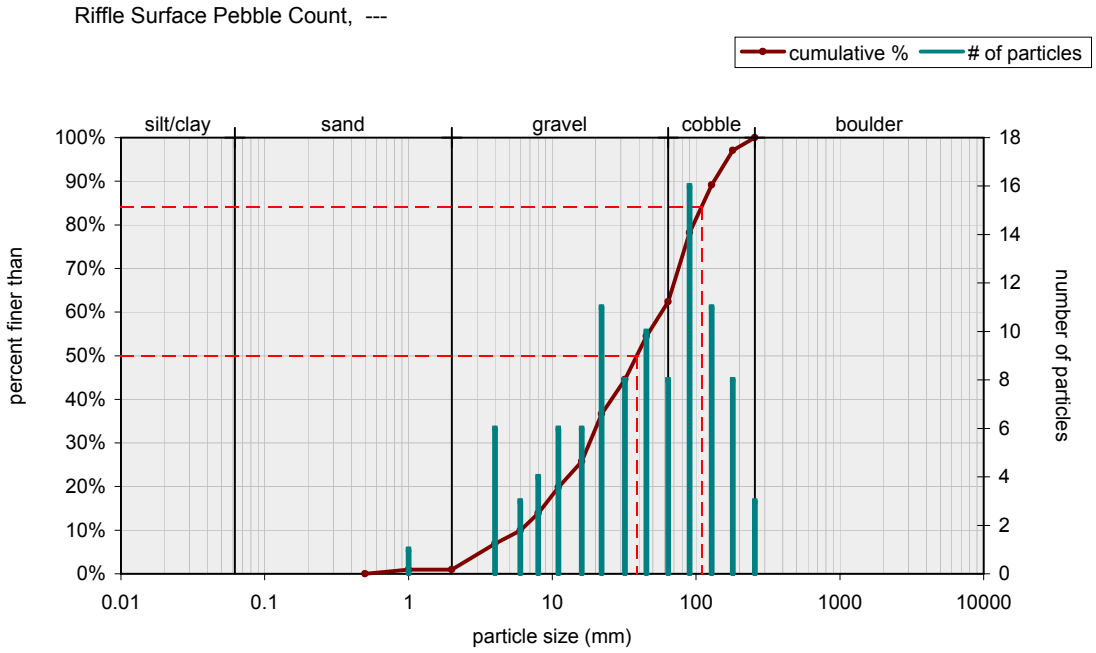
Size Distribution	
mean	31.1
dispersion	3.3
skewness	-0.14

Type	
silt/clay	0%
sand	0%
gravel	66%
cobble	33%
boulder	1%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	**1**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**6**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**4**
medium gravel	8 - 11	**6**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**11**
coarse gravel	22 - 32	**8**
very coarse gravel	32 - 45	**10**
very coarse gravel	45 - 64	**8**
small cobble	64 - 90	**16**
medium cobble	90 - 128	**11**
large cobble	128 - 180	**8**
very large cobble	180 - 256	**3**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		101
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		101

Note: XS14- Riffle (Gauge) (UTCC-US)



Size (mm)	
D16	9
D35	21
D50	39
D65	68
D84	110
D95	160

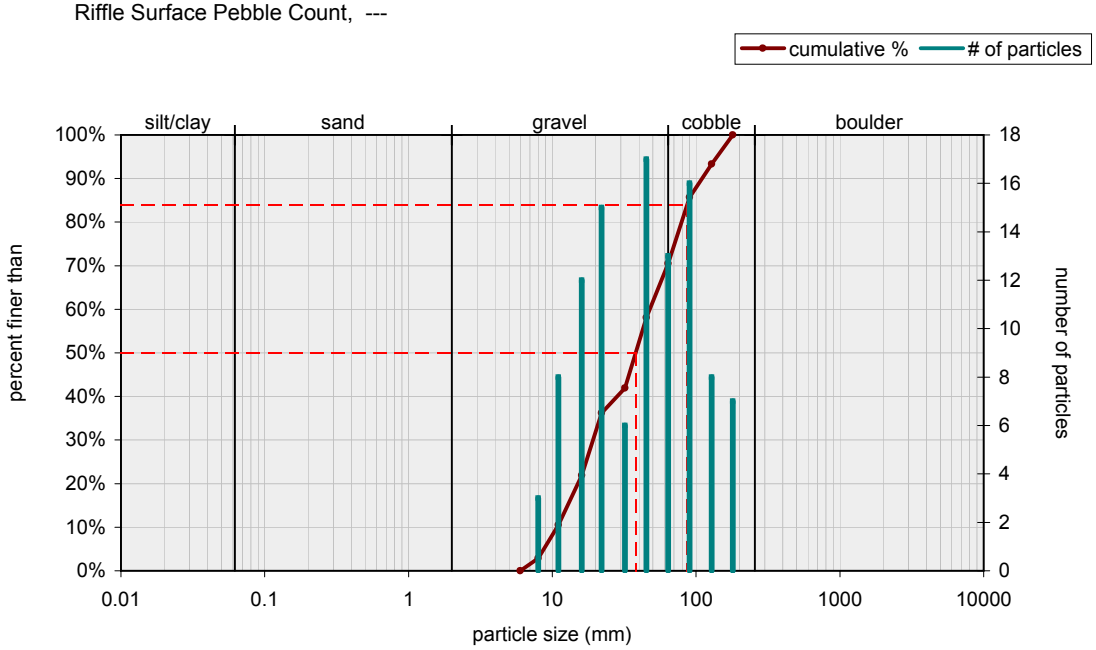
Size Distribution	
mean	31.5
dispersion	3.6
skewness	-0.09

Type	
silt/clay	0%
sand	1%
gravel	61%
cobble	38%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**8**
medium gravel	11 - 16	**12**
coarse gravel	16 - 22	**15**
coarse gravel	22 - 32	**6**
very coarse gravel	32 - 45	**17**
very coarse gravel	45 - 64	**13**
small cobble	64 - 90	**16**
medium cobble	90 - 128	**8**
large cobble	128 - 180	**7**
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		105
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		105

Note: XS16- Riffle (UTCC-US)



Size (mm)	
D16	13
D35	21
D50	38
D65	55
D84	87
D95	140

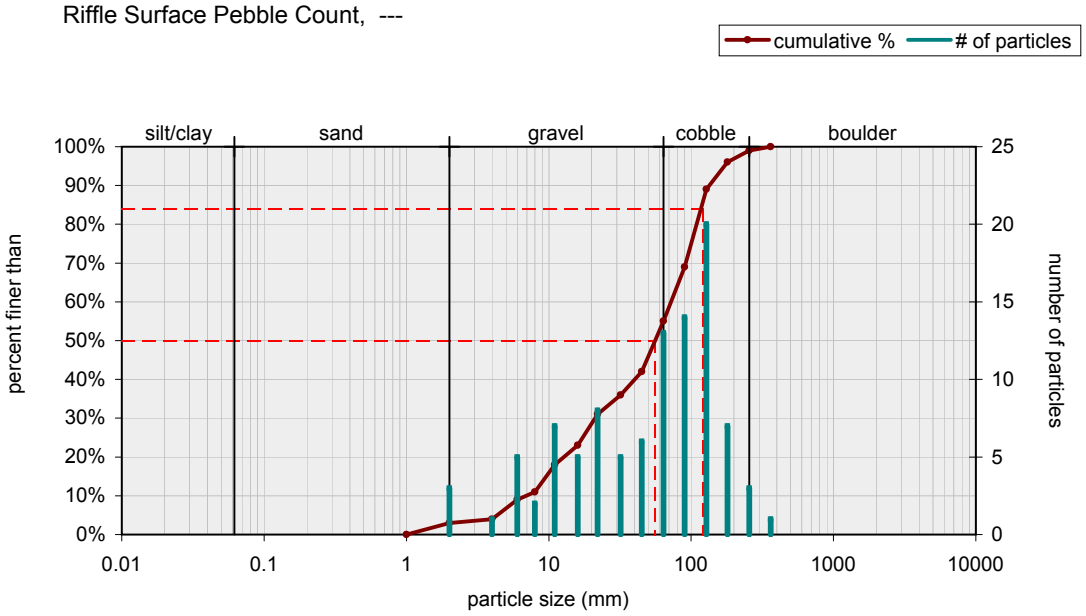
Size Distribution	
mean	33.6
dispersion	2.6
skewness	-0.06

Type	
silt/clay	0%
sand	0%
gravel	70%
cobble	30%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	**3**
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**5**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**7**
medium gravel	11 - 16	**5**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**5**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	**13**
small cobble	64 - 90	**14**
medium cobble	90 - 128	**20**
large cobble	128 - 180	**7**
very large cobble	180 - 256	**3**
small boulder	256 - 362	**1**
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS18- Riffle (UTCC-US)



Size (mm)		
D16	10	3.4
D35	30	12
D50	56	17
D65	82	20
D84	120	29
D95	170	39

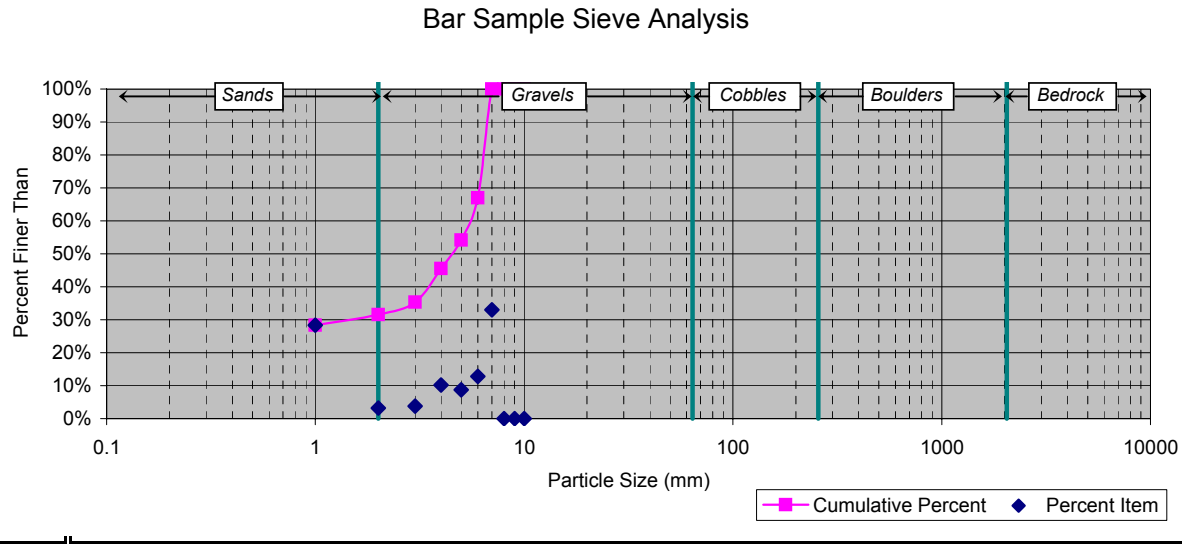
Size Distribution	
mean	34.6
dispersion	3.9
skewness	-0.20

Type	
silt/clay	0%
sand	3%
gravel	52%
cobble	44%
boulder	1%

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	270.5	28.3%	28.3%
1.0	30.5	3.2%	31.5%
2.0	36.0	3.8%	35.3%
4.0	97.5	10.2%	45.5%
8.0	83.0	8.7%	54.2%
16.0	122.0	12.8%	67.0%
31.5	315.0	33.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	954.5	100%	

Stream:	Crab Creek UTCC-US
Watershed:	
Location:	XS #12 UCC-US
Note:	Bar Sample # 2

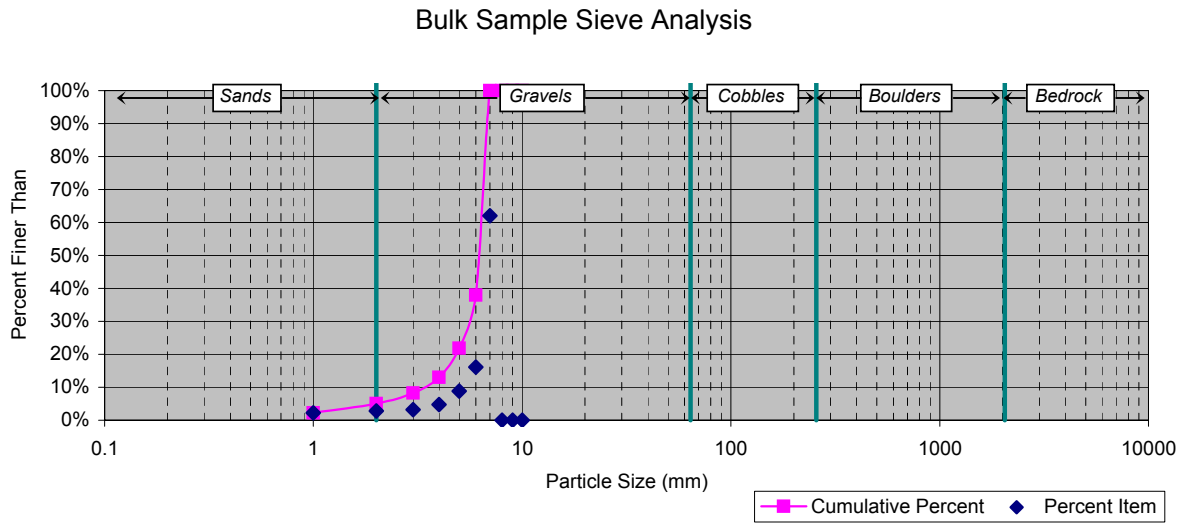


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
1.9	1.9	5.7	22.7	28.4	0%	35%	65%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	8	2.2%	2.2%
1.0	10.0	2.8%	5.0%
2.0	11.5	3.2%	8.3%
4.0	17.0	4.8%	13.0%
8.0	31.5	8.8%	21.9%
16.0	57.5	16.1%	38.0%
31.5	221.0	62.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	356.5	100%	

Stream: Crab Creek UTCC-US
Watershed:
Location: XS # 13 UTCC-US
Note: Bulk Sample # 3 (0.3.5 inches)

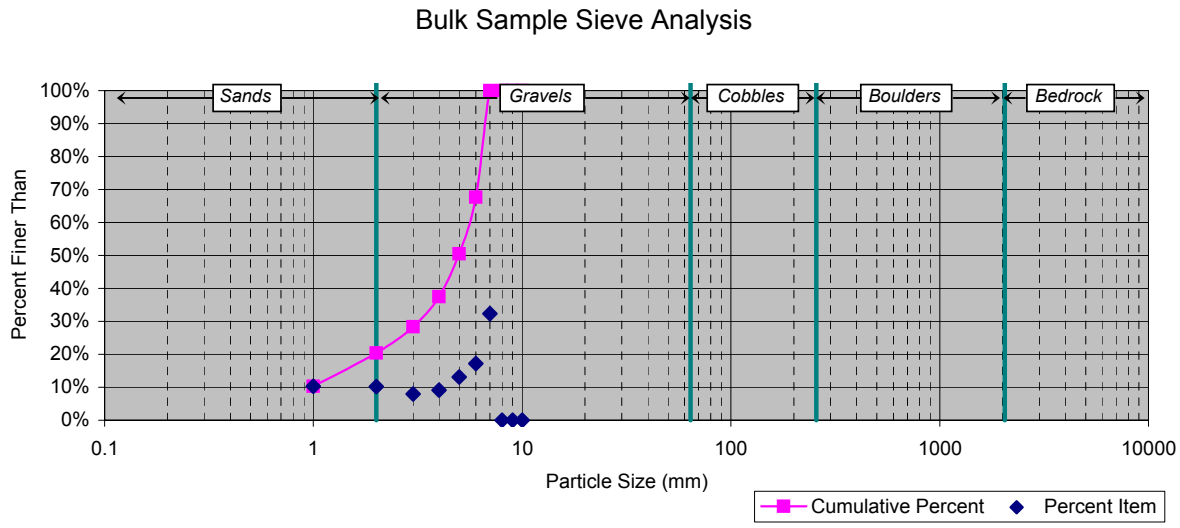


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
5.0	14.1	18.2	26.4	29.8	0%	8%	92%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	44	10.3%	10.3%
1.0	43.5	10.2%	20.4%
2.0	34.0	7.9%	28.4%
4.0	39.0	9.1%	37.5%
8.0	56.0	13.1%	50.5%
16.0	73.5	17.2%	67.7%
31.5	138.5	32.3%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	428.5	100%	

Stream: Crab Creek UTCC-US
Watershed:
Location: XS # 13 UTCC-US
Note: Bulk Sample # 3 (3.5-7 inches)

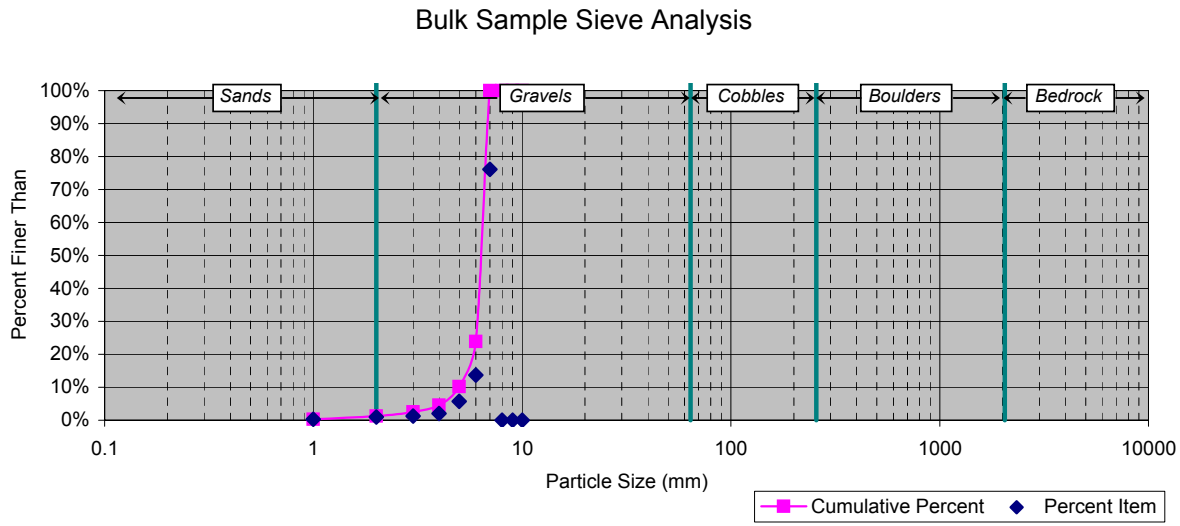


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
3.3	3.3	7.8	22.5	28.4	0%	28%	72%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	1	0.3%	0.3%
1.0	3.5	1.0%	1.3%
2.0	4.5	1.3%	2.6%
4.0	7.0	2.0%	4.6%
8.0	20.0	5.7%	10.2%
16.0	48.0	13.7%	23.9%
31.5	267.5	76.1%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	351.5	100%	

Stream: Crab Creek UTCC-US
Watershed:
Location: XS # 14 UTCC-US
Note: Bulk Sample # 4 (0-5 inches)

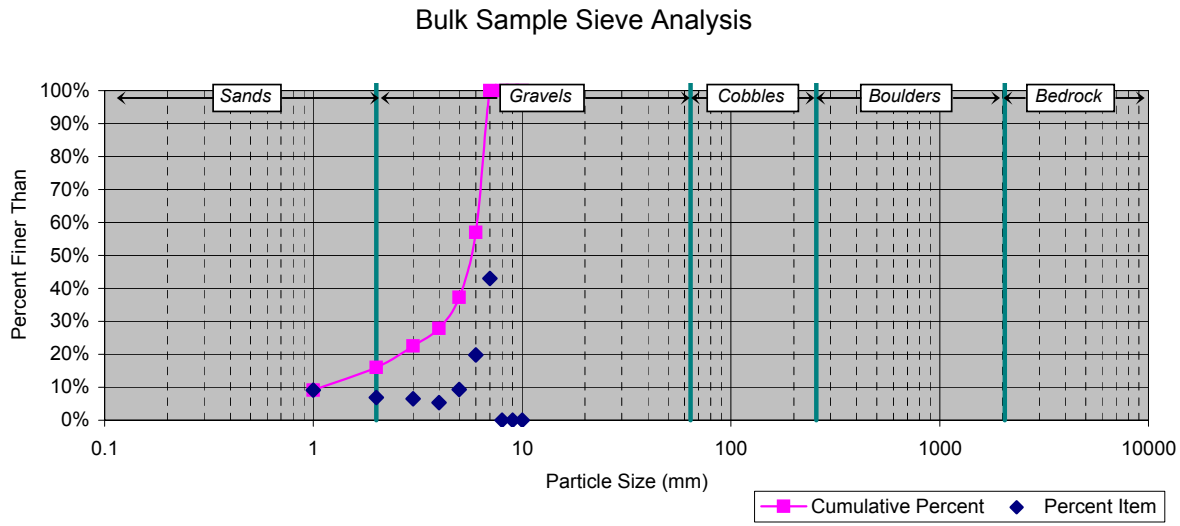


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
10.7	17.7	20.2	27.3	30.1	0%	3%	97%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	43	9.1%	9.1%
1.0	32.5	6.9%	16.1%
2.0	30.5	6.5%	22.6%
4.0	25.0	5.3%	27.9%
8.0	44.0	9.4%	37.2%
16.0	93.0	19.8%	57.0%
31.5	202.0	43.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	470.0	100%	

Stream: Crab Creek UTCC-US
Watershed:
Location: XS # 14 UTCC-US
Note: Bulk Sample # 4 (5-10 inches)

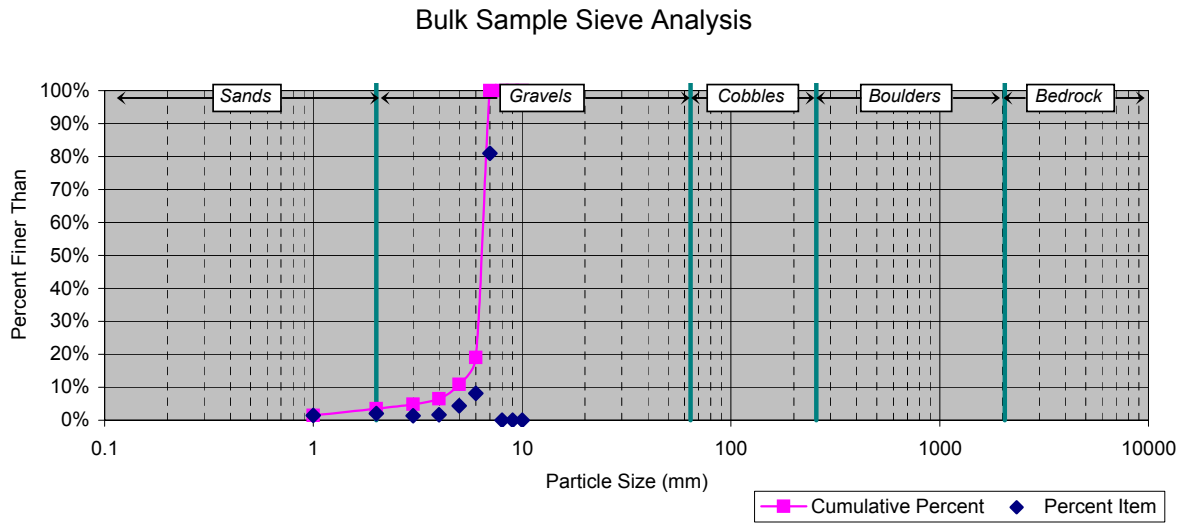


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
6.8	6.8	12.5	24.5	29.1	0%	23%	77%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	4.5	1.5%	1.5%
1.0	6.0	2.0%	3.5%
2.0	4.0	1.3%	4.8%
4.0	5.0	1.7%	6.5%
8.0	13.0	4.3%	10.8%
16.0	24.5	8.2%	19.0%
31.5	243.0	81.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	300.0	100%	

Stream: Crab Creek UTCC-US
Watershed:
Location: XS # 18 UTCC-US
Note: Bulk Sample # 5 (0-3 inches)

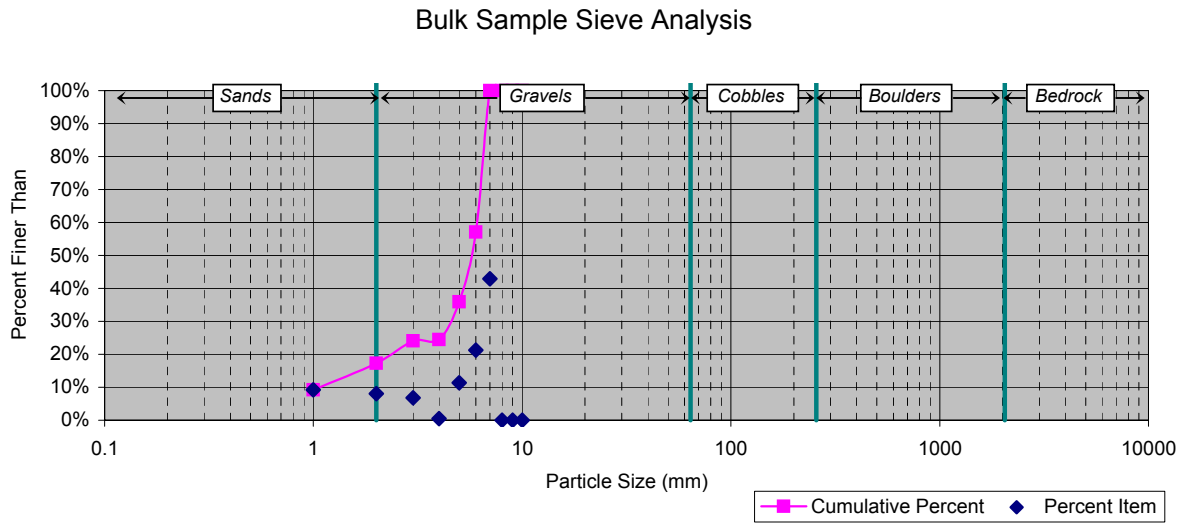


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
12.4	18.3	20.7	27.6	30.2	0%	5%	95%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	21	9.2%	9.2%
1.0	18.5	8.1%	17.3%
2.0	15.5	6.8%	24.1%
4.0	1.0	0.4%	24.5%
8.0	26.0	11.4%	35.9%
16.0	48.5	21.2%	57.1%
31.5	98.0	42.9%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	228.5	100%	

Stream: Crab Creek UTCC-US
Watershed:
Location: XS # 18 UTCC-US
Note: Bulk Sample # 5 (3-6 inches)



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
7.6	7.6	12.7	24.5	29.1	0%	24%	76%	0%	---	---

BEHI

Bank Erodibility Hazard Rating Guide

Stream: UTCC-US (Crab Creek Site) **Reach:** _____ **Date:** 4/24/07 **Crew:** AH

Bank Erosion Potential

Bank Height (ft): / Bankfull Height (ft):		Bank Height/ Bankfull Ht		Root Depth/ Bank Height		Root Density %		Bank Angle (Degrees)		Surface Protection%	
VERY LOW	Value Range	1.0	1.1	0.9	1.0	80	100	0.0	20.0	80	100
	Index Range	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9
	Choice	**V:**	**I:**	**V:**	**I:**	**V: 90.0**	**I: 1.5**	**V:**	**I:**	**V:**	**I:**
LOW	Value Range	1.11	1.19	0.5	0.89	55	79	21.0	60.0	55	79
	Index Range	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
MODERATE	Value Range	1.2	1.5	0.3	0.49	30	54	61.0	80.0	30	54
	Index Range	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9
	Choice	**V: 1.5**	**I: 5.9**	**V: 0.30**	**I: 5.9**	**V:**	**I:**	**V: 75.0**	**I: 5.4**	**V: 40.0**	**I: 5.1**
HIGH	Value Range	1.6	2.0	0.15	0.29	15	29	81.0	90.0	15	29
	Index Range	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
VERY HIGH	Value Range	2.1	2.8	0.05	0.14	5	14	91.0	119.0	10	14
	Index Range	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
EXTREME	Value Range	>2.8		<0.05		<5		>119		<10	
	Index Range	10		10		10		10		10	
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**

V = value, I = index

SUB-TOTAL (Sum one index from each column) 23.8

Bank Material Description:

Grass vegetation

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt Clay (+ 0: no adjustment)

Bank Sketch

BANK MATERIAL ADJUSTMENT 5

Stratification Comments:

_____

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT 5

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.9	10-19.9	20-29.9	30-39.9	40-45.9	46-50

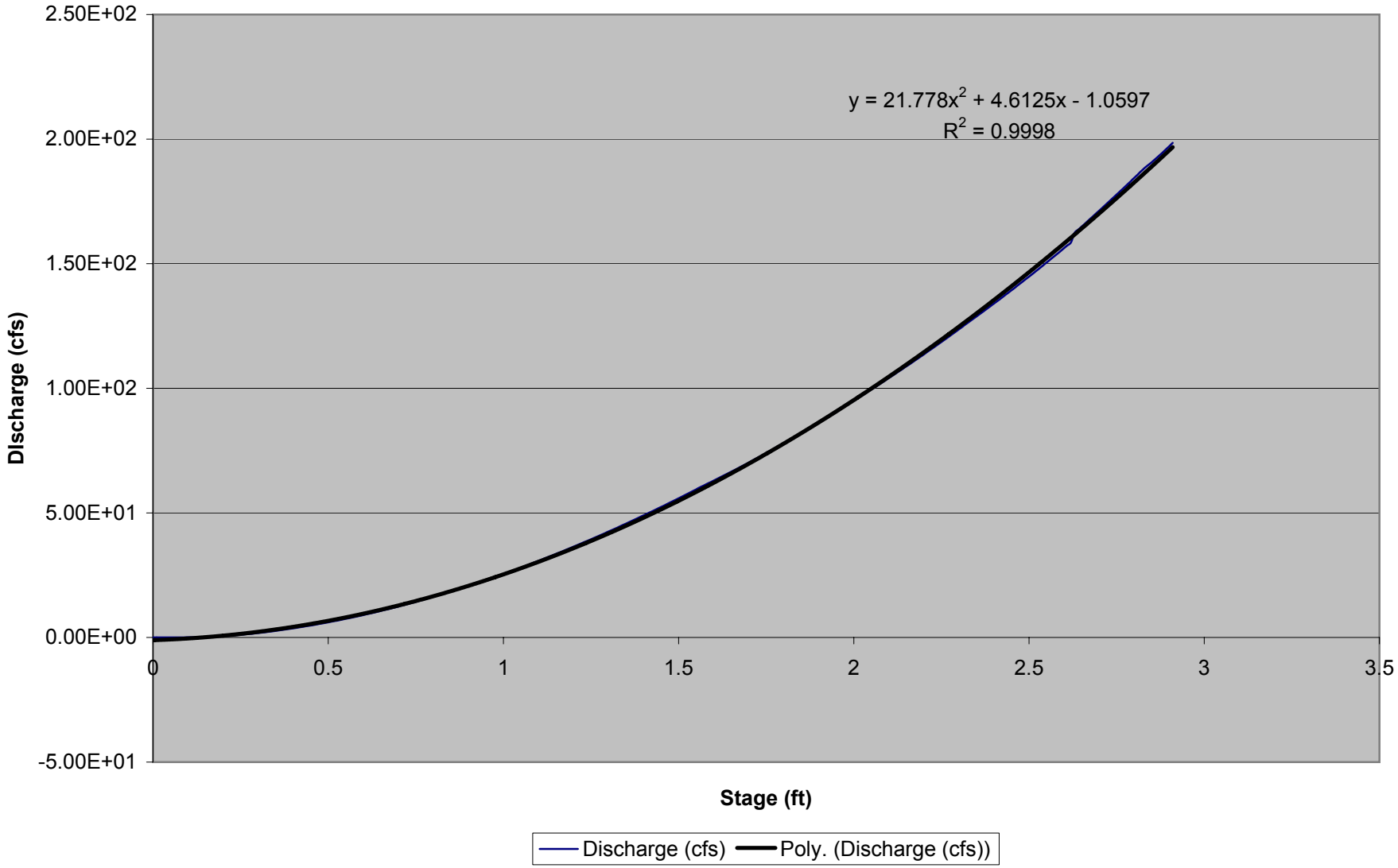
Bank location description (check one)

GRAND TOTAL 33.8

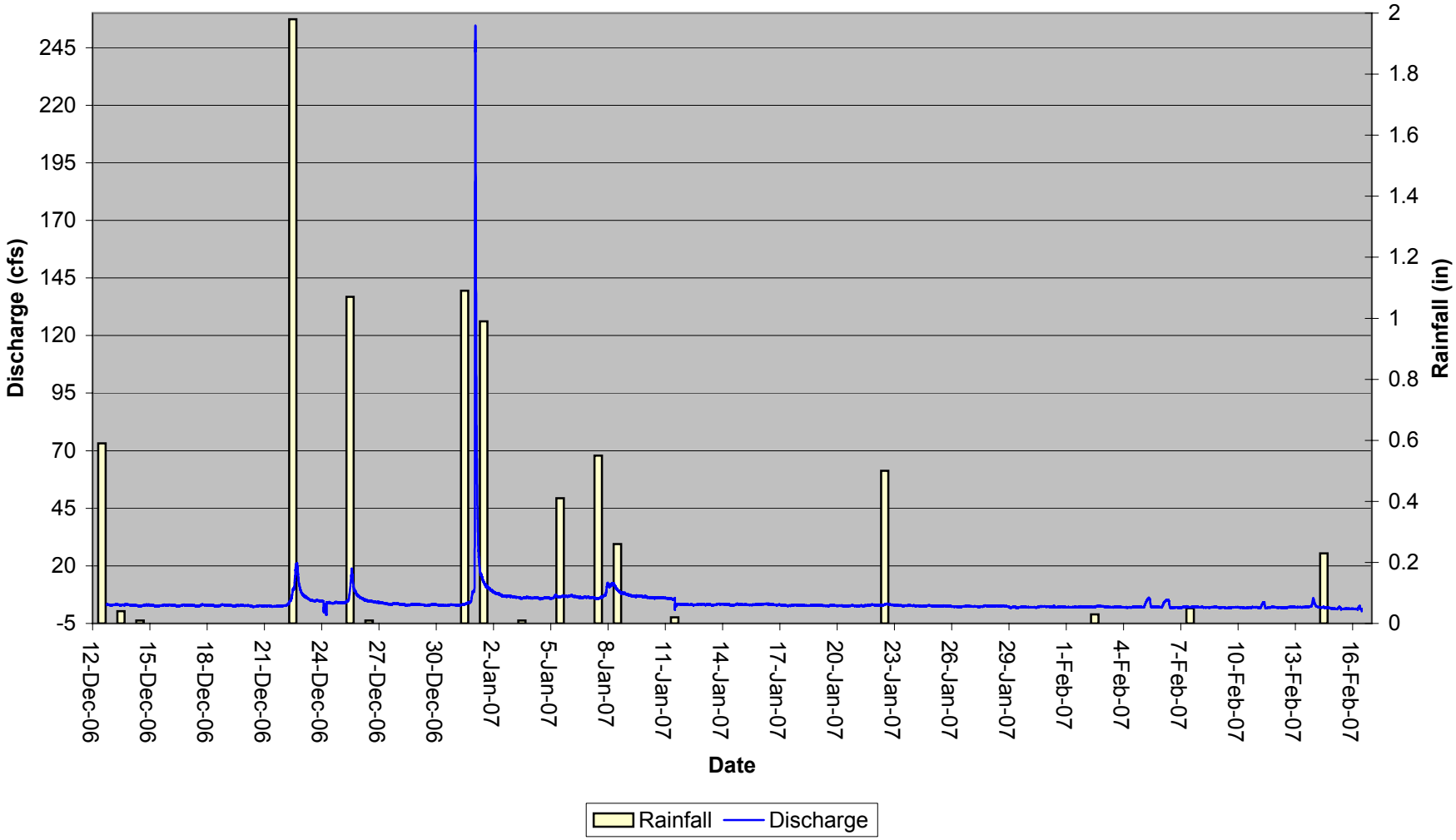
BEHI RATING HIGH

Rating Curve & Hydrographs

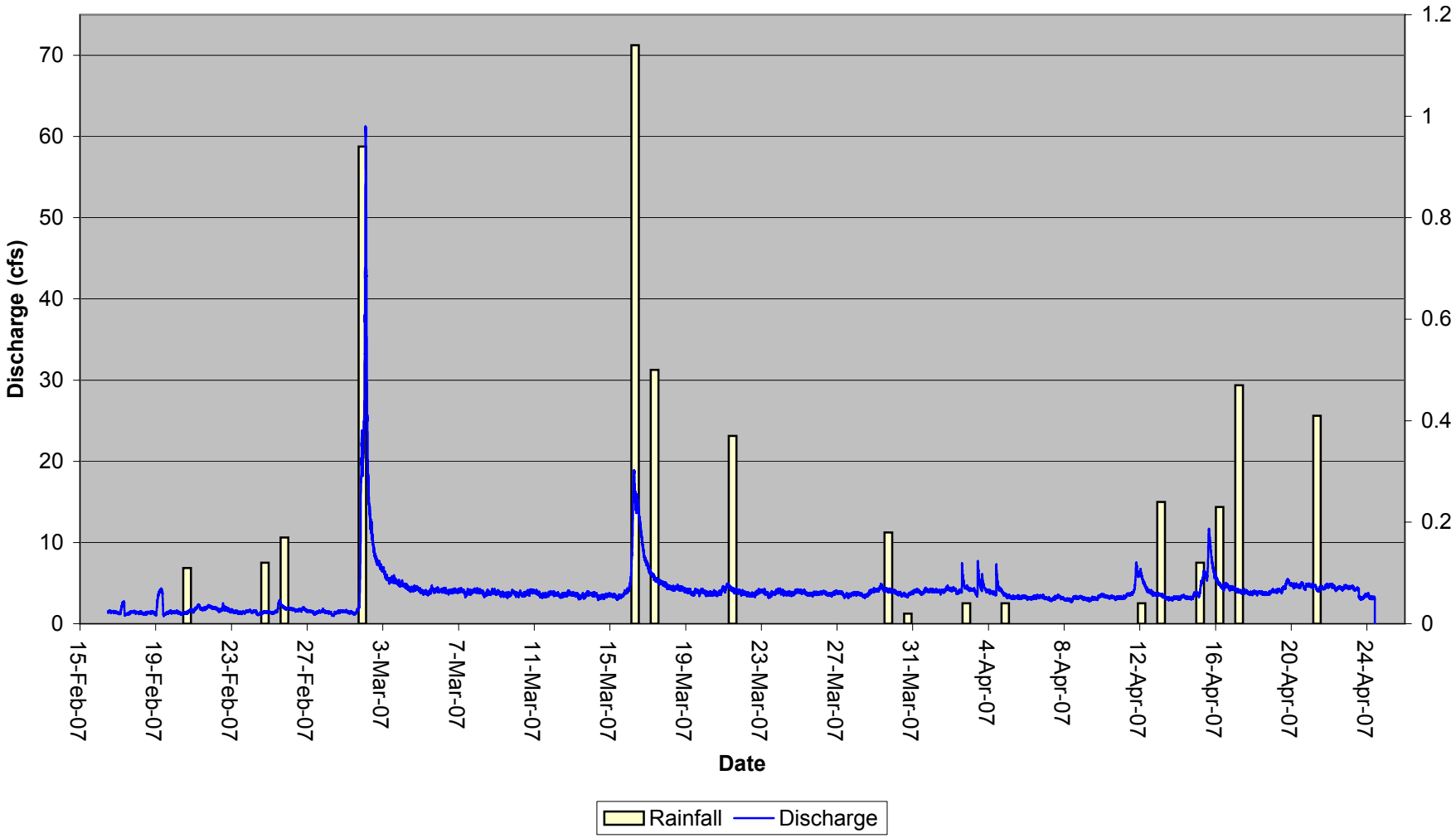
Gauge 1 (XS-14) Rating Curve



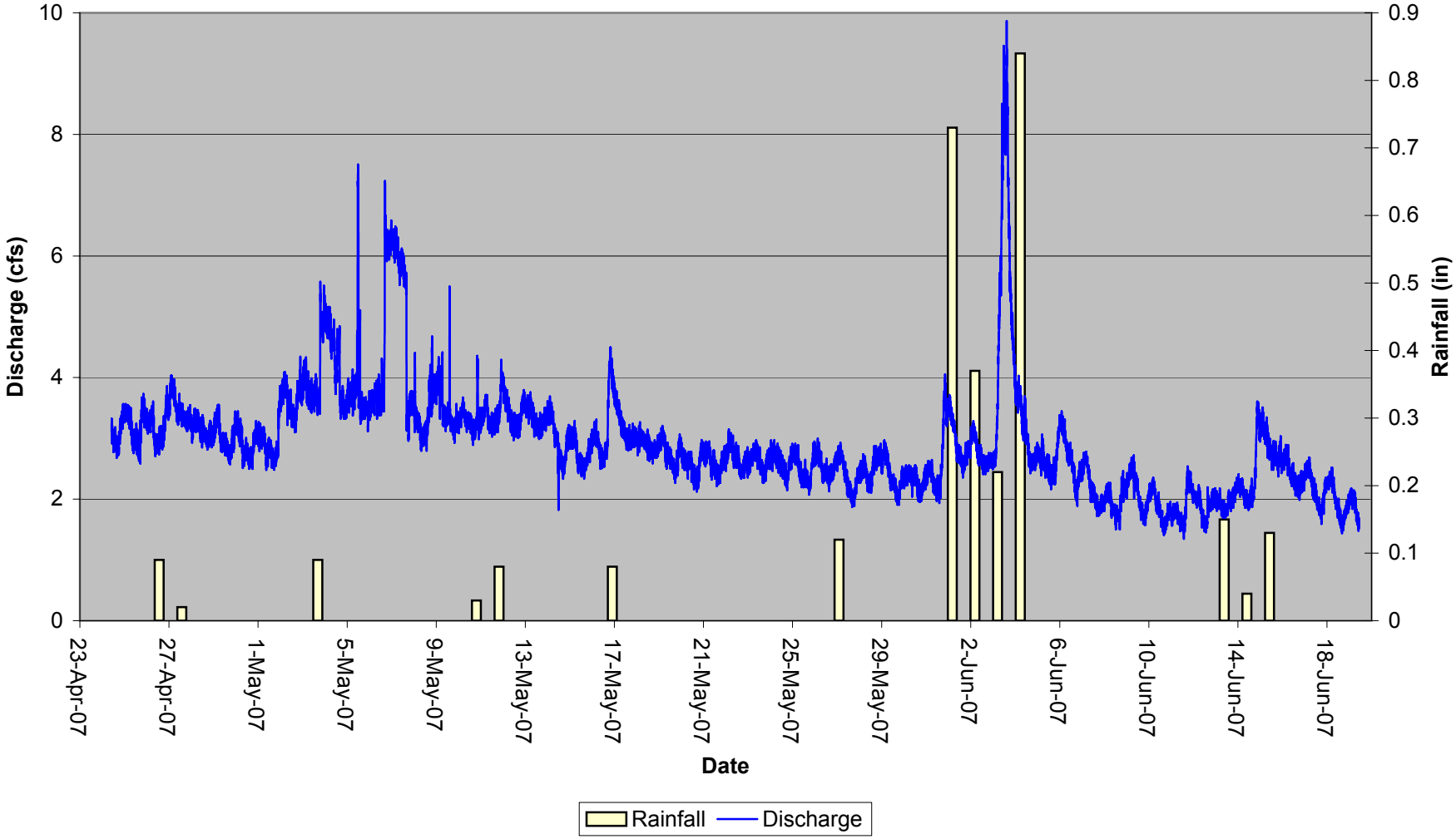
Crab Creek Gauge 1
(XS-14) Discharge Hydrograph
12/12/06 to 02/16/07



Crab Creek Gauge 1
(XS-14) Discharge Hydrograph
02/16/07 to 04/24/07



Crab Creek Gauge 1
(XS-14) Discharge Hydrograph
04/24/07 to 06/19/07



UTCC-DS

Existing Cross Sections

River Basin:	New
Watershed:	UTCC-DS
XS ID	XS - 19 RIFFLE
Drainage Area (sq mi):	2.64
Date:	4/27/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2552.90
5.2	2552.99
10.3	2552.87
15.4	2552.95
18.1	2552.74
19.5	2552.13
20.5	2551.36
21.5	2550.86
23.9	2550.34
26.9	2549.65
30.0	2549.57
32.4	2549.23
34.4	2549.01
36.0	2549.06
38.3	2549.35
38.6	2551.27
39.1	2551.81
40.7	2552.16
43.2	2552.38
45.8	2551.94
48.2	2551.86
53.5	2551.72
57.6	2552.37
60.4	2552.60
65.5	2552.30
69.4	2551.95

SUMMARY DATA	
Bankfull Elevation:	2551.8
Bankfull Cross-Sectional Area:	37.2
Bankfull Width:	19.1
Flood Prone Area Elevation:	2554.5
Flood Prone Width:	>70
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	2.0
W / D Ratio:	9.8
Entrenchment Ratio:	3.7
Bank Height Ratio:	1.1
Water Surface Slope (ft/ft):	0.008

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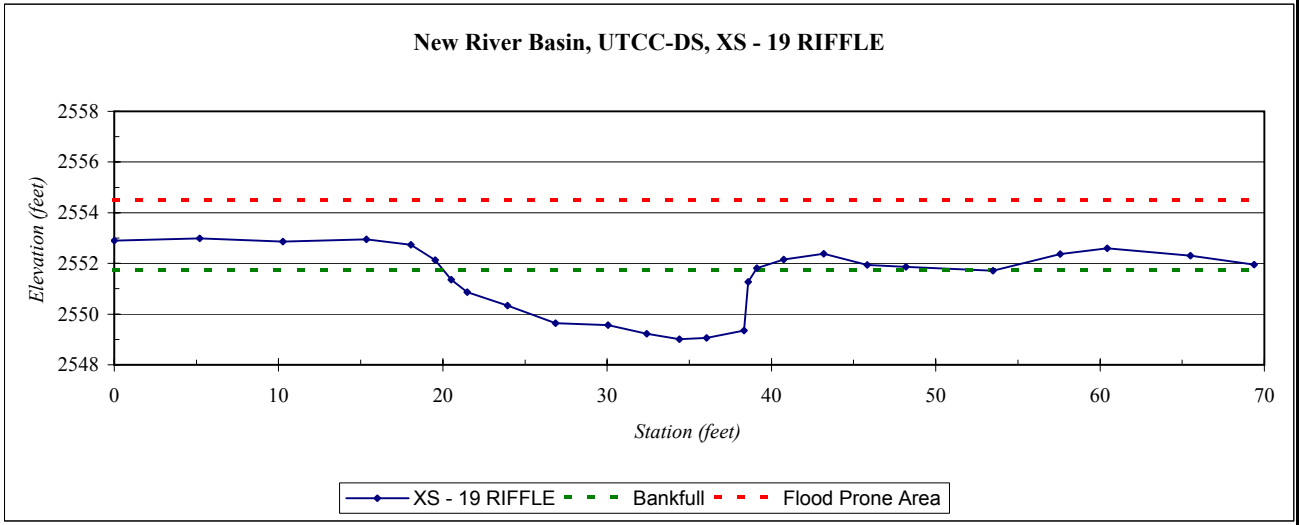
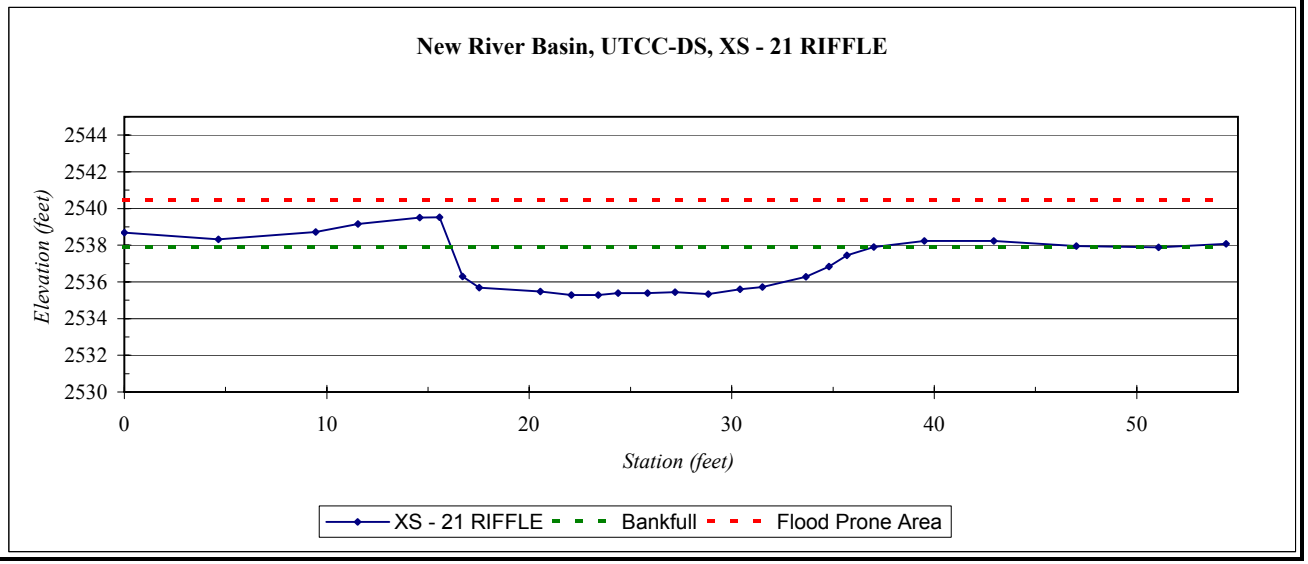


River Basin:	New
Watershed:	UTCC-DS
XS ID	XS - 21 RIFFLE
Drainage Area (sq mi):	2.64
Date:	4/27/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

Station	Elevation
0.0	2538.68
4.6	2538.32
9.5	2538.72
11.5	2539.16
14.6	2539.51
15.6	2539.52
16.7	2536.29
17.5	2535.69
20.5	2535.48
22.1	2535.29
23.4	2535.29
24.4	2535.38
25.8	2535.39
27.2	2535.44
28.8	2535.34
30.4	2535.59
31.5	2535.71
33.7	2536.27
34.8	2536.84
35.7	2537.45
37.0	2537.91
39.5	2538.23
42.9	2538.23
47.0	2537.95
51.1	2537.89
54.4	2538.08

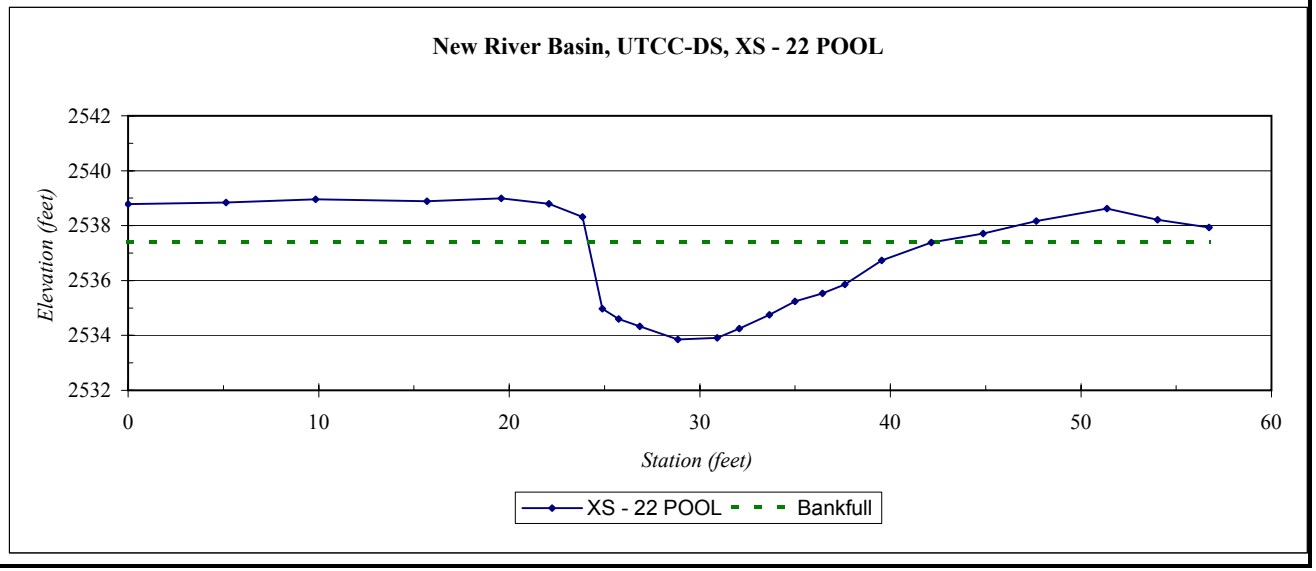
SUMMARY DATA	
Bankfull Elevation:	2537.89
Bankfull Cross-Sectional Area:	42.8
Bankfull Width:	20.8
Flood Prone Area Elevation:	2540.5
Flood Prone Width:	>60
Max Depth at Bankfull:	2.6
Mean Depth at Bankfull:	2.1
W / D Ratio:	10.1
Entrenchment Ratio:	2.9
Bank Height Ratio:	1.0
Water Surface Slope (ft/ft):	0.008



River Basin:	New
Watershed:	UTCC-DS
XS ID	XS - 22 POOL
Drainage Area (sq mi):	2.64
Date:	4/26/2007
Field Crew:	A. Davis, A. French, K. Knight, B. Roberts, E. Solchik

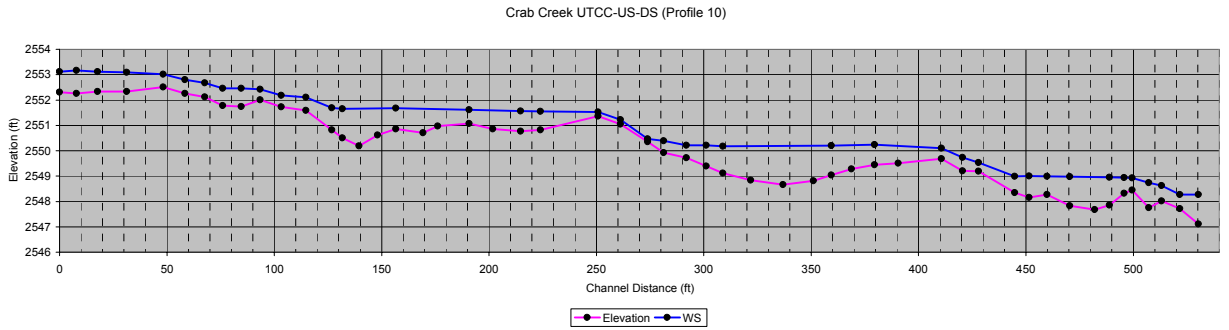
Station	Elevation
0.0	2538.78
5.1	2538.84
9.8	2538.96
15.7	2538.89
19.6	2538.99
22.1	2538.80
23.8	2538.32
24.9	2534.98
25.7	2534.60
26.9	2534.33
28.9	2533.85
30.9	2533.92
32.1	2534.25
33.6	2534.75
35.0	2535.25
36.4	2535.53
37.6	2535.86
39.6	2536.73
42.2	2537.38
44.9	2537.71
47.6	2538.16
51.4	2538.62
54.0	2538.21
56.7	2537.93

SUMMARY DATA	
Bankfull Elevation:	2537.4
Bankfull Cross-Sectional Area:	40.0
Bankfull Width:	18.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.5
Mean Depth at Bankfull:	2.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-
Water Surface Slope (ft/ft):	0.008



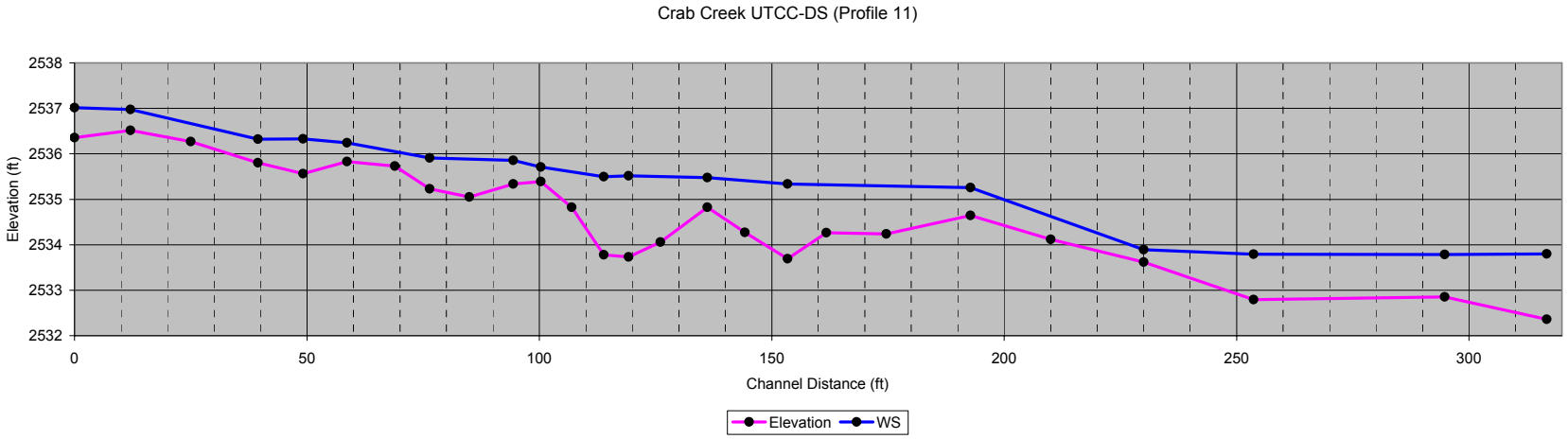
Existing Profiles

Slope Profile



		Elevation BM:	100															
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO10_TW		0		100									2552.315					2553.119
PRO10_TW	8.0	8.0		100									2552.259					2553.161
PRO10_TW	9.8	17.8		100									2552.334					2553.119
PRO10_TW	13.5	31.3		100									2552.336					2553.086
PRO10_BRI	17.0	48.3		100									2552.508					2553.016
PRO10_RI	10.1	58.5		100									2552.259					2552.796
PRO10_RI	9.2	67.7		100									2552.122					2552.669
PRO10_ERI	8.3	76.0		100									2551.784					2552.457
PRO10_TW	8.6	84.6		100									2551.736					2552.459
PRO10_BRI	8.8	93.4		100									2552.005					2552.426
PRO10_RI	9.9	103.3		100									2551.735					2552.183
PRO10_RI	11.4	114.8		100									2551.594					2552.11
PRO10_ERI	12.0	126.8		100									2550.814					2551.69
PRO10_TW	5.0	131.8		100									2550.506					2551.649
PRO10_TW	7.8	139.5		100									2550.192					
PRO10_TW	8.6	148.1		100									2550.62					
PRO10_TW	8.5	156.6488		100									2550.853					2551.681
PRO10_TW	12.7	169.3173		100									2550.704					
PRO10_TW	6.8	176.1192		100									2550.971					
PRO10_TW	14.5	190.6629		100									2551.068					2551.613
PRO10_TW	11.1	201.7903		100									2550.864					
PRO10_TW	12.9	214.7317		100									2550.769					2551.562
PRO10_TW=FENCE	9.2	223.9794		100									2550.817					2551.557
PRO10_BRIF	26.8	250.8029		100									2551.357					2551.528
PRO10_RIF	10.4	261.164		100									2551.053					2551.228
PRO10_ERIF	12.6	273.8074		100									2550.348					2550.472
PRO10_TW=SC_TW	7.4	281.2561		100									2549.92					2550.389
PRO10_TW	10.6	291.8782		100									2549.72					2550.209
PRO10_TW	9.2	301.0998		100									2549.398					2550.211
PRO10_BPO	7.8	308.8556		100									2549.121					2550.177
PRO10_PO	13.0	321.8484		100									2548.835					
PRO10_PO	15.0	336.8387		100									2548.666					
PRO10_PO	14.3	351.111		100									2548.813					
PRO10_EPO	8.3	359.4534		100									2549.035					2550.201
PRO10_TW	9.4	368.8347		100									2549.281					
PRO10_GL	10.8	379.5881		100									2549.449					2550.237
PRO10_GL	11.0	390.5727		100									2549.505					
PRO10_BRIF	20.1	410.7031		100									2549.691					2550.102
PRO10_RIF	9.8	420.4928		100									2549.21					2549.735
PRO10_RIF=GAUGE2	7.5	427.9908		100									2549.189					2549.528
PRO10_ERIF	16.7	444.7111		100									2548.343					2548.985
PRO10_TW	6.8	451.5365		100									2548.152					2548.998
PRO10_TW	8.3	459.8632		100									2548.275					2548.991
PRO10_TW	10.5	470.4113		100									2547.831					2548.978
PRO10_TW	11.7	482.0975		100									2547.676					
PRO10_TW	6.8	488.8957		100									2547.853					2548.954
PRO10_TW	6.9	495.7926		100									2548.327					2548.94
PRO10_BRI	3.7	499.5153		100									2548.444					2548.923
PRO10_RI	7.8	507.2817		100									2547.75					2548.732
PRO10_RI	5.8	513.1311		100									2548.023					2548.618
PRO10_ERI	8.5	521.6026		100									2547.717					2548.268
PRO10_TW	8.7	530.2629		100									2547.116					2548.273

Slope Profile



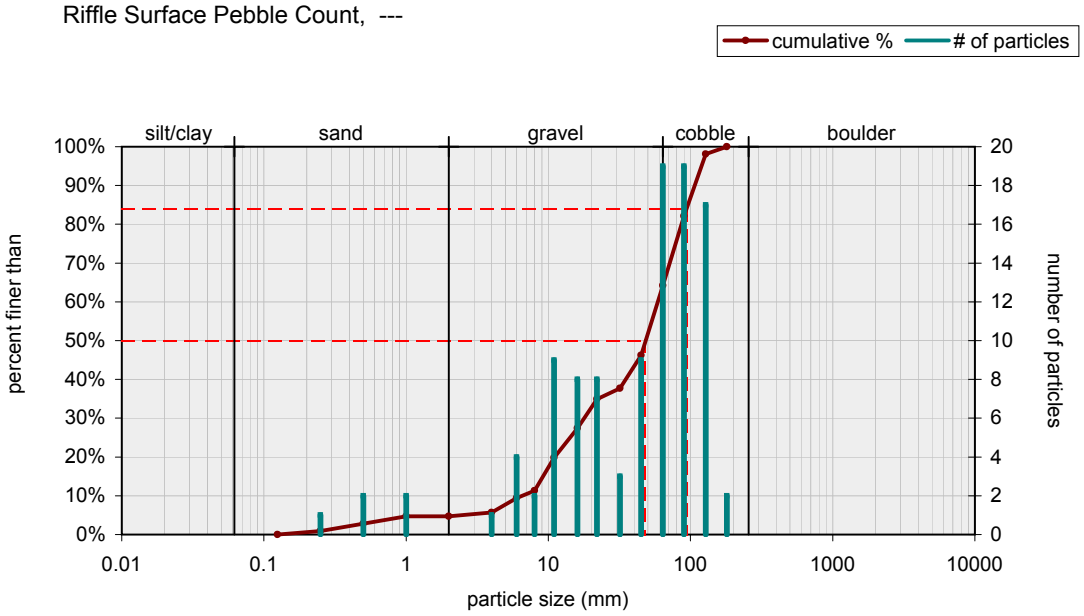
		Elevation BM:	100															
	inc		BS	HI	FS	FS	depth	FS	FS	FS	FS	AZ	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
notes	distance	station	0	100	TP	bed	water	LB	RB	BKF	WS	azimuth	bed	water srf	LF	RB	BKF	WS
PRO11_TW		0		100									2536.358					2537.013
PRO11_BRIF	12.0	12.0		100									2536.515					2536.977
PRO11_RIF	13.0	25.0		100									2536.269					
PRO11_ERIF	14.5	39.5		100									2535.802					2536.325
PRO11_TW	9.8	49.2		100									2535.562					2536.326
PRO11_BRIF	9.5	58.7		100									2535.829					2536.243
PRO11_RIF	10.2	68.9		100									2535.728					
PRO11_RIF	7.5	76.4		100									2535.227					2535.908
PRO11_RIF	8.5	85.0		100									2535.049					
PRO11_RIF	9.4	94.4		100									2535.339					2535.855
PRO11_RIF	5.9	100.3		100									2535.389					2535.712
PRO11_RU	6.7	107.0		100									2534.825					
PRO11_BPO	6.9	113.9		100									2533.777					2535.497
PRO11_EPO	5.3	119.2		100									2533.729					2535.515
PRO11_GL	6.8	126.1		100									2534.06					
PRO11_TW	10.1	136.2		100									2534.825					2535.478
PRO11_TW	8.1	144.224		100									2534.269					
PRO11_TW	9.2	153.4029		100									2533.691					2535.334
PRO11_TW	8.4	161.7896		100									2534.265					
PRO11_TW	12.8	174.6393		100									2534.235					
PRO11_BRIF	18.2	192.791		100									2534.644					2535.26
PRO11_RIF	17.2	210.0191		100									2534.115					
PRO11_ERIF	20.0	230.0644		100									2533.621					2533.894
PRO11_TW	23.6	253.6765		100									2532.795					2533.79
PRO11_TW	41.1	294.7574		100									2532.853					2533.786
PRO11_TW	22.0	316.7455		100									2532.359					2533.798

Sediment

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**1**
medium sand	0.25 - 0.5	**2**
coarse sand	0.5 - 1	**2**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**9**
medium gravel	11 - 16	**8**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**3**
very coarse gravel	32 - 45	**9**
very coarse gravel	45 - 64	**19**
small cobble	64 - 90	**19**
medium cobble	90 - 128	**17**
large cobble	128 - 180	**2**
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		106
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		106

Note: XS19- Riffle (Gauge) (UTCC-DS)



Size (mm)		
D16	9.5	3.4
D35	22	12
D50	48	17
D65	65	20
D84	94	29
D95	120	39

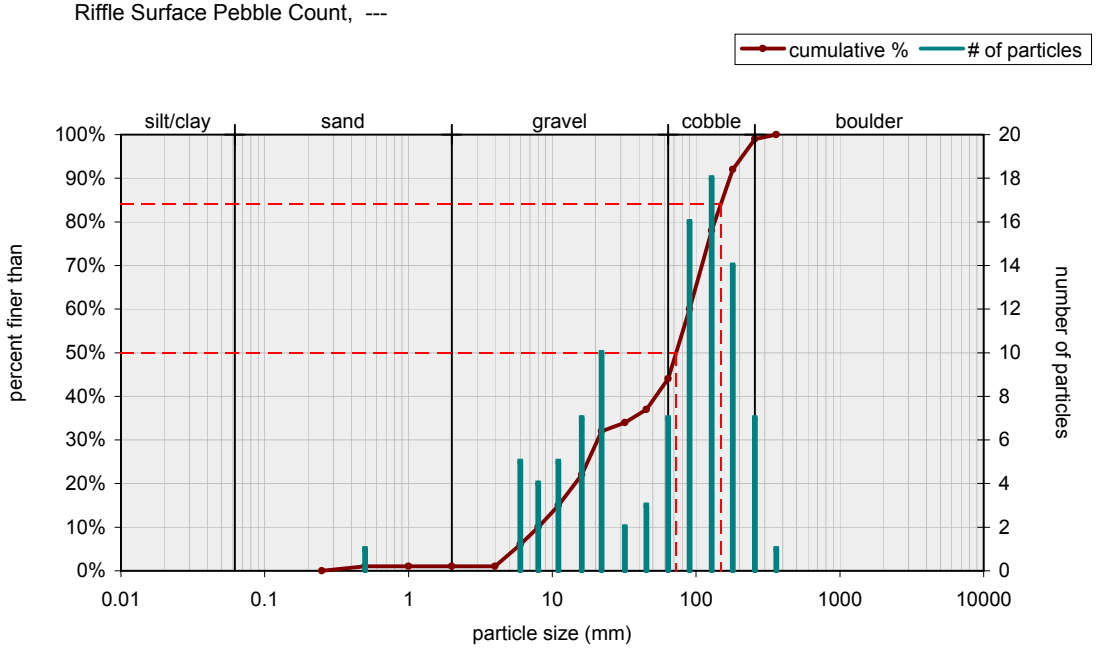
Size Distribution	
mean	29.9
dispersion	3.5
skewness	-0.21

Type	
silt/clay	0%
sand	5%
gravel	59%
cobble	36%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**1**
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**5**
fine gravel	6 - 8	**4**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**10**
coarse gravel	22 - 32	**2**
very coarse gravel	32 - 45	**3**
very coarse gravel	45 - 64	**7**
small cobble	64 - 90	**16**
medium cobble	90 - 128	**18**
large cobble	128 - 180	**14**
very large cobble	180 - 256	**7**
small boulder	256 - 362	**1**
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS21- Riffle (UTCC-DS)



Size (mm)	
D16	12
D35	36
D50	73
D65	99
D84	150
D95	210

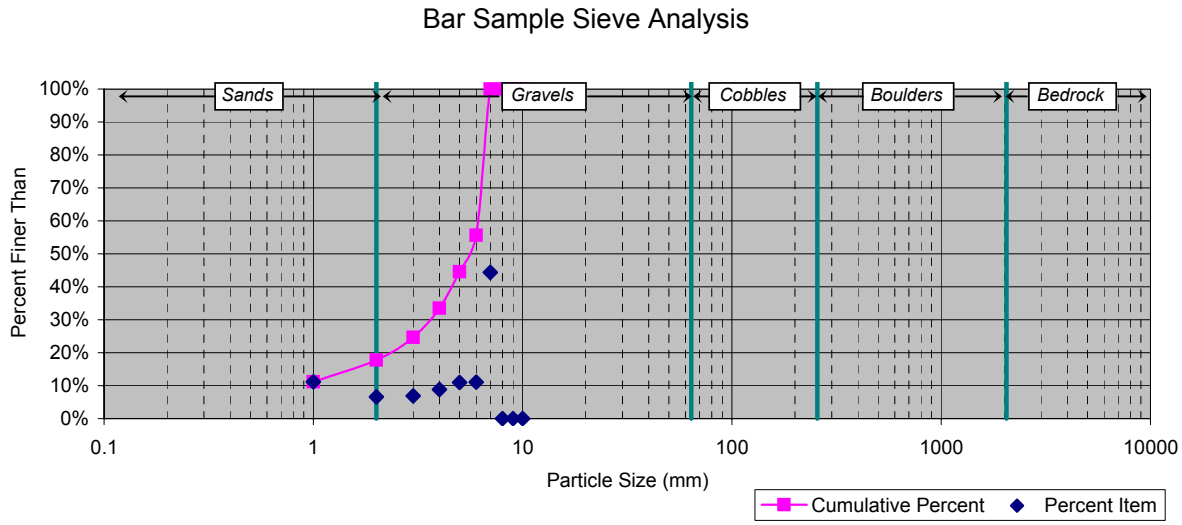
Size Distribution	
mean	42.4
dispersion	4.1
skewness	-0.23

Type	
silt/clay	0%
sand	1%
gravel	43%
cobble	55%
boulder	1%

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	152.5	11.1%	11.1%
1.0	90.5	6.6%	17.7%
2.0	95.0	6.9%	24.7%
4.0	121.5	8.9%	33.5%
8.0	151.0	11.0%	44.5%
16.0	152.0	11.1%	55.6%
31.5	608.5	44.4%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	1371.0	100%	

Stream:	Crab Creek Bar UTCC-DS
Watershed:	
Location:	125 feet upstream of XS #21 on UTCC-DS
Note:	Bar Sample # 3

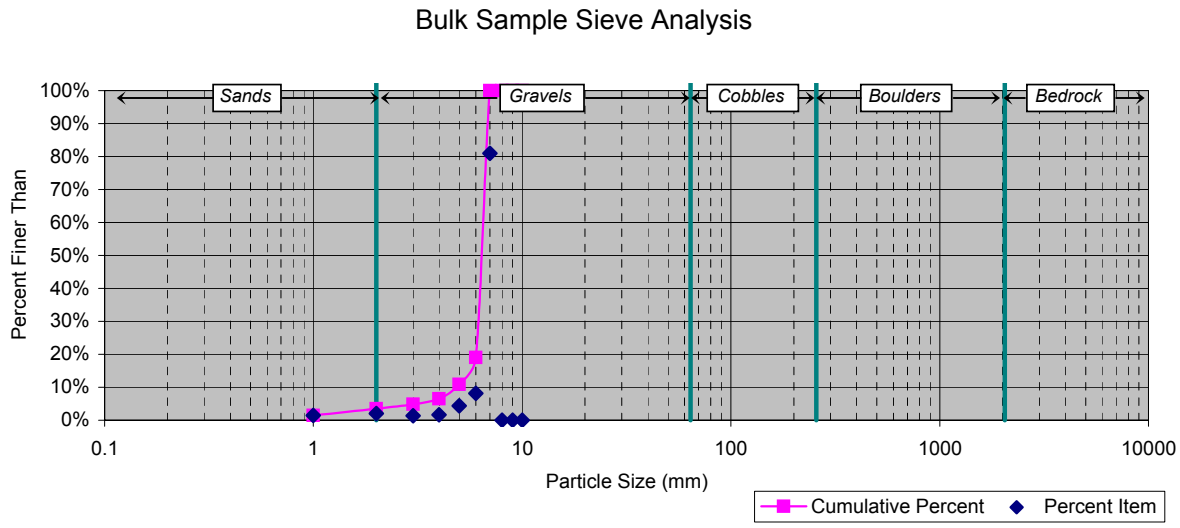


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
4.4	4.4	11.3	24.7	29.2	0%	25%	75%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	4.5	1.5%	1.5%
1.0	6.0	2.0%	3.5%
2.0	4.0	1.3%	4.8%
4.0	5.0	1.7%	6.5%
8.0	13.0	4.3%	10.8%
16.0	24.5	8.2%	19.0%
31.5	243.0	81.0%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	300.0	100%	

Stream: Crab Creek UTCC-DS
Watershed:
Location: XS # 21 UTCC-DS
Note: Bulk Sample # 6 (0-5.5 inches)

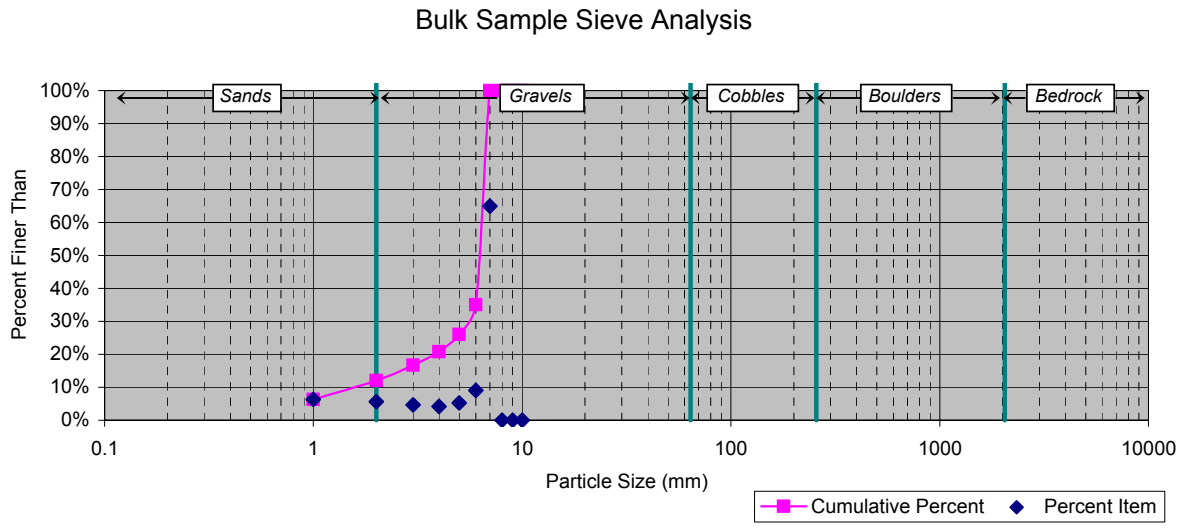


Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
12.4	18.3	20.7	27.6	30.2	0%	5%	95%	0%	---	---

Bar Sample Sieve Analysis

Smallest Sieve Passed (mm)	Weight (oz)	% Item	Percent Finer Than
<1	52	6.3%	6.3%
1.0	46.5	5.7%	12.0%
2.0	38.0	4.6%	16.7%
4.0	34.0	4.1%	20.8%
8.0	43.0	5.2%	26.1%
16.0	74.0	9.0%	35.1%
31.5	532.0	64.9%	100.0%
128.0	0.0	0.0%	100.0%
256.0	0.0	0.0%	100.0%
> 256.0	0.0	0.0%	100.0%
Total:	819.5	100%	

Stream:	Crab Creek UTCC-DS
Watershed:	
Location:	XS # 21 UTCC-DS
Note:	Bulk Sample # 6 (5.5-11 inches)



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
1.8	15.9	18.7	26.7	29.9	0%	17%	83%	0%	---	---

BEHI

Bank Erodibility Hazard Rating Guide

Stream: UTCC-DS (Crab Creek Site) **Reach:** _____ **Date:** 4/24/07 **Crew:** AH

Bank Erosion Potential

Bank Height (ft): / Bankfull Height (ft):		Bank Height/ Bankfull Ht		Root Depth/ Bank Height		Root Density %		Bank Angle (Degrees)		Surface Protection%	
VERY LOW	Value Range	1.0	1.1	0.9	1.0	80	100	0.0	20.0	80	100
	Index Range	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9	1.0	1.9
	Choice	**V: 1.0**	**I: 1.0**	**V:**	**I:**	**V: 80.0**	**I: 1.9**	**V:**	**I:**	**V: 100.0**	**I: 1.0**
LOW	Value Range	1.11	1.19	0.5	0.89	55	79	21.0	60.0		79
	Index Range	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9	2.0	3.9
	Choice	**V:**	**I:**	**V: 0.80**	**I: 2.4**	**V:**	**I:**	**V: 45.0**	**I: 3.2**	**V:**	**I:**
MODERATE	Value Range	1.2	1.5	0.3	0.49	30	54	61.0	80.0	30	54
	Index Range	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9	4.0	5.9
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
HIGH	Value Range	1.6	2.0	0.15	0.29	15	29	81.0	90.0	15	29
	Index Range	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9	6.0	7.9
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
VERY HIGH	Value Range	2.1	2.8	0.05	0.14	5	14	91.0	119.0	10	14
	Index Range	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0	8.0	9.0
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**
EXTREME	Value Range	>2.8		<0.05		<5		>119		<10	
	Index Range	10		10		10		10		10	
	Choice	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**	**V:**	**I:**

V = value, I = index

SUB-TOTAL (Sum one index from each column) 9.5

Bank Material Description:

Consistent Layer

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt Clay (+ 0: no adjustment)

Bank Sketch

BANK MATERIAL ADJUSTMENT 5

Stratification Comments:

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.9	10-19.9	20-29.9	30-39.9	40-45.9	46-50

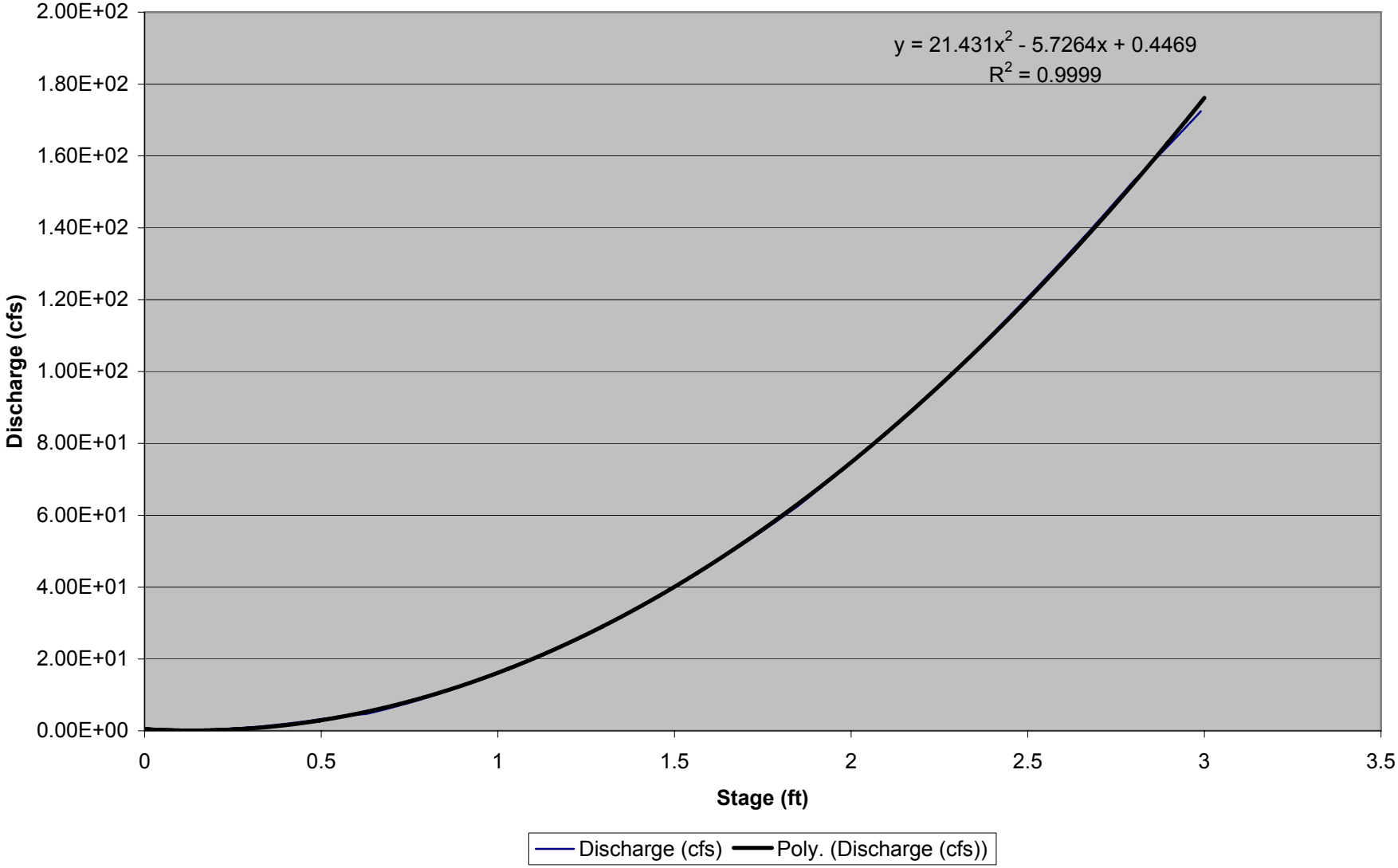
Bank location description (check one)

GRAND TOTAL 14.5

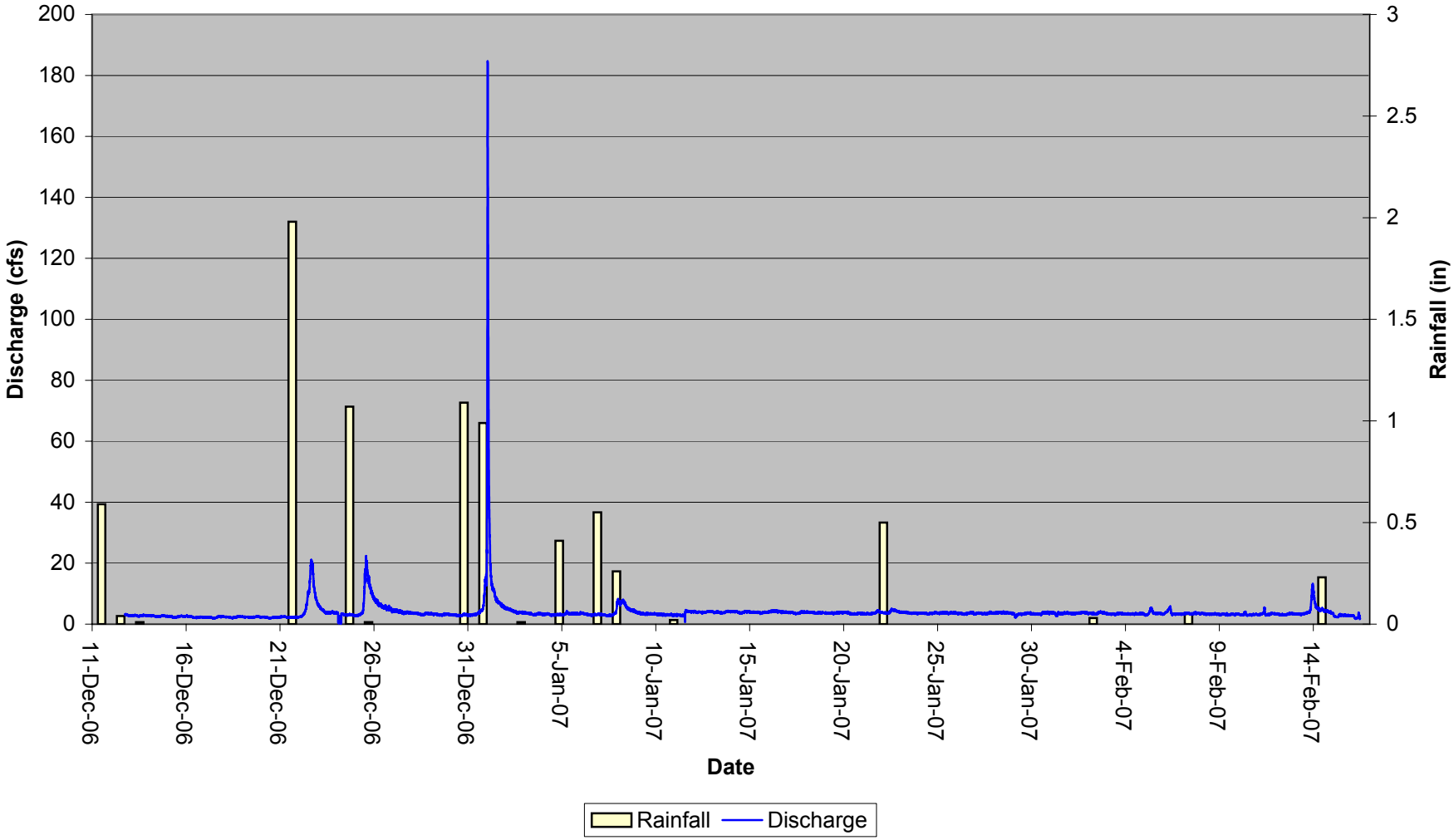
BEHI RATING Low

Rating Curve & Hydrographs

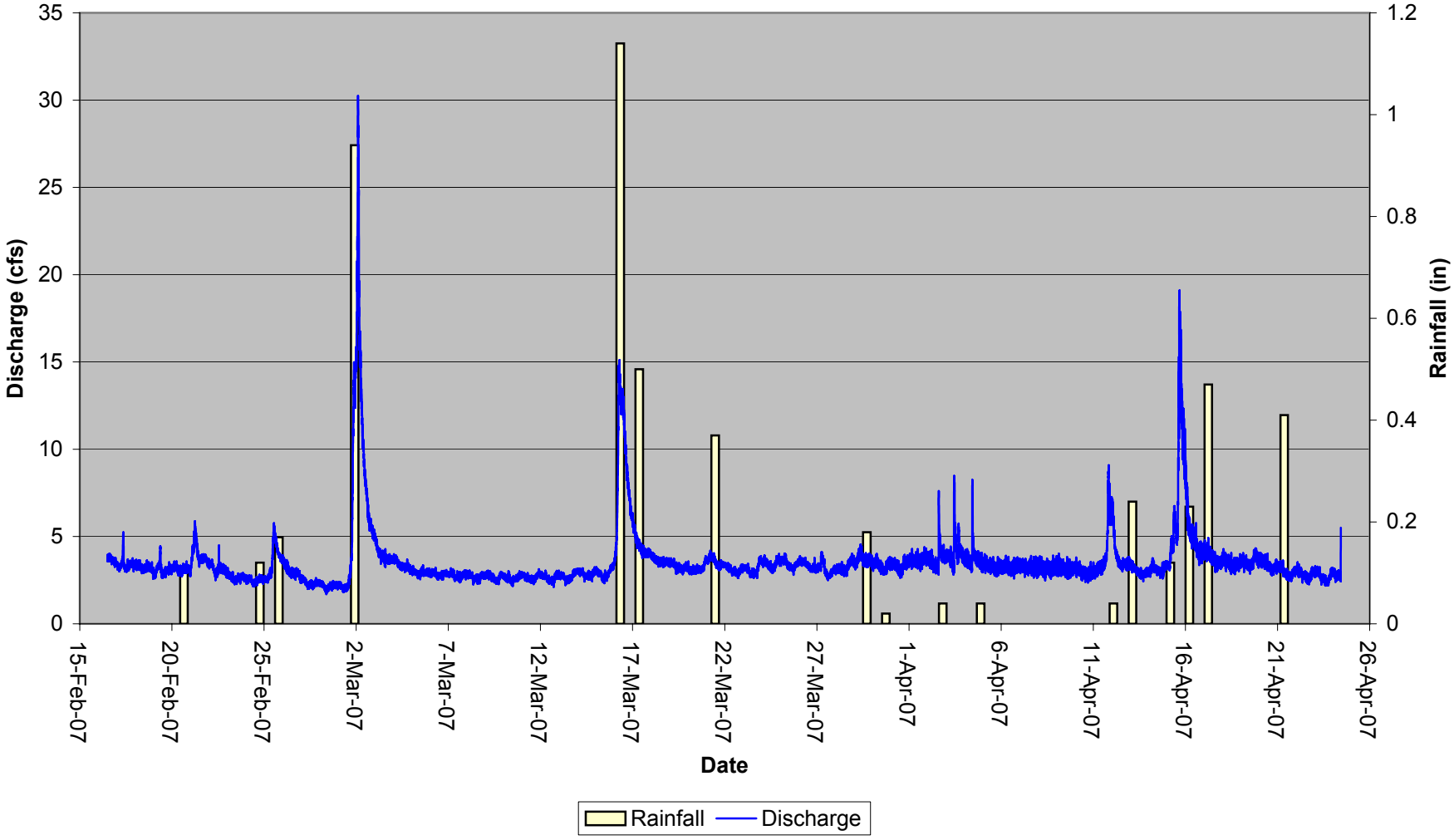
Gauge 2 (XS-19) Rating Curve



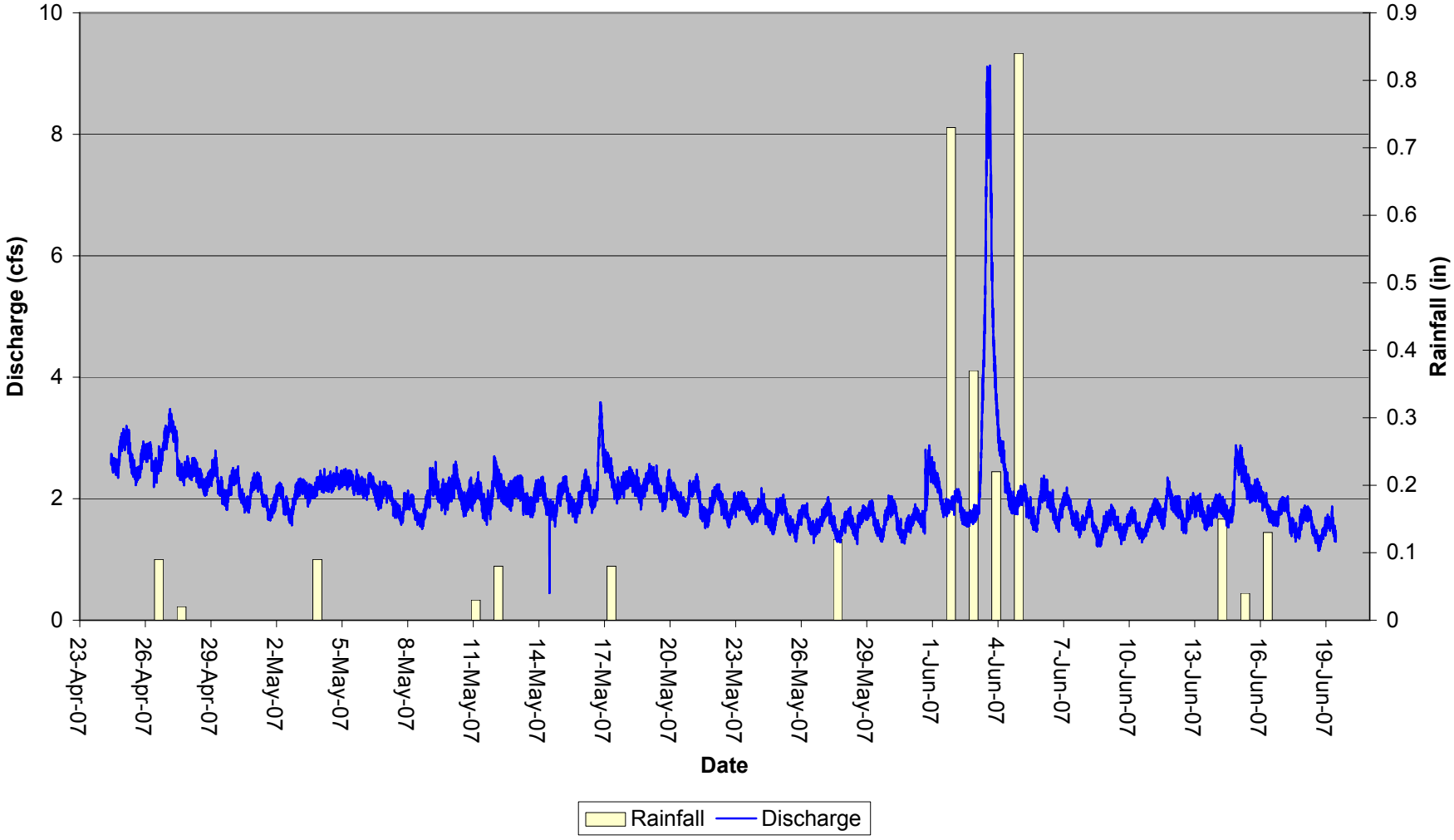
Crab Creek Gauge 2
(XS-19) Discharge Hydrograph
12/12/06 to 02/16/07



Crab Creek Gauge 2
(XS-19) Discharge Hydrograph
02/16/07 to 04/24/07



Crab Creek Gauge 2
(XS-19) Discharge Hydrograph
04/24/07 to 06/19/07



Appendix H

Reference Reach Data

Reference Reach Database

LeiLani Paugh, NCDOT
(919) 733-1194
lpaugh@dot.state.nc.us

NC STATE UNIVERSITY

Stream ID	12
Stream Name	Lost Cove Creek
Contact	Dan Clinton
Organization	NCSU
Email	dan_clinton@ncsu.edu
Date Surveyed	6/8/1998

Location

River Basin	Catawba
8-digit HUC	03050101
Location	Town of Edgemont, NC, within Pisgah National Forest
Reach Description	
State	NC
Latitude	(decimal degrees)
Longitude	(decimal degrees)
County	Avery
Physio. Region	Mountain (coast, Piedmont, mtns)
Ecoregion	
Public/Private	U
Right of Entry	☑ (check for yes)
USGS Quad	Grandfather M

Hydraulics

Bankfull Discharge		(cfs)
Bankfull Velocity		(ft/s)
Manning's n		
Method of Calculating Manning's n		

Channel Materials

Percent Silt/Clay	0%	
Percent Sand	18%	
Percent Gravel	5%	
Percent Cobble	48%	
Percent Boulder	18%	
Percent Bedrock	11%	
D16	1.4	(mm)
D35		(mm)
D50	144	(mm)
D84	512	(mm)
D95		(mm)

Note: 2,049 mm corresponds to BEDROCK

Reference Reach Database

LeiLani Paugh, NCDOT
(919) 733-1194
lpaugh@dot.state.nc.us

Stream ID 12

Stream Name Lost Cove Creek

Profile

Avg Water Surface Slope 0.0088

Avg Valley Slope 0.0084

Valley Length

Sinuosity 1.2

X-Sec Stationing	Run Slope	Pool Slope	Riffle Slope	Glide Slope
	0.0324	0.0044	0.0266	0
	0.0033	0	0.0324	0
	0.0021	0	0.0146	0.002
		0.0006	0.0217	0.005
		0	0.0475	

Data Standards

No survey data provided	☐	No material analysis provided	☐
No pattern data provided	☐	Data do not align with regional curve	☐
No profile data provided	☐	No location information provided	☐
No hydraulics data provided	☑		

Description

Rosgen Stream Type	C3	Soils Type	
Reach Length	1,034 (ft)	BEHI Score	
Watershed Drainage Area	24.80 (sq. mi)	Avg Water Surface Slope	0.0088
Watershed % Impervious		Valley Slope	0.0084
Valley Type	A (C- colluvial or A- alluvial)	Valley Length	(ft)
Land Use	R (U- urban or R- rural)	Sinuosity	1.20
Site Description	Within Pisgah National Forest	DWQ Index No.	11-38-34-11
		DWQ Reference Reach	☐ (check for yes)
		DWQ Benthic Monitoring	☐ (check for yes)

Description of any Associated Wetlands	
Description of Vegetative Communities	Dense shrub and deciduous vegetation line banks and adjacent hillslopes
Watershed Description	Entirely within National Forest boundaries

Reference Reach Database

LeiLani Paugh, NCDOT
(919) 733-1194
lpaugh@dot.state.nc.us

Stream ID 12

Stream Name Lost Cove Creek

X-Section

X-Sec Station	Feature	Bankfull Width (ft)	Bankfull Depth (ft)	Bankfull Area (ft2)	BKF Max Depth (ft)	Width FPA (ft)	Low Bank Ht (ft)
0+57	Riffle	64.9	3.4	218	5	200	5
1+71	Riffle	59.7	3.3	198	5.8	296	5.8
5+60	Pool	59.5	4.2	251.2	7.7		

Reference Reach Database

LeiLani Paugh, NCDOT
(919) 733-1194
lpaugh@dot.state.nc.us

Stream ID 12 **Sinuosity** 1.2

Stream Name Lost Cove Creek

Pattern

Meander Length (ft)	Radius of Curvature (ft)	Meander Belt Width (ft)	Pool to Pool Spacing (ft)
540	55.1	500	133.8
91			323
51.3			116
53.5			188
61.6			

Reference Reach Database

LeiLani Paugh, NCDOT
(919) 733-1194
lpaugh@dot.state.nc.us

Stream ID	12
Stream Name	Lost Cove Creek

Dimension Ratios	Mean	Minimum	Maximum
Bankfull Width: Depth Ratio	18.59	18.09	19.09
Entrenchment Ratio	4.02	3.08	4.96
Bank Height Ratio	1.00	1.00	1.00
Pool width: Bankfull width*	0.96	0.96	0.96
Max pool depth: Bankfull depth*	2.30	2.30	2.30
Mean pool depth: Bankfull depth*	1.25	1.25	1.25
Pool area: Riffle area*	1.21	1.21	1.21

* Ratio denominators are the riffle mean bankfull value.

Pattern Ratios	Mean	Minimum	Maximum
Pool to pool Spacing: Bkfl width	3.05	1.86	5.18
Meander length ratio	2.56	0.82	8.67
Radius of curvature ratio	0.88	0.88	0.88
Meander width ratio	8.03	8.03	8.03

Profile Ratios	Mean	Minimum	Maximum
Pool slope: Avg WS slope	0.11	0.00	0.50
Riffle slope: Avg WS slope	3.25	1.66	5.40
Glide slope: Avg WS slope	0.20	0.00	0.57
Run slope: Avg WS slope	1.43	0.24	3.68

Appendix I

Detailed Soils Investigation and Mapping for the Crab Creek Site

Detailed Soils Investigation and Mapping for the Crab Creek Site

In December 2006, KCI completed a detailed soils investigation at the Crab Creek Site in Alleghany County, North Carolina. The results of this investigation are described below and displayed in the following figure (Soil Investigation Map).

For at least the past 50 years, the soils at the Crab Creek Site have undergone varying degrees of anthropogenic modifications. In particular, the soils in cleared areas have been altered by sediment deposition from frequent overwash, channelization and a ditch/spoil drainage system to prepare the land for pasture and cultivation. Primarily, the ditch/spoil drainage system effectively captures hydrologic inputs from adjacent properties and conveys it to an unnamed tributary to Crab Creek (UTCC). The hydrologic inputs to these man-made channels produce continual flow onto the site throughout the year in such quantity as to produce jurisdictional wetlands on the ditch bottoms of the drainage system. KCI plans to abandon these ditches to restore hydrology to drained wetlands. In addition, UTCC will be restored and the excavated spoil removed from the cultivated areas.

The Alleghany County Soil Survey has classified the soils within the floodplain areas of the site as predominately Alluvial Land, Wet. Based on field results, KCI has remapped and reclassified the primary soil as the Nikwasi Series (Coarse-loamy over sandy or sandy skeletal, mixed, superactive, nonacid, mesic Cumulic Humaquepts). Inclusions of Toxaway Series (Fine-loamy, mixed, superactive, nonacid, mesic Cumulic Humaquepts) were also identified along the outer edges of the floodplain away from UTCC. In contrast to the Nikwasi series, the Toxaway inclusions are typically finer soils with a Cg horizon containing less than 35 percent coarse fragments within 40 inches below the surface. These inclusions into the Nikwasi series likely represent less than 20 percent of the hydric soils on the site. The Nikwasi and Toxaway series are listed as hydric soils due to saturation for a significant period during the growing season and are in accordance with the federal and state hydric soils list. Since neither soil was mapped in Alleghany County, the NRCS has not included them on the hydric soils list for the county.

In disturbed areas, the existing soil is classified as a Nikwasi variant, because of the ditch spoil/fills from man-made alterations and sediment deposition from frequent overwash. Some pedons in the disturbed areas have recent layers of overburden/spoil/fill up to 24 inches thick that are loamy and variable in color and fall outside the range of characteristics for the Ap and A horizons of the Nikwasi series.

The reclassification of the soils is based on our findings obtained from a detailed soils investigation at the site. This detailed soils investigation was conducted by augering numerous soil borings across the site, classifying the soils in accordance with soil taxonomy, and delineating two soil mapping units on a 2005 aerial photograph. The primary difference between the two soil mapping units is that one mapping unit has 18-24 inches fill or overburden applied to the surface and the other mapping unit has not been filled. To verify the purity of the soil mapping units, additional auger borings were advanced on-site and two representative soil descriptions, one from each mapping unit, were prepared describing the vertical soil profiles (see Soil Investigation Map*).* Soil boring #19 is representative of the more natural soils while soil boring C (located downstream of the culvert) has been altered by filling. The asterisk shown on the soil description indicates the altered horizons. These soil profile descriptions fall within the range of characteristics of the Nikwasi series.

The Nikwasi series consists of poorly drained and very poorly drained, moderately rapidly permeable soils on floodplains in the Blue Ridge. These soils formed in recent alluvium consisting of loamy material that is moderately deep to strata of sand, gravel, and /or cobbles. These soils are often mapped as hydric inclusions within better drained soils that are very frequently flooded. A typical soil profile description is as follows:

Typical Soil Pedon
A - 0-8 inches, very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; very friable; common fine roots; few rounded gravel; common fine and medium flakes of mica; slightly acid; clear wavy boundary.

A - 8-26 inches, very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; very friable; common fine roots; few rounded gravel; common fine and medium flakes of mica; slightly acid; clear smooth boundary. (Combined thickness of the A subhorizons is 24 to 35 inches).

Cg - 26-60 inches, dark grayish brown (10YR 4/2) and multicolored extremely gravelly coarse sand; single grained; loose dominantly water worn gravel with cobbles; common fine and medium flakes of mica; moderately acid.

Range of Characteristics
The range of characteristics of the A horizon has a hue of 2.5Y or 10YR, a value of 2 or 3, and a chroma ranging from 1 to 3 or it is neutral with a value of 2 or 3. It is fine sandy loam, sandy loam, or loam in the fine earth fraction.

The AC horizon, where present, has colors similar to the A horizon. It is loamy sand, loamy fine sand, loamy coarse sand, sand, or coarse sand in the fine earth fraction.

Steven F. Stokes, LSS
Licensed Soil Scientist

SOIL PROFILE DESCRIPTION

Client: North Carolina Ecosystem Enhancement Program — Date: 12/20/2006
Project: UT to Crab Creek Restoration Site — Project #: 12053743H
County: Alleghany — State: NC
Location: — Site/Lot: Soil boring # 19
Soil Series: Nikwasi (Unaltered)
Soil Classification: Coarse-loamy over sandy-skeletal, mixed superactive, nonacid, mesic Cumulic Humaquepts
AWT: 6" — SHWT: 0-12" — Slope: 0-3% — Infiltration: very slow to ponded runoff
Elevation: — Drainage: Poorly and very poorly drained — Permeability: moderately rapid
Vegetation: Weedy, first year successional
Borings terminated at 41 Inches

HORIZON	DEPTH (IN)	MATRIX	MOTTLES	TEXTURE	STRUCTURE	CONSISTENCE	BOUNDARY	NOTES
Ap	0-15	10YR2/2		fsl	2fgr	very friable	cw	
A	15-28	10YR2/2		sl	1fgr	very friable	cs	
Cg1	28-40	10YR 3/1		ls	sg	loose	cs	compact structure in
								place, but loose when
								removed.
Cg2	40-41	10YR 3/1		s	sg to	strongly cemented		sand and waterworn
					structureless			gravels and/or cobbles

COMMENTS:
Auger refusal on cobbles at 41 inches.

DESCRIBED BY: _____ DATE: _____

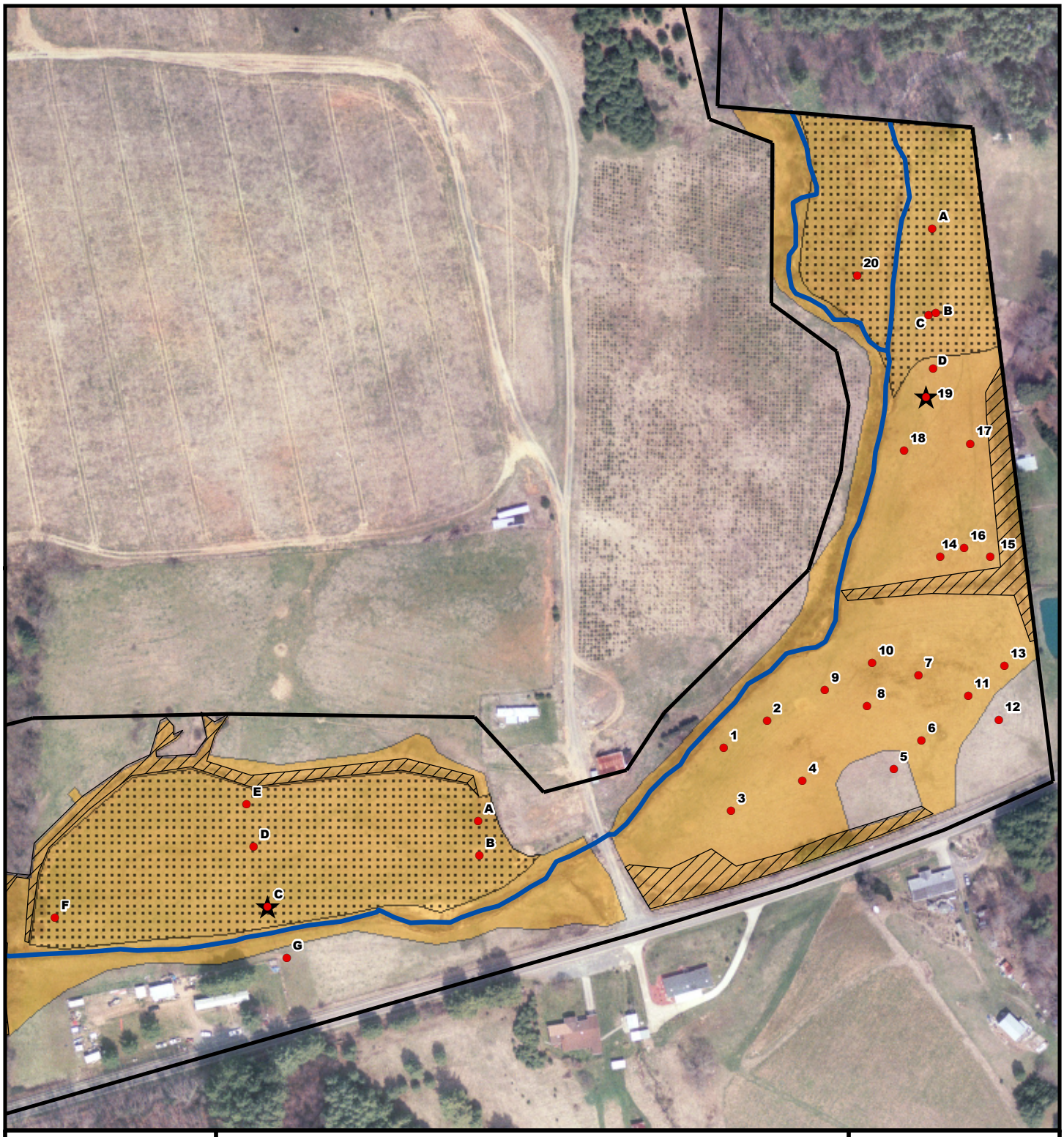
SOIL PROFILE DESCRIPTION

Client: North Carolina Ecosystem Enhancement Program Date: 12/20/2006
Project: UT to Crab Creek Restoration Site Project #: 12053743H
County: Alleghany State: NC
Location: Site/Lot: Soil boring C (downstream of culvert)
Soil Series: Nikwasi variant (Altered)
Soil Classification: Coarse-loamy over sandy-skeletal, mixed superactive, nonacid, mesic Cumulic Humaquepts
AWT: 20 SHWT: >12 Slope: 0-3% Infiltration: very slow to ponded runoff
Elevation: Drainage: Poorly and very poorly drained Permeability: moderately rapid
Vegetation: Fescue
Borings terminated at 44 Inches

HORIZON	DEPTH (IN)	MATRIX	MOTTLES	TEXTURE	STRUCTURE	CONSISTENCE	BOUNDARY	NOTES
*Ap	0-12	10YR 4/6		ls-s	sg	loose	ab	Fill
*A	12-24	10YR 4/6	10YR 2/2	ls-s	sg	loose	ab	Fill-mixed soils
Ab	24-32	10YR 2/2		fsl	2fgr	very friable	cw	buried horizon
Cg1	32-44	10YR 2/2		cos	sg	loose	cs	compact structure in
								place, but loose when
								removed.
Cg2	44					strongly cemented		Auger refusal,
								gravel and/or cobbles

COMMENTS:
Auger refusal on gravels or cobbles at 44 inches.
Spoil likely placed on pasture after creek straightened
Asterisks indicate altered horizons

DESCRIBED BY: _____ DATE: _____



Soil Investigation Map

KCI ASSOCIATES OF NC

- Project Boundary
- Soil Boring Locations
- Representative Soil Descriptions
- Mapped Hydric Soils
- Disturbed Hydric Soils Within 18-24" Overburden
- Project Streams (Existing)
- Wetland (Existing)

1:2,400
1 inch equals 200 feet

200 100 0 200 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

Ecosystem Enhancement PROGRAM

Appendix J

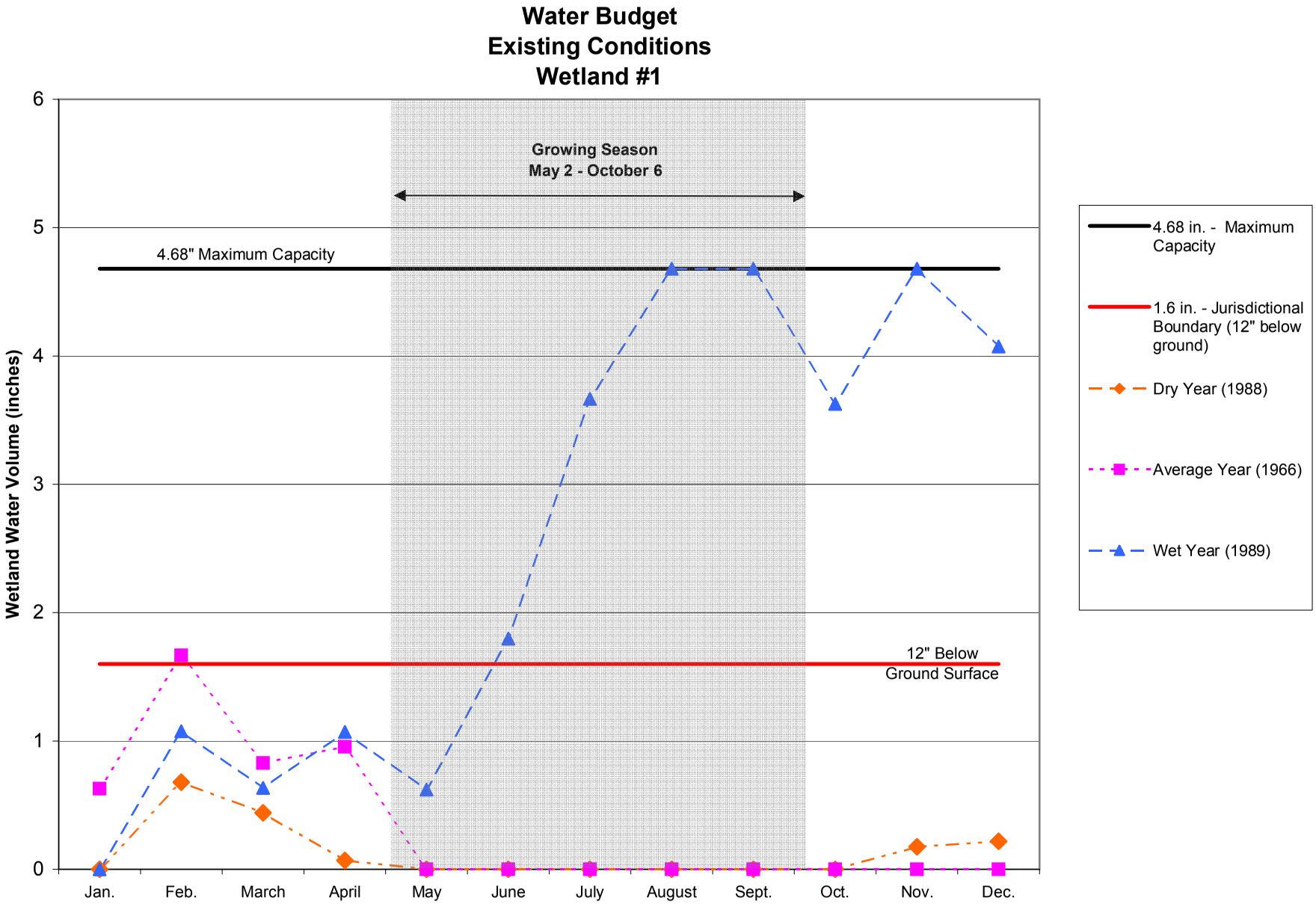
Water Budget Analysis

Crab Creek - Existing Conditions (Wetland #1)

Dry Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	1.42	0.04	0.25	0.00	0.29	0.00	2.02	-0.60	0.00	0.00
February	2.03	0.09	0.25	0.08	0.34	0.00	1.27	0.68	0.00	0.68
March	1.29	0.00	0.25	0.92	0.25	0.00	0.61	-0.24	0.00	0.44
April	4.18	0.38	0.25	1.97	0.63	0.00	2.58	-0.37	0.00	0.07
May	3.28	0.56	0.25	2.81	0.81	0.00	0.82	-0.35	0.00	0.00
June	2.77	0.04	0.25	4.10	0.29	0.00	0.52	-1.85	0.00	0.00
July	2.90	0.06	0.25	4.79	0.31	0.00	0.00	-1.89	0.00	0.00
August	2.98	0.18	0.25	4.78	0.43	0.00	0.00	-1.80	0.00	0.00
September	3.25	0.20	0.25	3.23	0.45	0.00	2.95	-2.94	0.00	0.00
October	1.60	0.06	0.25	1.27	0.31	0.00	1.16	-0.83	0.00	0.00
November	5.50	1.03	0.25	0.85	1.28	0.00	4.48	0.17	0.00	0.17
December	1.63	0.00	0.25	0.17	0.25	0.00	1.42	0.04	0.00	0.22
Annual Totals	**32.83**	**2.64**	**3.00**	**24.97**	**5.64**	**0.00**	**17.82**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	4.16	0.25	0.25	0.00	0.50	0.00	3.53	0.63	0.00	0.63
February	6.92	1.67	0.25	0.04	1.92	0.00	5.84	1.04	0.00	1.67
March	1.70	0.09	0.25	0.87	0.34	0.00	1.67	-0.84	0.00	0.83
April	3.41	0.13	0.25	1.79	0.38	0.00	1.49	0.13	0.00	0.95
May	4.03	0.11	0.25	3.16	0.36	0.00	1.88	-1.01	0.00	0.00
June	2.33	0.03	0.25	4.04	0.28	0.00	1.26	-2.97	0.00	0.00
July	3.34	0.49	0.25	4.81	0.74	0.00	0.00	-1.47	0.00	0.00
August	4.97	0.35	0.25	4.25	0.60	0.00	0.77	-0.04	0.00	0.00
September	6.76	2.48	0.25	2.97	2.73	0.00	5.11	-1.32	0.00	0.00
October	4.54	1.35	0.25	1.65	1.60	0.00	3.31	-0.42	0.00	0.00
November	4.48	0.94	0.25	0.85	1.19	0.00	4.04	-0.41	0.00	0.00
December	3.85	0.37	0.25	0.15	0.62	0.00	3.82	-0.12	0.00	0.00
Annual Totals	**50.49**	**8.27**	**3.00**	**24.58**	**11.27**	**0.00**	**32.72**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	2.26	0.00	0.25	0.40	0.25	0.00	2.59	-0.73	0.00	0.00
February	3.04	0.00	0.25	0.29	0.25	0.00	1.68	1.08	0.00	1.08
March	3.82	0.19	0.25	1.16	0.44	0.00	3.10	-0.44	0.00	0.63
April	2.6	0.00	0.25	1.81	0.25	0.00	0.36	0.44	0.00	1.07
May	5.38	0.76	0.25	2.68	1.01	0.00	3.15	-0.45	0.00	0.62
June	8.75	1.28	0.25	4.51	1.53	0.00	3.06	1.18	0.00	1.80
July	13.61	4.11	0.25	4.78	4.36	0.00	6.96	1.87	0.00	3.67
August	6.29	2.20	0.25	4.34	2.45	0.00	0.09	1.86	0.85	4.68
September	14.02	4.87	0.25	3.29	5.12	0.00	5.53	5.20	5.20	4.68
October	5.49	1.23	0.25	2.02	1.48	0.00	4.53	-1.05	0.00	3.63
November	8.98	5.02	0.25	0.64	5.27	0.00	4.72	3.62	2.56	4.68
December	2.04	0.08	0.25	0.00	0.33	0.00	2.65	-0.61	0.00	4.07
Annual Totals	**76.28**	**19.74**	**3.00**	**25.92**	**22.74**	**0.00**	**38.41**			

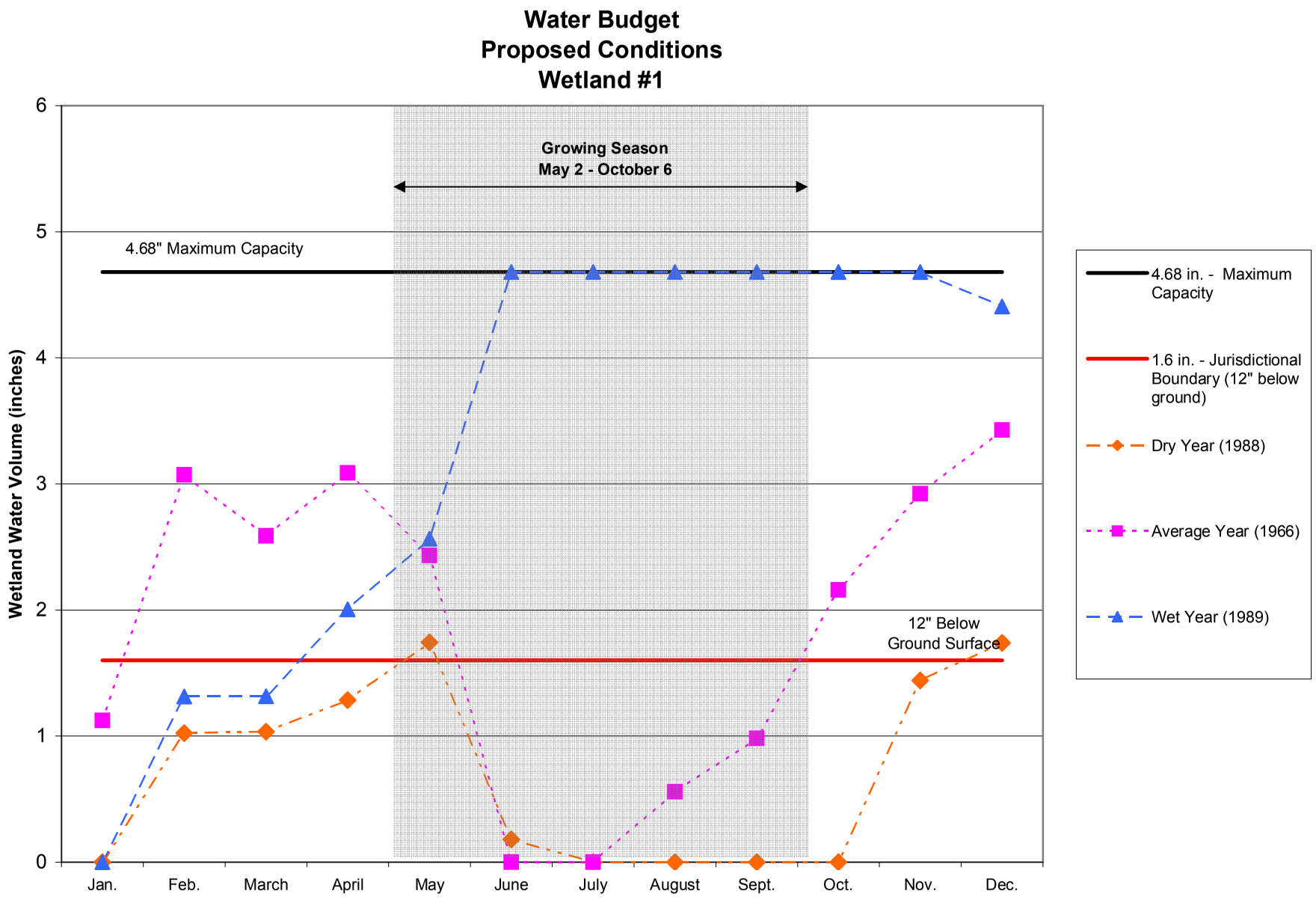

Water Budget
Existing Conditions
Wetland #1
Wetland Water Volume (inches)
6
5
4
3
2
1
0
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)

Crab Creek - Proposed Conditions (Wetland #1)

Dry Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	1.42	0.04	0.25	0.00	0.00	0.00	2.02	-0.30	0.00	0.00
February	2.03	0.09	0.25	0.08	0.00	0.00	1.27	1.02	0.00	1.02
March	1.29	0.00	0.25	0.92	0.00	0.00	0.61	0.01	0.00	1.03
April	4.18	0.38	0.25	1.97	0.00	0.00	2.58	0.25	0.00	1.29
May	3.28	0.56	0.25	2.81	0.00	0.00	0.82	0.46	0.00	1.74
June	2.77	0.04	0.25	4.10	0.00	0.00	0.52	-1.56	0.00	0.18
July	2.90	0.06	0.25	4.79	0.00	0.00	0.00	-1.58	0.00	0.00
August	2.98	0.18	0.25	4.78	0.00	0.00	0.00	-1.37	0.00	0.00
September	3.25	0.20	0.25	3.23	0.00	0.00	2.95	-2.49	0.00	0.00
October	1.60	0.06	0.25	1.27	0.00	0.00	1.16	-0.51	0.00	0.00
November	5.50	1.03	0.25	0.85	0.00	0.00	4.49	1.44	0.00	1.44
December	1.63	0.00	0.25	0.17	0.00	0.00	1.41	0.30	0.00	1.74
Annual Totals	**32.83**	**2.64**	**3.00**	**24.97**	**0.00**	**0.00**	**17.83**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	4.16	0.25	0.25	0.00	0.00	0.00	3.54	1.12	0.00	1.12
February	6.92	1.67	0.25	0.04	0.00	0.00	6.85	1.95	0.00	3.07
March	1.70	0.09	0.25	0.87	0.00	0.00	1.66	-0.48	0.00	2.59
April	3.41	0.13	0.25	1.79	0.00	0.00	1.50	0.50	0.00	3.09
May	4.03	0.11	0.25	3.16	0.00	0.00	1.88	-0.66	0.00	2.43
June	2.33	0.03	0.25	4.04	0.00	0.00	1.25	-2.68	0.00	0.00
July	3.34	0.49	0.25	4.81	0.00	0.00	0.00	-0.74	0.00	0.00
August	4.97	0.35	0.25	4.25	0.00	0.00	0.77	0.56	0.00	0.56
September	6.76	2.48	0.25	2.97	0.00	0.00	6.10	0.42	0.00	0.98
October	4.54	1.35	0.25	1.65	0.00	0.00	3.31	1.18	0.00	2.16
November	4.48	0.94	0.25	0.85	0.00	0.00	4.05	0.76	0.00	2.92
December	3.85	0.37	0.25	0.15	0.00	0.00	3.82	0.51	0.00	3.43
Annual Totals	**50.49**	**8.27**	**3.00**	**24.58**	**0.00**	**0.00**	**34.74**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	2.26	0.00	0.25	0.40	0.00	0.00	2.59	-0.48	0.00	0.00
February	3.04	0.00	0.25	0.29	0.00	0.00	1.69	1.31	0.00	1.31
March	3.82	0.19	0.25	1.16	0.00	0.00	3.09	0.00	0.00	1.32
April	2.6	0.00	0.25	1.81	0.00	0.00	0.35	0.69	0.00	2.01
May	5.38	0.76	0.25	2.68	0.00	0.00	3.15	0.56	0.00	2.57
June	8.75	1.28	0.25	4.51	0.00	0.00	3.07	2.70	0.59	4.68
July	13.61	4.11	0.25	4.78	0.00	0.00	7.94	5.24	5.24	4.68
August	6.29	2.20	0.25	4.34	0.00	0.00	0.09	4.31	4.31	4.68
September	14.02	4.87	0.25	3.29	0.00	0.00	6.54	9.31	9.31	4.68
October	5.49	1.23	0.25	2.02	0.00	0.00	4.53	0.43	0.43	4.68
November	8.98	5.02	0.25	0.64	0.00	0.00	5.71	7.89	7.89	4.68
December	2.04	0.08	0.25	0.00	0.00	0.00	2.64	-0.27	0.00	4.41
Annual Totals	**76.28**	**19.74**	**3.00**	**25.92**	**0.00**	**0.00**	**41.41**			

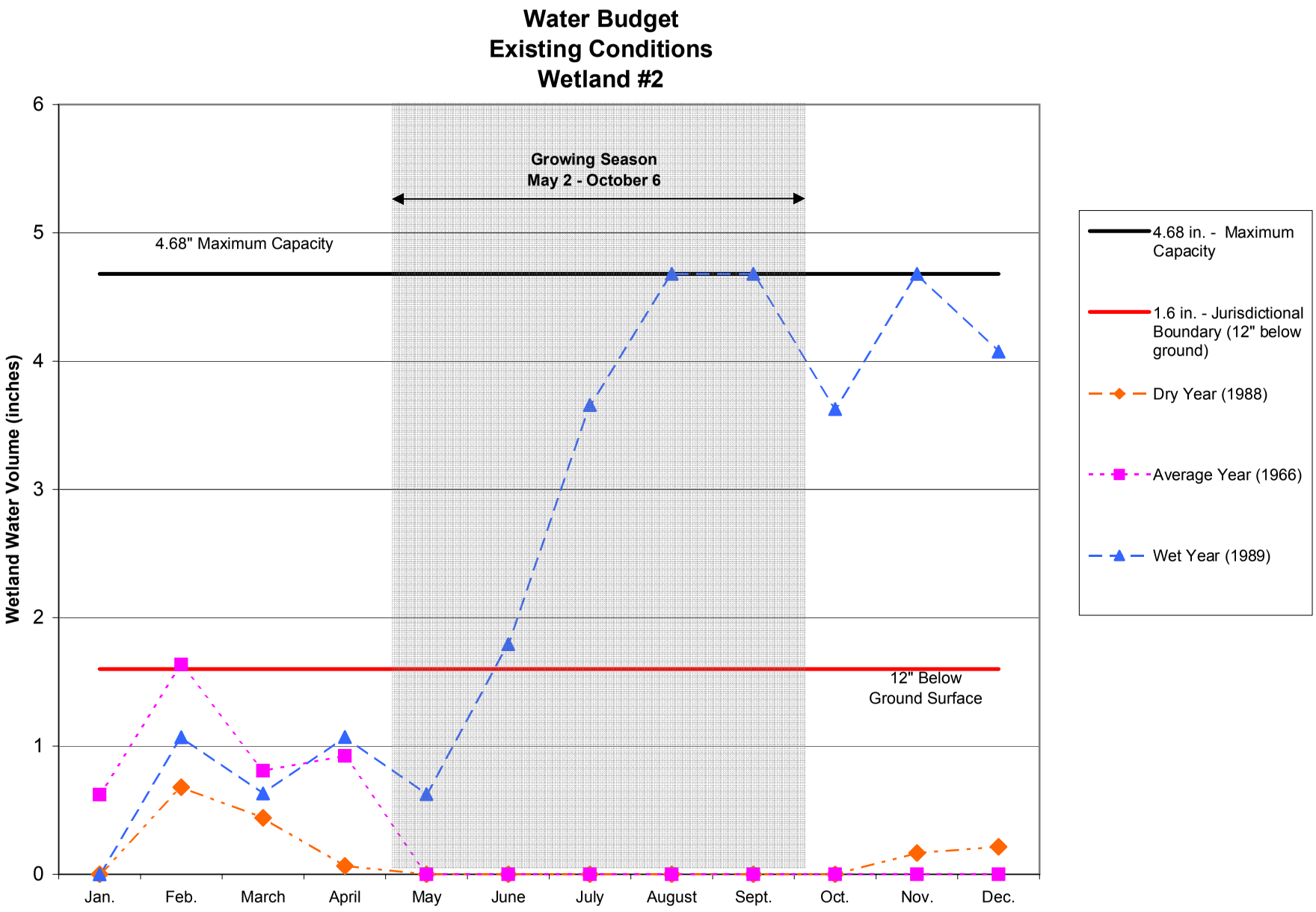

Water Budget
Proposed Conditions
Wetland #1
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Wetland Water Volume (inches)
0
1
2
3
4
5
6
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)

Crab Creek - Existing Conditions (Wetland #2)

Dry Year	*Water Inputs*			*Water Outputs*				Change in	Excess	Wetland
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**	**Storage**	**Water**	**Volume**
January	1.42	0.04	0.75	0.00	0.79	0.00	2.02	-0.60	0.00	0.00
February	2.03	0.09	0.75	0.08	0.84	0.00	1.27	0.68	0.00	0.68
March	1.29	0.00	0.75	0.92	0.75	0.00	0.61	-0.24	0.00	0.44
April	4.18	0.38	0.75	1.97	1.13	0.00	2.58	-0.37	0.00	0.07
May	3.28	0.56	0.75	2.81	1.31	0.00	0.82	-0.36	0.00	0.00
June	2.77	0.04	0.75	4.10	0.79	0.00	0.52	-1.85	0.00	0.00
July	2.90	0.06	0.75	4.79	0.81	0.00	0.00	-1.89	0.00	0.00
August	2.98	0.18	0.75	4.78	0.93	0.00	0.00	-1.80	0.00	0.00
September	3.25	0.20	0.75	3.23	0.95	0.00	2.95	-2.94	0.00	0.00
October	1.60	0.06	0.75	1.27	0.81	0.00	1.16	-0.83	0.00	0.00
November	5.50	1.03	0.75	0.85	1.78	0.00	4.48	0.17	0.00	0.17
December	1.63	0.00	0.75	0.17	0.75	0.00	1.41	0.05	0.00	0.21
Annual Totals	**32.83**	**2.64**	**9.00**	**24.97**	**11.64**	**0.00**	**17.83**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in	Excess	Wetland
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**	**Storage**	**Water**	**Volume**
January	4.16	0.25	0.75	0.00	1.00	0.00	3.54	0.62	0.00	0.62
February	6.92	1.67	0.75	0.04	2.42	0.00	5.86	1.01	0.00	1.63
March	1.70	0.09	0.75	0.87	0.84	0.00	1.66	-0.83	0.00	0.81
April	3.41	0.13	0.75	1.79	0.88	0.00	1.50	0.12	0.00	0.92
May	4.03	0.11	0.75	3.16	0.86	0.00	1.88	-1.01	0.00	0.00
June	2.33	0.03	0.75	4.04	0.78	0.00	1.25	-2.96	0.00	0.00
July	3.34	0.49	0.75	4.81	1.24	0.00	0.00	-1.47	0.00	0.00
August	4.97	0.35	0.75	4.25	1.10	0.00	0.77	-0.04	0.00	0.00
September	6.76	2.48	0.75	2.97	3.23	0.00	5.11	-1.33	0.00	0.00
October	4.54	1.35	0.75	1.65	2.10	0.00	3.31	-0.42	0.00	0.00
November	4.48	0.94	0.75	0.85	1.69	0.00	4.05	-0.42	0.00	0.00
December	3.85	0.37	0.75	0.15	1.12	0.00	3.82	-0.12	0.00	0.00
Annual Totals	**50.49**	**8.27**	**0.00**	**24.58**	**17.27**	**0.00**	**32.76**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in	Excess	Wetland
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**	**Storage**	**Water**	**Volume**
January	2.26	0.00	0.75	0.40	0.75	0.00	2.59	-0.73	0.00	0.00
February	3.04	0.00	0.75	0.29	0.75	0.00	1.69	1.07	0.00	1.07
March	3.82	0.19	0.75	1.16	0.94	0.00	3.09	-0.44	0.00	0.63
April	2.6	0.00	0.75	1.81	0.75	0.00	0.35	0.44	0.00	1.07
May	5.38	0.76	0.75	2.68	1.51	0.00	3.15	-0.45	0.00	0.62
June	8.75	1.28	0.75	4.51	2.03	0.00	3.07	1.17	0.00	1.79
July	13.61	4.11	0.75	4.78	4.86	0.00	6.96	1.86	0.00	3.66
August	6.29	2.20	0.75	4.34	2.95	0.00	0.09	1.86	0.84	4.68
September	14.02	4.87	0.75	3.29	5.62	0.00	5.55	5.18	5.18	4.68
October	5.49	1.23	0.75	2.02	1.98	0.00	4.53	-1.05	0.00	3.63
November	8.98	5.02	0.75	0.64	5.77	0.00	4.73	3.61	2.56	4.68
December	2.04	0.08	0.75	0.00	0.83	0.00	2.65	-0.61	0.00	4.07
Annual Totals	**76.28**	**19.74**	**0.00**	**25.92**	**28.74**	**0.00**	**38.45**			

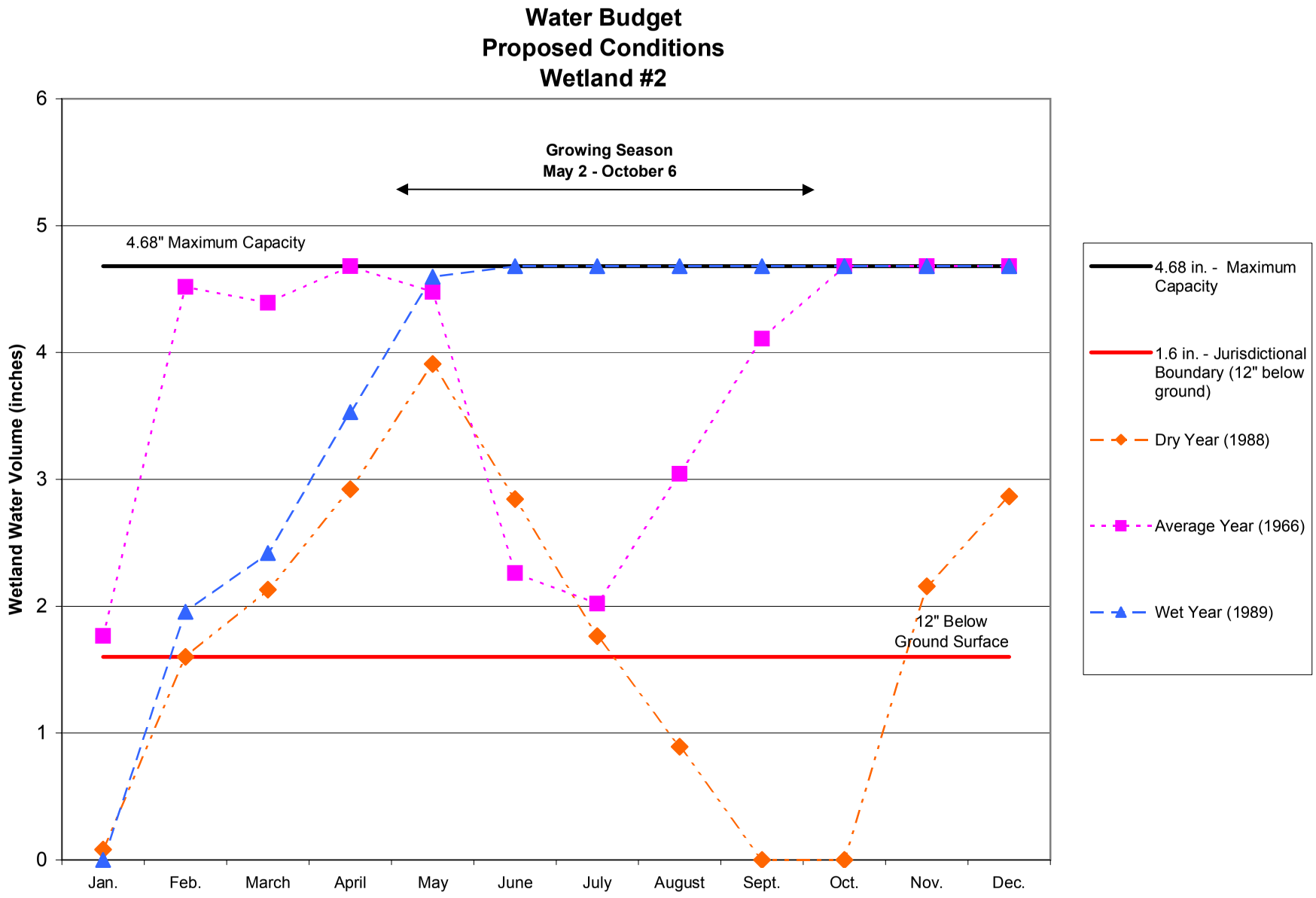

Water Budget
Existing Conditions
Wetland #2
Wetland Water Volume (inches)
6
5
4
3
2
1
0
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)

Crab Creek - Proposed Conditions (Wetland #2)

Dry Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	1.42	0.04	0.75	0.00	0.00	0.00	2.13	0.08	0.00	0.08
February	2.03	0.09	0.75	0.08	0.00	0.00	1.27	1.52	0.00	1.60
March	1.29	0.00	0.75	0.92	0.00	0.00	0.59	0.53	0.00	2.13
April	4.18	0.38	0.75	1.97	0.00	0.00	2.54	0.79	0.00	2.92
May	3.28	0.56	0.75	2.81	0.00	0.00	0.79	0.99	0.00	3.91
June	2.77	0.04	0.75	4.10	0.00	0.00	0.52	-1.07	0.00	2.84
July	2.90	0.06	0.75	4.79	0.00	0.00	0.00	-1.08	0.00	1.76
August	2.98	0.18	0.75	4.78	0.00	0.00	0.00	-0.87	0.00	0.89
September	3.25	0.20	0.75	3.23	0.00	0.00	2.93	-1.96	0.00	0.00
October	1.60	0.06	0.75	1.27	0.00	0.00	1.26	-0.12	0.00	0.00
November	5.50	1.03	0.75	0.85	0.00	0.00	4.27	2.16	0.00	2.16
December	1.63	0.00	0.75	0.17	0.00	0.00	1.50	0.71	0.00	2.86
Annual Totals	**32.83**	**2.64**	**9.00**	**24.97**	**0.00**	**0.00**	**17.81**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	4.16	0.25	0.75	0.00	0.00	0.00	3.40	1.77	0.00	1.77
February	6.92	1.67	0.75	0.04	0.00	0.00	6.55	2.75	0.00	4.52
March	1.70	0.09	0.75	0.87	0.00	0.00	1.80	-0.12	0.00	4.39
April	3.41	0.13	0.75	1.79	0.00	0.00	1.35	1.15	0.86	4.68
May	4.03	0.11	0.75	3.16	0.00	0.00	1.93	-0.20	0.00	4.48
June	2.33	0.03	0.75	4.04	0.00	0.00	1.29	-2.22	0.00	2.26
July	3.34	0.49	0.75	4.81	0.00	0.00	0.00	-0.24	0.00	2.02
August	4.97	0.35	0.75	4.25	0.00	0.00	0.80	1.02	0.00	3.04
September	6.76	2.48	0.75	2.97	0.00	0.00	5.96	1.07	0.00	4.11
October	4.54	1.35	0.75	1.65	0.00	0.00	3.35	1.64	1.07	4.68
November	4.48	0.94	0.75	0.85	0.00	0.00	3.78	1.53	1.53	4.68
December	3.85	0.37	0.75	0.15	0.00	0.00	3.86	0.96	0.96	4.68
Annual Totals	**50.49**	**8.27**	**9.00**	**24.58**	**0.00**	**0.00**	**34.07**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	2.26	0.00	0.75	0.40	0.00	0.00	2.70	-0.10	0.00	0.00
February	3.04	0.00	0.75	0.29	0.00	0.00	1.55	1.96	0.00	1.96
March	3.82	0.19	0.75	1.16	0.00	0.00	3.13	0.46	0.00	2.42
April	2.6	0.00	0.75	1.81	0.00	0.00	0.43	1.11	0.00	3.53
May	5.38	0.76	0.75	2.68	0.00	0.00	3.15	1.07	0.00	4.60
June	8.75	1.28	0.75	4.51	0.00	0.00	2.94	3.33	3.24	4.68
July	13.61	4.11	0.75	4.78	0.00	0.00	7.79	5.89	5.89	4.68
August	6.29	2.20	0.75	4.34	0.00	0.00	0.17	4.73	4.73	4.68
September	14.02	4.87	0.75	3.29	0.00	0.00	6.12	10.23	10.23	4.68
October	5.49	1.23	0.75	2.02	0.00	0.00	4.60	0.86	0.86	4.68
November	8.98	5.02	0.75	0.64	0.00	0.00	5.69	8.42	8.42	4.68
December	2.04	0.08	0.75	0.00	0.00	0.00	2.68	0.19	0.19	4.68
Annual Totals	**76.28**	**19.74**	**9.00**	**25.92**	**0.00**	**0.00**	**40.96**			

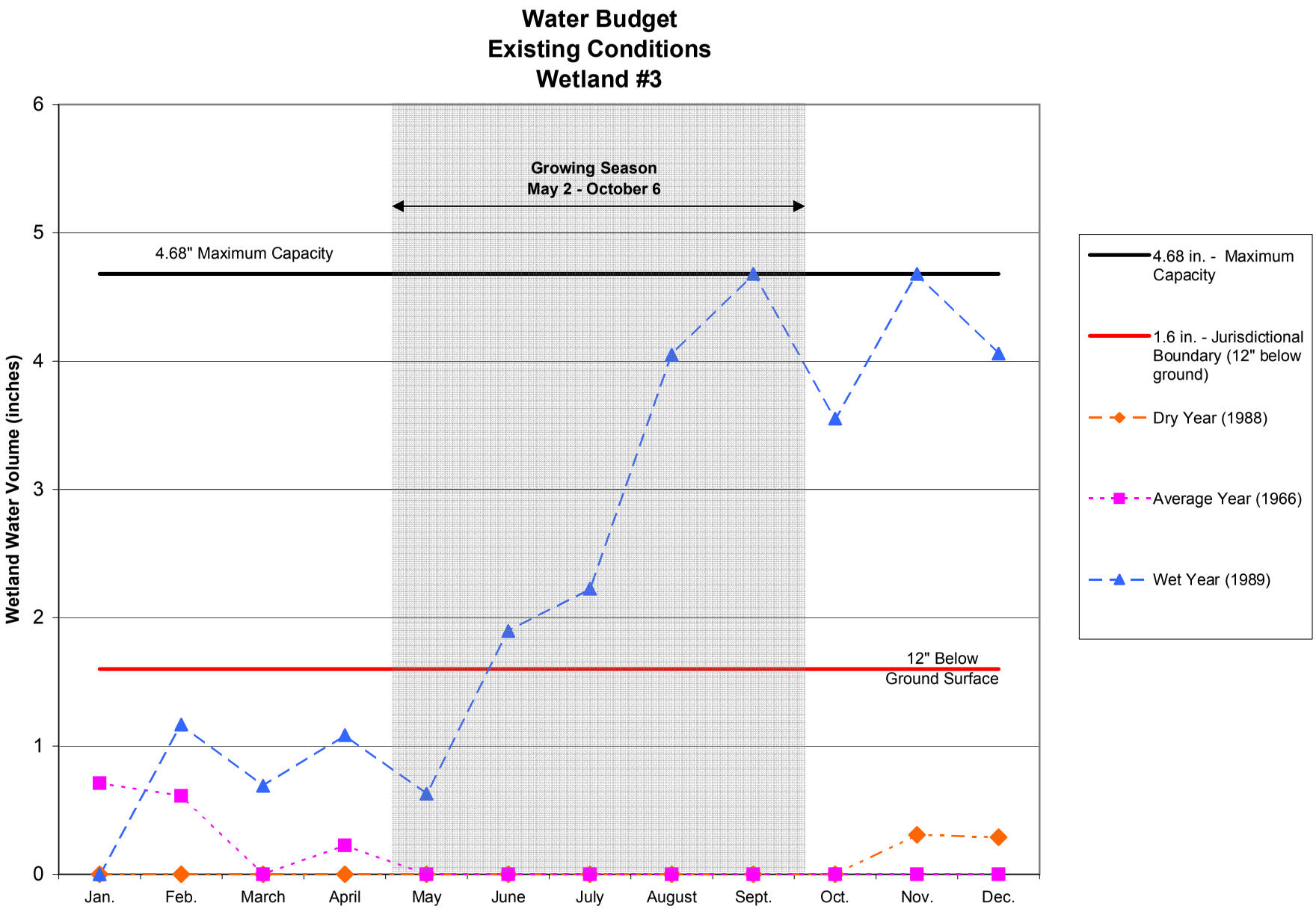

Water Budget
Proposed Conditions
Wetland #2
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Wetland Water Volume (inches)
0
1
2
3
4
5
6
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)

Crab Creek - Existing Conditions (Wetland #3)

Dry Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	1.42	0.04	0.50	0.00	0.54	0.00	2.08	-0.66	0.00	0.00
February	2.03	0.09	0.50	0.08	0.59	0.00	9.13	-7.18	0.00	0.00
March	1.29	0.00	0.50	0.92	0.50	0.00	0.60	-0.23	0.00	0.00
April	4.18	0.38	0.50	1.97	0.88	0.00	2.56	-0.35	0.00	0.00
May	3.28	0.56	0.50	2.81	1.06	0.00	0.80	-0.33	0.00	0.00
June	2.77	0.04	0.50	4.10	0.54	0.00	0.53	-1.86	0.00	0.00
July	2.90	0.06	0.50	4.79	0.56	0.00	0.00	-1.89	0.00	0.00
August	2.98	0.18	0.50	4.78	0.68	0.00	0.00	-1.80	0.00	0.00
September	3.25	0.20	0.50	3.23	0.70	0.00	2.97	-2.95	0.00	0.00
October	1.60	0.06	0.50	1.27	0.56	0.00	1.19	-0.85	0.00	0.00
November	5.50	1.03	0.50	0.85	1.53	0.00	4.34	0.31	0.00	0.31
December	1.63	0.00	0.50	0.17	0.50	0.00	1.48	-0.02	0.00	0.29
Annual Totals	**32.83**	**2.64**	**6.00**	**24.97**	**8.64**	**0.00**	**25.68**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	4.16	0.25	0.50	0.00	0.75	0.00	3.45	0.71	0.00	0.71
February	6.92	1.67	0.50	0.04	2.17	0.00	6.98	-0.10	0.00	0.61
March	1.70	0.09	0.50	0.87	0.59	0.00	1.76	-0.93	0.00	0.00
April	3.41	0.13	0.50	1.79	0.63	0.00	1.39	0.23	0.00	0.23
May	4.03	0.11	0.50	3.16	0.61	0.00	1.91	-1.04	0.00	0.00
June	2.33	0.03	0.50	4.04	0.53	0.00	1.28	-2.99	0.00	0.00
July	3.34	0.49	0.50	4.81	0.99	0.00	0.00	-1.48	0.00	0.00
August	4.97	0.35	0.50	4.25	0.85	0.00	0.79	-0.06	0.00	0.00
September	6.76	2.48	0.50	2.97	2.98	0.00	6.35	-2.56	0.00	0.00
October	4.54	1.35	0.50	1.65	1.85	0.00	3.33	-0.44	0.00	0.00
November	4.48	0.94	0.50	0.85	1.44	0.00	3.86	-0.23	0.00	0.00
December	3.85	0.37	0.50	0.15	0.87	0.00	3.86	-0.16	0.00	0.00
Annual Totals	**50.49**	**8.27**	**6.00**	**24.58**	**14.27**	**0.00**	**34.97**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	2.26	0.00	0.50	0.40	0.50	0.00	2.66	-0.80	0.00	0.00
February	3.04	0.00	0.50	0.29	0.50	0.00	1.59	1.17	0.00	1.17
March	3.82	0.19	0.50	1.16	0.69	0.00	3.13	-0.48	0.00	0.69
April	2.6	0.00	0.50	1.81	0.50	0.00	0.40	0.40	0.00	1.09
May	5.38	0.76	0.50	2.68	1.26	0.00	3.16	-0.46	0.00	0.63
June	8.75	1.28	0.50	4.51	1.78	0.00	2.97	1.27	0.00	1.90
July	13.61	4.11	0.50	4.78	4.61	0.00	8.50	0.33	0.00	2.23
August	6.29	2.20	0.50	4.34	2.70	0.00	0.13	1.82	0.00	4.05
September	14.02	4.87	0.50	3.29	5.37	0.00	6.92	3.81	3.18	4.68
October	5.49	1.23	0.50	2.02	1.73	0.00	4.60	-1.13	0.00	3.55
November	8.98	5.02	0.50	0.64	5.52	0.00	6.31	2.03	0.90	4.68
December	2.04	0.08	0.50	0.00	0.58	0.00	2.66	-0.62	0.00	4.06
Annual Totals	**76.28**	**19.74**	**6.00**	**25.92**	**25.74**	**0.00**	**43.02**			

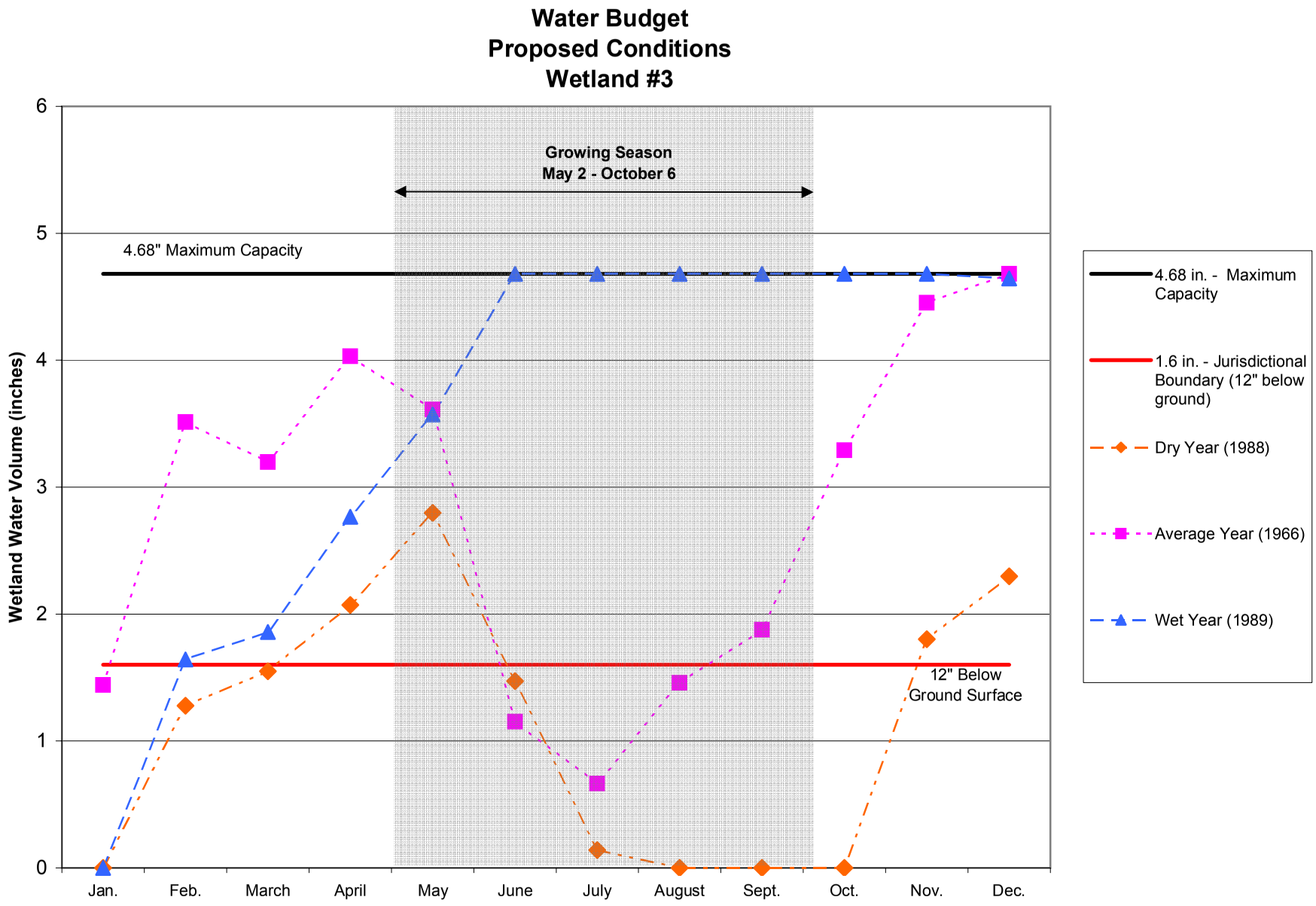

Water Budget
Existing Conditions
Wetland #3
Wetland Water Volume (inches)
6
5
4
3
2
1
0
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)

Crab Creek - Proposed Conditions (Wetland #3)

Dry Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	1.42	0.04	0.50	0.00	0.00	0.00	2.06	-0.10	0.00	0.00
February	2.03	0.09	0.50	0.08	0.00	0.00	1.26	1.28	0.00	1.28
March	1.29	0.00	0.50	0.92	0.00	0.00	0.60	0.27	0.00	1.55
April	4.18	0.38	0.50	1.97	0.00	0.00	2.56	0.52	0.00	2.07
May	3.28	0.56	0.50	2.81	0.00	0.00	0.80	0.73	0.00	2.80
June	2.77	0.04	0.50	4.10	0.00	0.00	0.54	-1.33	0.00	1.47
July	2.90	0.06	0.50	4.79	0.00	0.00	0.00	-1.33	0.00	0.14
August	2.98	0.18	0.50	4.78	0.00	0.00	0.00	-1.12	0.00	0.00
September	3.25	0.20	0.50	3.23	0.00	0.00	2.96	-2.25	0.00	0.00
October	1.60	0.06	0.50	1.27	0.00	0.00	1.18	-0.29	0.00	0.00
November	5.50	1.03	0.50	0.85	0.00	0.00	4.38	1.80	0.00	1.80
December	1.63	0.00	0.50	0.17	0.00	0.00	1.46	0.50	0.00	2.30
Annual Totals	**32.83**	**2.64**	**6.00**	**24.97**	**0.00**	**0.00**	**17.81**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	4.16	0.25	0.50	0.00	0.00	0.00	3.47	1.44	0.00	1.44
February	6.92	1.67	0.50	0.04	0.00	0.00	6.98	2.07	0.00	3.51
March	1.70	0.09	0.50	0.87	0.00	0.00	1.74	-0.32	0.00	3.20
April	3.41	0.13	0.50	1.79	0.00	0.00	1.42	0.83	0.00	4.03
May	4.03	0.11	0.50	3.16	0.00	0.00	1.90	-0.42	0.00	3.61
June	2.33	0.03	0.50	4.04	0.00	0.00	1.28	-2.46	0.00	1.15
July	3.34	0.49	0.50	4.81	0.00	0.00	0.00	-0.49	0.00	0.67
August	4.97	0.35	0.50	4.25	0.00	0.00	0.78	0.79	0.00	1.46
September	6.76	2.48	0.50	2.97	0.00	0.00	6.35	0.42	0.00	1.88
October	4.54	1.35	0.50	1.65	0.00	0.00	3.32	1.41	0.00	3.29
November	4.48	0.94	0.50	0.85	0.00	0.00	3.90	1.16	0.00	4.45
December	3.85	0.37	0.50	0.15	0.00	0.00	3.85	0.72	0.49	4.68
Annual Totals	**50.49**	**8.27**	**6.00**	**24.58**	**0.00**	**0.00**	**35.01**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	2.26	0.00	0.50	0.40	0.00	0.00	2.63	-0.28	0.00	0.00
February	3.04	0.00	0.50	0.29	0.00	0.00	1.61	1.64	0.00	1.64
March	3.82	0.19	0.50	1.16	0.00	0.00	3.13	0.22	0.00	1.86
April	2.6	0.00	0.50	1.81	0.00	0.00	0.39	0.91	0.00	2.77
May	5.38	0.76	0.50	2.68	0.00	0.00	3.16	0.81	0.00	3.57
June	8.75	1.28	0.50	4.51	0.00	0.00	2.99	3.03	1.92	4.68
July	13.61	4.11	0.50	4.78	0.00	0.00	9.04	4.39	4.39	4.68
August	6.29	2.20	0.50	4.34	0.00	0.00	0.11	4.54	4.54	4.68
September	14.02	4.87	0.50	3.29	0.00	0.00	7.93	8.17	8.17	4.68
October	5.49	1.23	0.50	2.02	0.00	0.00	4.63	0.58	0.58	4.68
November	8.98	5.02	0.50	0.64	0.00	0.00	7.06	6.80	6.80	4.68
December	2.04	0.08	0.50	0.00	0.00	0.00	2.65	-0.04	0.00	4.64
Annual Totals	**76.28**	**19.74**	**6.00**	**25.92**	**0.00**	**0.00**	**45.33**			

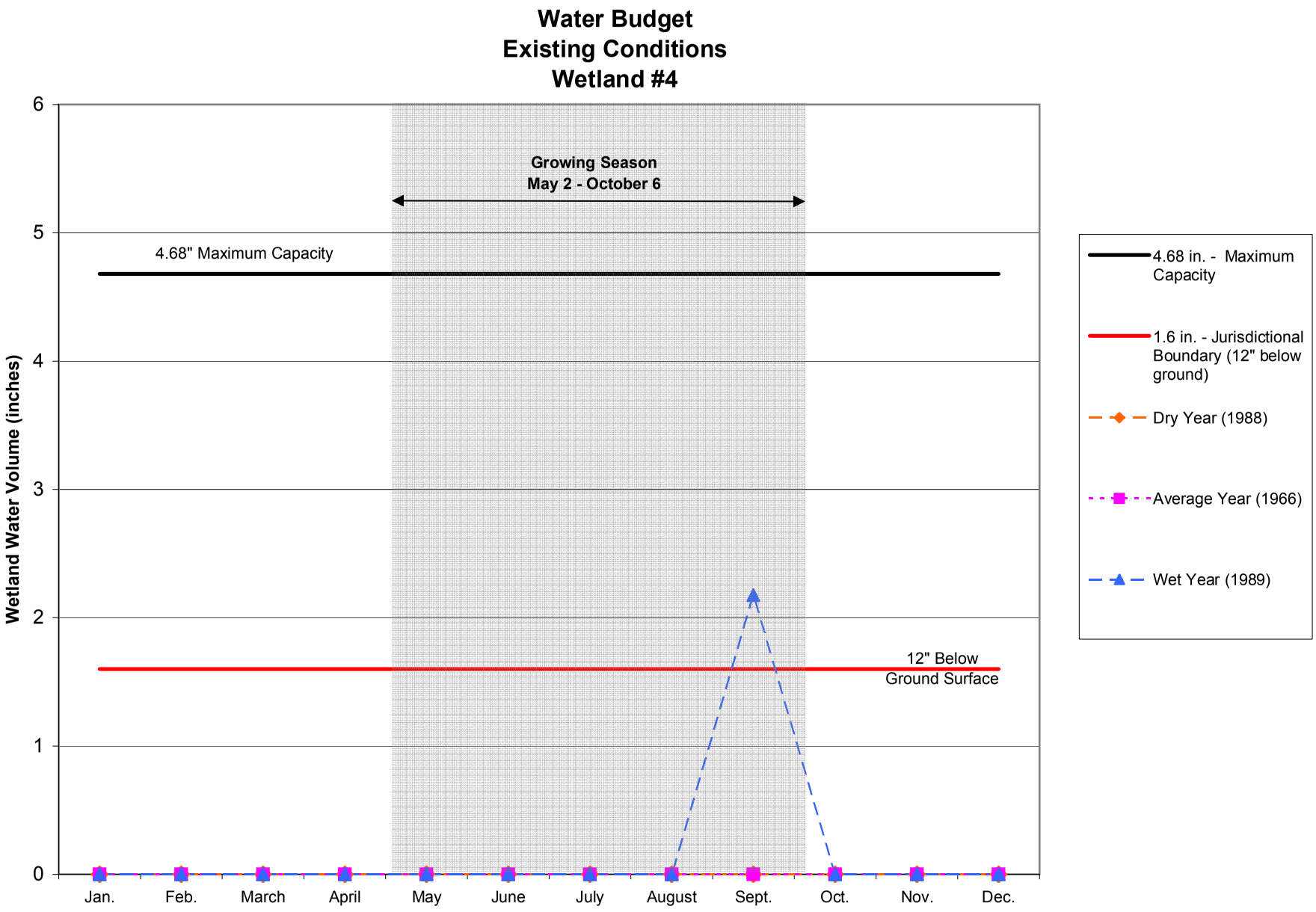

Water Budget
Proposed Conditions
Wetland #3
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Wetland Water Volume (inches)
0
1
2
3
4
5
6
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)

Crab Creek - Existing Conditions (Wetland #4)

Dry Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	1.42	0.04	1.00	0.00	1.04	0.00	10.48	-9.06	0.00	0.00
February	2.03	0.09	1.00	0.08	1.09	0.00	9.13	-7.18	0.00	0.00
March	1.29	0.00	1.00	0.92	1.00	0.00	8.91	-8.54	0.00	0.00
April	4.18	0.38	1.00	1.97	1.38	0.00	7.85	-5.64	0.00	0.00
May	3.28	0.56	1.00	2.81	1.56	0.00	3.61	-3.15	0.00	0.00
June	2.77	0.04	1.00	4.10	1.04	0.00	2.85	-4.17	0.00	0.00
July	2.90	0.06	1.00	4.79	1.06	0.00	2.61	-4.50	0.00	0.00
August	2.98	0.18	1.00	4.78	1.18	0.00	2.56	-4.36	0.00	0.00
September	3.25	0.20	1.00	3.23	1.20	0.00	6.93	-6.92	0.00	0.00
October	1.60	0.06	1.00	1.27	1.06	0.00	6.72	-6.39	0.00	0.00
November	5.50	1.03	1.00	0.85	2.03	0.00	9.89	-5.24	0.00	0.00
December	1.63	0.00	1.00	0.17	1.00	0.00	9.69	-8.22	0.00	0.00
Annual Totals	**32.83**	**2.64**	**12.00**	**24.97**	**14.64**	**0.00**	**81.22**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	4.16	0.25	1.00	0.00	1.25	0.00	11.90	-7.74	0.00	0.00
February	6.92	1.67	1.00	0.04	2.67	0.00	12.87	-5.99	0.00	0.00
March	1.70	0.09	1.00	0.87	1.09	0.00	9.34	-8.50	0.00	0.00
April	3.41	0.13	1.00	1.79	1.13	0.00	7.77	-6.15	0.00	0.00
May	4.03	0.11	1.00	3.16	1.11	0.00	4.77	-3.90	0.00	0.00
June	2.33	0.03	1.00	4.04	1.03	0.00	3.72	-5.43	0.00	0.00
July	3.34	0.49	1.00	4.81	1.49	0.00	1.60	-3.07	0.00	0.00
August	4.97	0.35	1.00	4.25	1.35	0.00	4.98	-4.25	0.00	0.00
September	6.76	2.48	1.00	2.97	3.48	0.00	7.18	-3.39	0.00	0.00
October	4.54	1.35	1.00	1.65	2.35	0.00	8.95	-6.06	0.00	0.00
November	4.48	0.94	1.00	0.85	1.94	0.00	9.40	-5.77	0.00	0.00
December	3.85	0.37	1.00	0.15	1.37	0.00	12.18	-8.47	0.00	0.00
Annual Totals	**50.49**	**8.27**	**12.00**	**24.58**	**20.27**	**0.00**	**94.64**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Ditches/Stream**			
January	2.26	0.00	1.00	0.40	1.00	0.00	10.65	-8.79	0.00	0.00
February	3.04	0.00	1.00	0.29	1.00	0.00	9.43	-6.68	0.00	0.00
March	3.82	0.19	1.00	1.16	1.19	0.00	10.82	-8.16	0.00	0.00
April	2.6	0.00	1.00	1.81	1.00	0.00	6.02	-5.23	0.00	0.00
May	5.38	0.76	1.00	2.68	1.76	0.00	5.44	-2.74	0.00	0.00
June	8.75	1.28	1.00	4.51	2.28	0.00	6.91	-2.67	0.00	0.00
July	13.61	4.11	1.00	4.78	5.11	0.00	9.09	-0.26	0.00	0.00
August	6.29	2.20	1.00	4.34	3.20	0.00	2.37	-0.42	0.00	0.00
September	14.02	4.87	1.00	3.29	5.87	0.00	8.55	2.18	0.00	2.18
October	5.49	1.23	1.00	2.02	2.23	0.00	9.79	-6.31	0.00	0.00
November	8.98	5.02	1.00	0.64	6.02	0.00	10.04	-1.70	0.00	0.00
December	2.04	0.08	1.00	0.00	1.08	0.00	10.96	-8.92	0.00	0.00
Annual Totals	**76.28**	**19.74**	**12.00**	**25.92**	**31.74**	**0.00**	**100.06**			

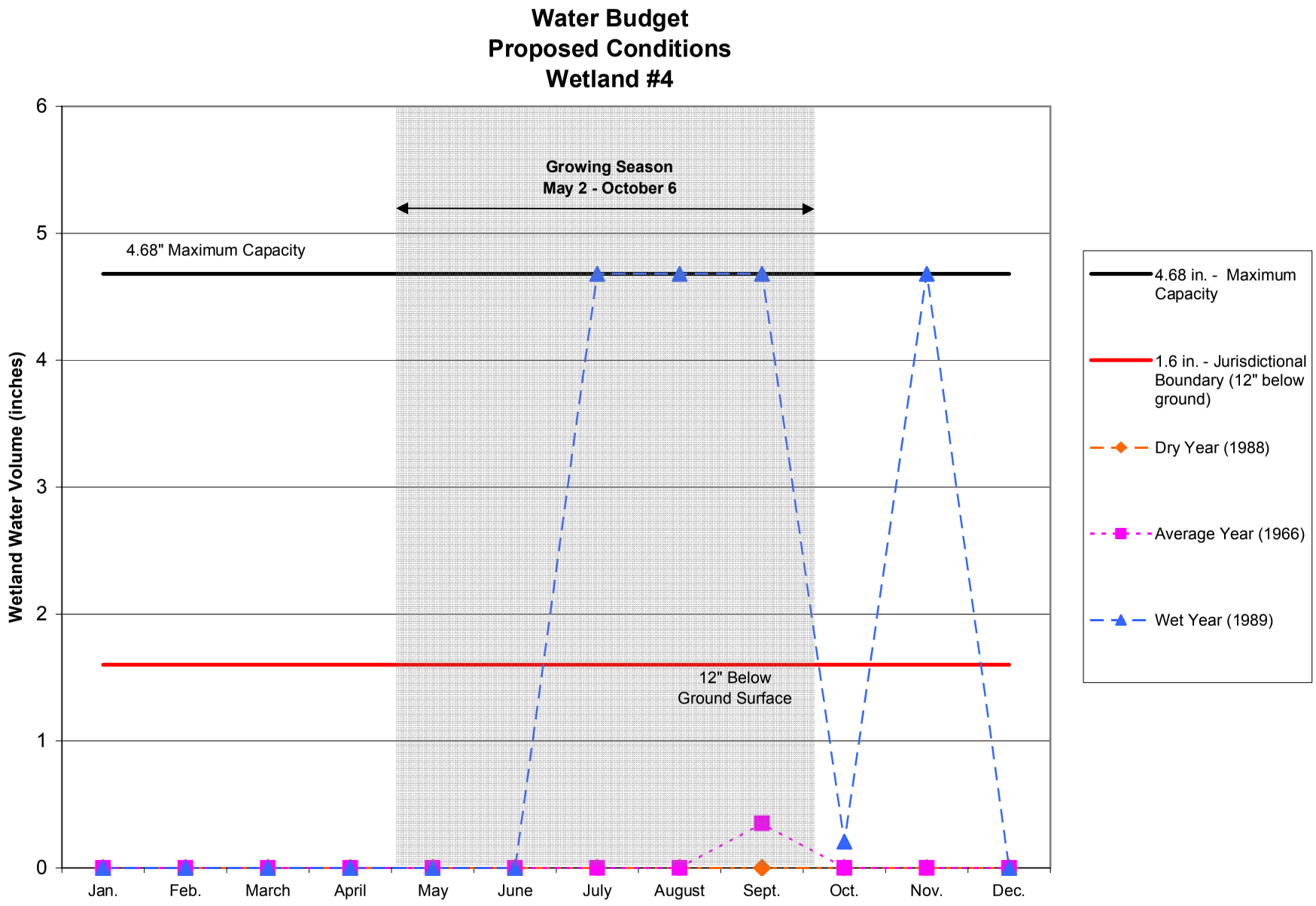

Water Budget
Existing Conditions
Wetland #4
Wetland Water Volume (inches)
6
5
4
3
2
1
0
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)

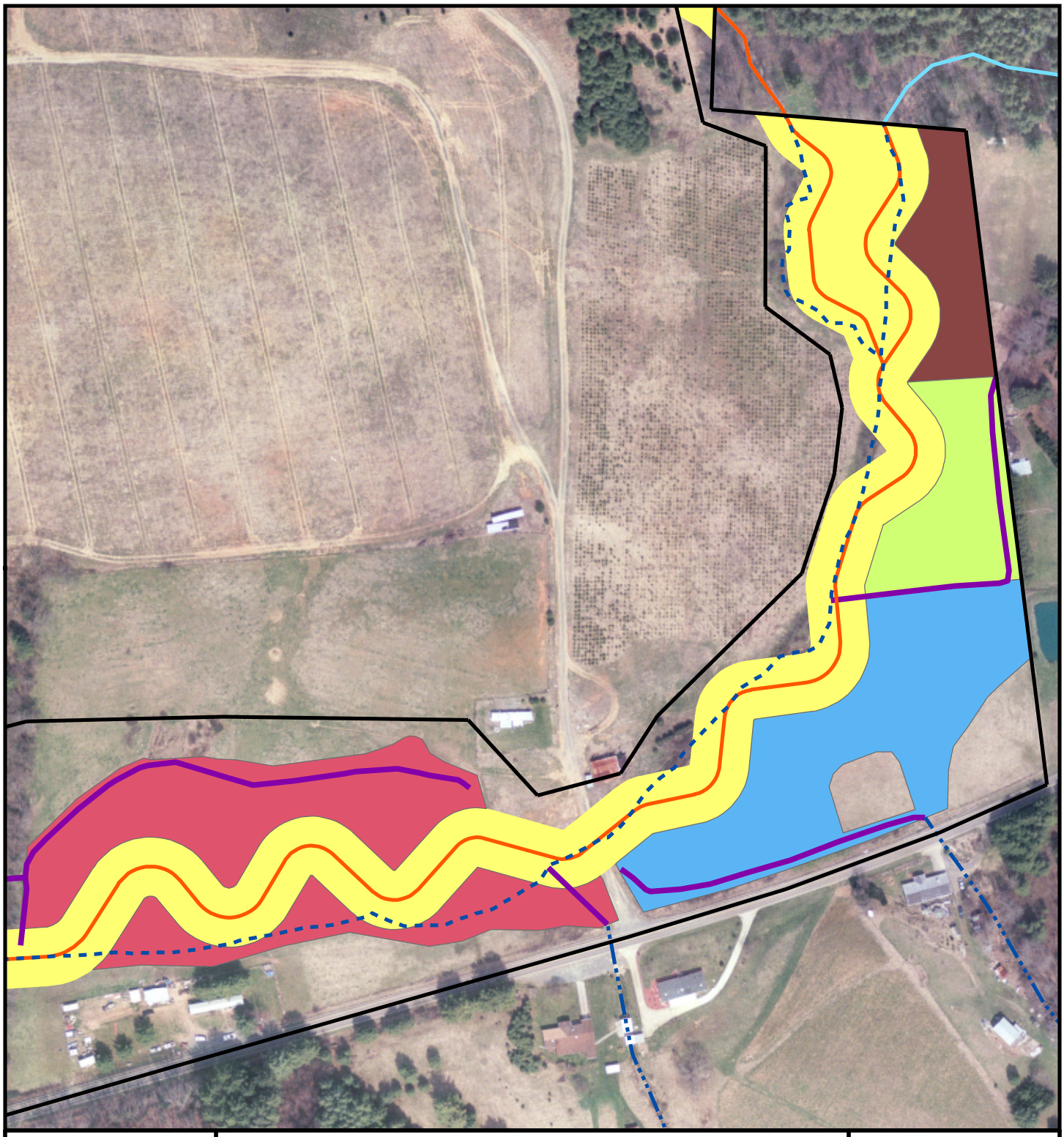
Crab Creek - Proposed Conditions (Wetland #4)

Dry Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1988	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	1.42	0.04	1.00	0.00	0.00	0.00	11.01	-8.55	0.00	0.00
February	2.03	0.09	1.00	0.08	0.00	0.00	9.81	-6.77	0.00	0.00
March	1.29	0.00	1.00	0.92	0.00	0.00	8.91	-7.54	0.00	0.00
April	4.18	0.38	1.00	1.97	0.00	0.00	10.36	-6.77	0.00	0.00
May	3.28	0.56	1.00	2.81	0.00	0.00	6.79	-4.76	0.00	0.00
June	2.77	0.04	1.00	4.10	0.00	0.00	3.50	-3.79	0.00	0.00
July	2.90	0.06	1.00	4.79	0.00	0.00	2.26	-3.09	0.00	0.00
August	2.98	0.18	1.00	4.78	0.00	0.00	2.44	-3.07	0.00	0.00
September	3.25	0.20	1.00	3.23	0.00	0.00	6.74	-5.52	0.00	0.00
October	1.60	0.06	1.00	1.27	0.00	0.00	6.70	-5.31	0.00	0.00
November	5.50	1.03	1.00	0.85	0.00	0.00	9.28	-2.60	0.00	0.00
December	1.63	0.00	1.00	0.17	0.00	0.00	9.61	-7.15	0.00	0.00
Annual Totals	**32.83**	**2.64**	**12.00**	**24.97**	**0.00**	**0.00**	**87.41**			

Avg. Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1966	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	4.16	0.25	1.00	0.00	0.00	0.00	10.63	-5.22	0.00	0.00
February	6.92	1.67	1.00	0.04	0.00	0.00	11.28	-1.73	0.00	0.00
March	1.70	0.09	1.00	0.87	0.00	0.00	10.43	-8.50	0.00	0.00
April	3.41	0.13	1.00	1.79	0.00	0.00	9.74	-6.99	0.00	0.00
May	4.03	0.11	1.00	3.16	0.00	0.00	8.11	-6.14	0.00	0.00
June	2.33	0.03	1.00	4.04	0.00	0.00	4.50	-5.17	0.00	0.00
July	3.34	0.49	1.00	4.81	0.00	0.00	1.96	-1.95	0.00	0.00
August	4.97	0.35	1.00	4.25	0.00	0.00	4.58	-2.50	0.00	0.00
September	6.76	2.48	1.00	2.97	0.00	0.00	6.92	0.35	0.00	0.35
October	4.54	1.35	1.00	1.65	0.00	0.00	8.63	-3.39	0.00	0.00
November	4.48	0.94	1.00	0.85	0.00	0.00	8.93	-3.36	0.00	0.00
December	3.85	0.37	1.00	0.15	0.00	0.00	11.36	-6.29	0.00	0.00
Annual Totals	**50.49**	**8.27**	**12.00**	**24.58**	**0.00**	**0.00**	**97.08**			

Wet Year	*Water Inputs*			*Water Outputs*				Change in Storage	Excess Water	Wetland Volume
1989	**P**	**Si ***	**Gi**	**PET**	**So**	**Go**	**Loss to Stream**			
January	2.26	0.00	1.00	0.40	0.00	0.00	10.96	-8.10	0.00	0.00
February	3.04	0.00	1.00	0.29	0.00	0.00	8.33	-4.57	0.00	0.00
March	3.82	0.19	1.00	1.16	0.00	0.00	11.77	-7.93	0.00	0.00
April	2.6	0.00	1.00	1.81	0.00	0.00	8.80	-7.00	0.00	0.00
May	5.38	0.76	1.00	2.68	0.00	0.00	8.50	-4.03	0.00	0.00
June	8.75	1.28	1.00	4.51	0.00	0.00	6.69	-0.17	0.00	0.00
July	13.61	4.11	1.00	4.78	0.00	0.00	8.84	5.10	0.42	4.68
August	6.29	2.20	1.00	4.34	0.00	0.00	3.14	2.01	2.01	4.68
September	14.02	4.87	1.00	3.29	0.00	0.00	6.74	9.86	9.86	4.68
October	5.49	1.23	1.00	2.02	0.00	0.00	10.18	-4.47	0.00	0.21
November	8.98	5.02	1.00	0.64	0.00	0.00	9.35	5.01	0.54	4.68
December	2.04	0.08	1.00	0.00	0.00	0.00	10.93	-7.81	0.00	0.00
Annual Totals	**76.28**	**19.74**	**12.00**	**25.92**	**0.00**	**0.00**	**104.21**			


Water Budget
Proposed Conditions
Wetland #4
Growing Season
May 2 - October 6
4.68" Maximum Capacity
12" Below
Ground Surface
Wetland Water Volume (inches)
0
1
2
3
4
5
6
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
4.68 in. - Maximum Capacity
1.6 in. - Jurisdictional Boundary (12" below ground)
Dry Year (1988)
Average Year (1966)
Wet Year (1989)



Hydrologic Analysis Areas

- Project Boundary
- Stream Restoration
- Existing Stream
- Other Streams
- Other Streams (Intermittent)
- Ditches
- Area 1
- Area 2
- Area 3
- Area 4
- 30-ft Stream Buffer

1:2,400
1 inch equals 200 feet

200 100 0 200 Feet

Image Source: Alleghany County GIS, Orthoimagery 2005

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Ecosystem Enhancement PROGRAM

Appendix K

Sediment Competence Calculation Form

Worksheet 5-15. Sediment competence calculation form to assess bed stability.

Stream: UTCC-US to Crab Creek			Stream Type:		
Location:			Valley Type:		
Observers: A.D			Date:		
Enter required information					
39	D_{50}	Riffle bed material D_{50} (mm)			
57	$\hat{D}_{50}$	Bar sample D_{50} (mm)			
.34	D_{max}	Largest particle from bar sample (ft)	104	(mm)	304.8 mm/ft
.009	S	Existing bankfull water surface slope (ft/ft)			
1.7	d	Existing bankfull mean depth (ft)			
1.65	γ_s	Submerged specific weight of sediment			
Select the appropriate equation and calculate critical dimensionless shear stress					
6.8	$D_{50}/\hat{D}_{50}$	Range: 3 – 7	Use EQUATION 1: $\tau^* = 0.0834 \left(D_{50}/\hat{D}_{50} \right)^{-0.872}$		
2.6	D_{max}/D_{50}	Range: 1.3 – 3.0	Use EQUATION 2: $\tau^* = 0.0384 \left(D_{max}/D_{50} \right)^{-0.887}$		
.016	τ^*	Bankfull Dimensionless Shear Stress	EQUATION USED:	2	
Calculate bankfull mean depth required for entrainment of largest particle in bar sample					
1.0	d	Required bankfull mean depth (ft) $d = \frac{\tau^* \gamma_s D_{max}}{S}$			
Check ✓: ☐ Stable ☐ Aggrading ☒ Degrading Existing depth deeper than required					
Calculate bankfull water surface slope required for entrainment of largest particle in bar sample					
.005	S	Required bankfull water surface slope (ft/ft) $S = \frac{\tau^* \gamma_s D_{max}}{d}$			
Check ✓: ☐ Stable ☐ Aggrading ☒ Degrading Existing Slope Steeper than required					
Sediment competence using dimensional shear stress					
.89	Bankfull shear stress $\tau = \gamma dS$ (lbs/ft²) (substitute hydraulic radius, R, with mean depth, d)				
130	Moveable particle size (mm) at bankfull shear stress (**Figure 5-54**)				
.160	Predicted shear stress required to initiate movement of D_{max} (mm) (**Figure 5-54**) (τ^*)				
1.0	Predicted mean depth required to initiate movement of D_{max} (mm) $d = \frac{\tau^*}{\gamma S}$				
.005	Predicted slope required to initiate movement of D_{max} (mm) $S = \frac{\tau}{\gamma d}$				

Worksheet 5-15. Sediment competence calculation form to assess bed stability.

Stream: UTCC-US to Crab Creek			Stream Type:		
Location: Proposed Stream			Valley Type:		
Observers: A.D			Date:		
Enter required information					
39	D_{50}	Riffle bed material D_{50} (mm)			
5.7	$\hat{D}_{50}$	Bar sample D_{50} (mm)	104 mm		
.34	D_{max}	Largest particle from bar sample (ft)	4.1"	(mm)	304.8 mm/ft
.009	S	Existing bankfull water surface slope (ft/ft)			
1.4	d	~~Existing~~ bankfull mean depth (ft) Proposed depth			
1.65	γ_s	Submerged specific weight of sediment			
Select the appropriate equation and calculate critical dimensionless shear stress					
6.8	$D_{50}/\hat{D}_{50}$	Range: 3 – 7	Use EQUATION 1: $\tau^* = 0.0834\ (D_{50}/\hat{D}_{50})^{-0.872}$		
2.6	D_{max}/D_{50}	Range: 1.3 – 3.0	Use EQUATION 2: $\tau^* = 0.0384\ (D_{max}/D_{50})^{-0.887}$		
.016	τ^*	Bankfull Dimensionless Shear Stress	EQUATION USED:	2	
Calculate bankfull mean depth required for entrainment of largest particle in bar sample					
1.0	d	Required bankfull mean depth (ft) $d = \frac{\tau^* \gamma_s D_{max}}{S}$			
Check ✓: ☐ Stable ☐ Aggrading ☐ Degrading					
Calculate bankfull water surface slope required for entrainment of largest particle in bar sample					
.006	S	Required bankfull water surface slope (ft/ft) $S = \frac{\tau^* \gamma_s D_{max}}{d}$			
Check ✓: ☐ Stable ☐ Aggrading ☐ Degrading					
Sediment competence using dimensional shear stress $\gamma = 62.4$ $R = 1.3$					
.73	Bankfull shear stress $\tau = \gamma dS$ (lbs/ft²) (substitute hydraulic radius, R, with mean depth, d)				
125	Moveable particle size (mm) at bankfull shear stress (**Figure 5-54**)				
.160	Predicted shear stress required to initiate movement of D_{max}^{104} (mm) (**Figure 5-54**) (τ^*)				
1.0	Predicted mean depth required to initiate movement of D_{max} (mm) $d = \frac{\tau^*}{\gamma S}$				
.006	Predicted slope required to initiate movement of D_{max} (mm) $S = \frac{\tau}{\gamma d}$				