Johnson Site
Iredell County, North Carolina

Stream Restoration Plan

Contract No. 532199
State Purchase Order No. EP4261663

Ecosystem Enhancement PROGRAM

NCEEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

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EXECUTIVE SUMMARY

The North Carolina Department of Transportation (NCDOT) initiated the Johnson Site Mitigation Feasibility Study in November 2002 to evaluate the feasibility of restoring a degraded section of an unnamed tributary to Little Hunting Creek (UTLHC) and stabilizing two tributaries that drain to it. With the creation of the North Carolina Ecosystem Enhancement Program (EEP), this project was shifted to this new agency. The purpose of the potential mitigation project would be to compensate for unavoidable stream impacts in the Upper Yadkin River Basin.

The project site is part of a 197-acre parcel owned by Mrs. Lottie V. Johnson that is located west of Harmony Highway (NC 21) and north of Hunting Creek Road (SR 1111) in rural Iredell County, North Carolina. The primary land uses on the property include a dairy operation, rangeland, agriculture (small grain), and forest. UTLHC is a first-order, perennial stream that drains in a south-southwest direction across the subject property before joining Little Hunting Creek. The project reach is located within USGS Hydrologic Unit Code 03040102, in a Non-EEP Targeted Local Watershed portion of the NC Division of Water Quality (NCDWQ) Priority Sub-basin 03-07-06 and has a WS-III usage classification (NCDENR, 2002).

A portion of UTLHC within the project site has been degraded due to poor grazing management and the removal of riparian vegetation. Coordination with the landowner was conducted to identify current and planned land use requirements associated with the project site. A Rosgen Level III assessment and qualitative stream stability evaluations were conducted to characterize existing stream conditions and determine the potential for restoration. Further, the presence of conditions or characteristics that have the potential to constrain restoration activities on the project site was evaluated.

A reference reach study of an unnamed tributary to Fisher River was conducted. A stream gauge was installed on UTLHC in the project site to evaluate flows. From sediment transport modeling, a design shear stress was established for the anticipated gradation of the streambed. Based on the reference reach surveys and sound geomorphic principles, the proposed mitigation stream alignment, profile and typical cross sections were developed.

The stream restoration plan proposes restoring approximately 2,260 linear feet of channel by constructing 2,156 linear feet of channel using a Priority Level III approach. The restoration will establish a bankfull channel generally within the existing stream corridor/belt width through adjustments to the stream dimension and profile. UTLHC will be restored to a Rosgen "B4c" stream type. A minimum width 50-foot buffer will be provided on both sides of the proposed channel. This buffer will be enclosed by exclusion fence, have one heavy duty stream crossing, and will be revegetated with hardwood species. The plantings within the conservation easement will consist of woody plantings on the banks and floodplain within the exclusion fencing.

Table 1. Project Restoration Structure and Objectives

Restoration Segment / Reach ID	Station Range	Restoration Type	Priority Approach	Existing Linear Footage	Designed Linear Footage	Comment
UTLHC	10+00 – 31+56	Restoration	P3	2,260	2,156	
UT1	-	Stabilization	P4	117	117	
UT2	-	Stabilization	P4	300	300	

Based on the existing and reference condition descriptions within this report, the restoration goals and objectives for the Johnson Site Stream Restoration project are as follows:

- Restore a stable "B4c" channel in accordance with the specified design criteria;
- Improve water quality by excluding livestock (thus, reducing direct fecal source) and establishing riparian buffers.
- Reduce land and riparian vegetation loss resulting from lateral bank erosion and bed degradation;
- Improve terrestrial/aquatic habitat by introducing streambed variability and distinct stream features, establishing bank and riparian vegetation and by improving water quality (refer above).

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1.0 INTRODUCTION

1.1 Project Description

The EEP intends to utilize the Johnson Site for a comprehensive restoration of an unnamed tributary to Little Hunting Creek (UTLHC), two tributaries, UT1 and UT2, and their woody corridors. The purpose of this project would be to compensate for unavoidable stream and buffer impacts in the Upper Yadkin River Basin.

This restoration plan presents detailed information regarding the existing site and watershed conditions, the morphological design criteria developed from a selected reference reach, and the project design parameters based upon natural channel restoration methodologies.

1.2 Project Goals and Objectives

The goals and objectives of the Johnson Site Stream Restoration Project are:

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- Improve water quality by excluding livestock (thus, reducing direct fecal source) and establishing riparian buffers.
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2.0 PROJECT SITE LOCATION

2.1 General Description

The project site is part of a 197-acre parcel owned by Mrs. Lottie V. Johnson that is located west of Harmony Highway (NC 21) and north of Hunting Creek Road (SR 1111) in Hamptonville, Iredell County, North Carolina (Figure 1. Vicinity Map). UTLHC is a first-order, perennial stream that drains in a south-southwest direction across the subject property before joining Little Hunting Creek.

The property is an active dairy with several structures for housing livestock and storing farm machinery, feed, and equipment. The primary land uses on the property include the dairy operation, rangeland, agriculture (small grain), and forest. A private residence is also located in the northeast portion of the subject property. Little Hunting Creek and Hunting Creek form the western and southern property boundaries, respectively.

2.2 USGS and NCDWQ River Basin Designations

The project reach is located within USGS Hydrologic Unit Code 03040102, in a Non-EEP Targeted Local Watershed portion of the NC Division of Water Quality (NCDWQ) Priority Sub-basin 03-07-06.

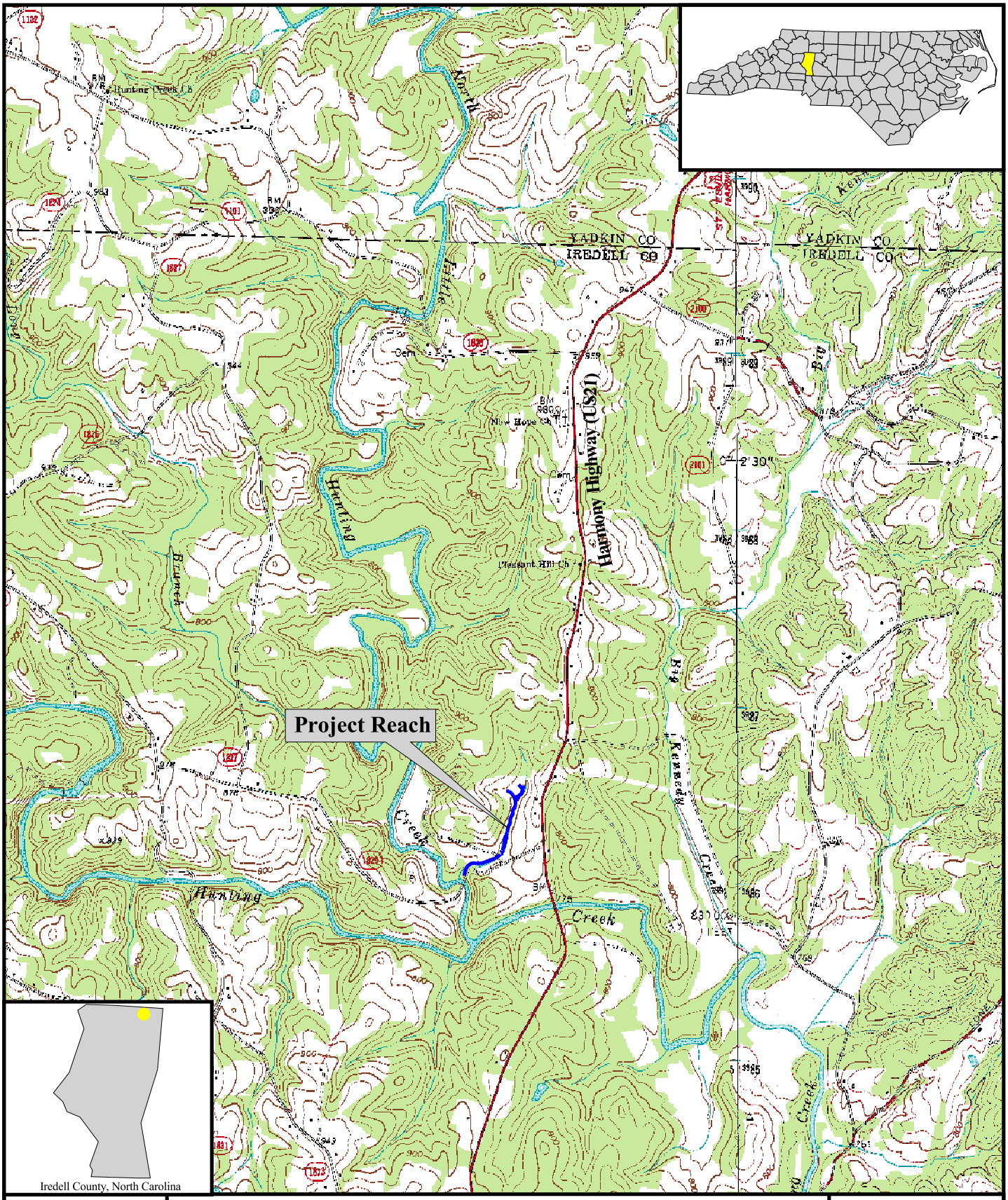

Figure 1. Vicinity Map **Johnson Site**

Project Reach Location

N

1000 0 1000 2000 Feet

Source: Brooks Crossroads and Lone Hickory USGS 7.5' Topographic Quadrangles

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2.3 NCDWQ Surface Water Classification

The NCDWQ assigns surface waters a classification in order to help protect, maintain, and preserve water quality. Little Hunting Creek (NCDWQ Stream Index Number 12-108-16-2), including the unnamed tributary that comprises the project reach, is designated a WS-III usage classification (NCDENR, 2002). WS-III indicates waters protected as water supplies, which are generally in low to moderately developed watersheds. Point source discharges (wastewater) are permitted and local programs to control non-point sources and stormwater discharges shall be required. WS-III is suitable for all Class C uses. Class C is a baseline water quality classification, intended to protect water resources for fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and secondary recreation. 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.

3.0 WATERSHED CHARACTERIZATION

3.1 General Description

The project site is located in a rural setting within the Northern Inner Piedmont ecoregion of the Piedmont physiographic province. Site topography is characterized as rolling to hilly with elevations ranging from 920 feet above mean sea level (AMSL) to 830 feet AMSL over a longitudinal distance of 0.76 miles (2.2% mean slope).

3.2 Drainage Area

The drainage area of the project reach at the upstream limits is 0.08 square miles. An additional 0.09 square miles (0.17 square miles total) drain to UTLHC before its confluence with Little Hunting Creek; both UT1 and UT2 have watersheds that are less than 10 acres (Figure 2. Project Watershed). The soil types of the watershed are presented in Figure 3 (Soils).

Table 2. Drainage Areas

Restoration Segment / Reach ID	Drainage Area (Acres)
UTLHC	111
UT1	< 10
UT2	< 10

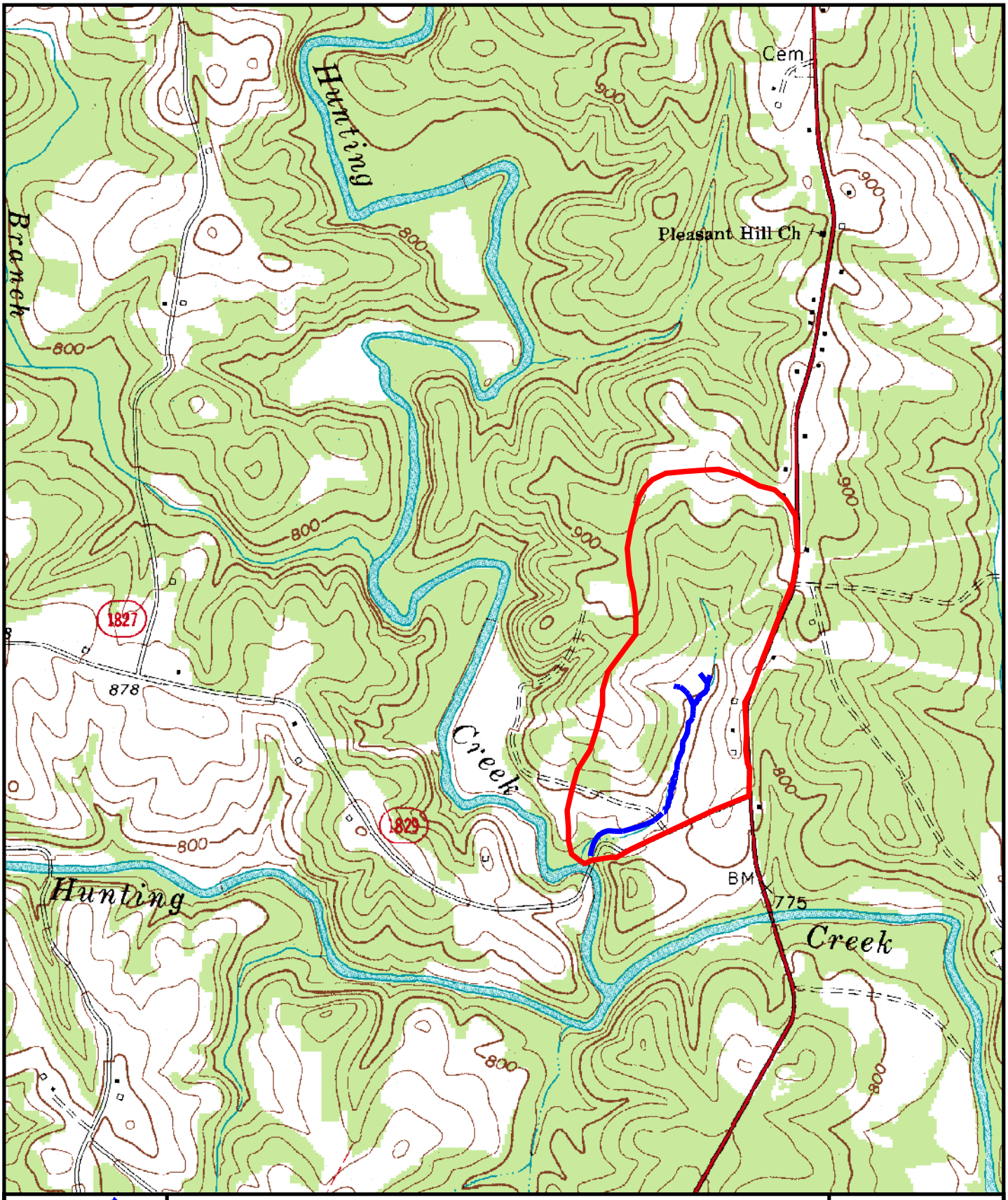

Figure 2. Project Watershed **Johnson Site**

Project Reach Location

Drainage Area 0.17 sq. miles

N

500 0 500 1000 Feet

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Source: Brooks Crossroads USGS 7.5' Topo Quadrangle

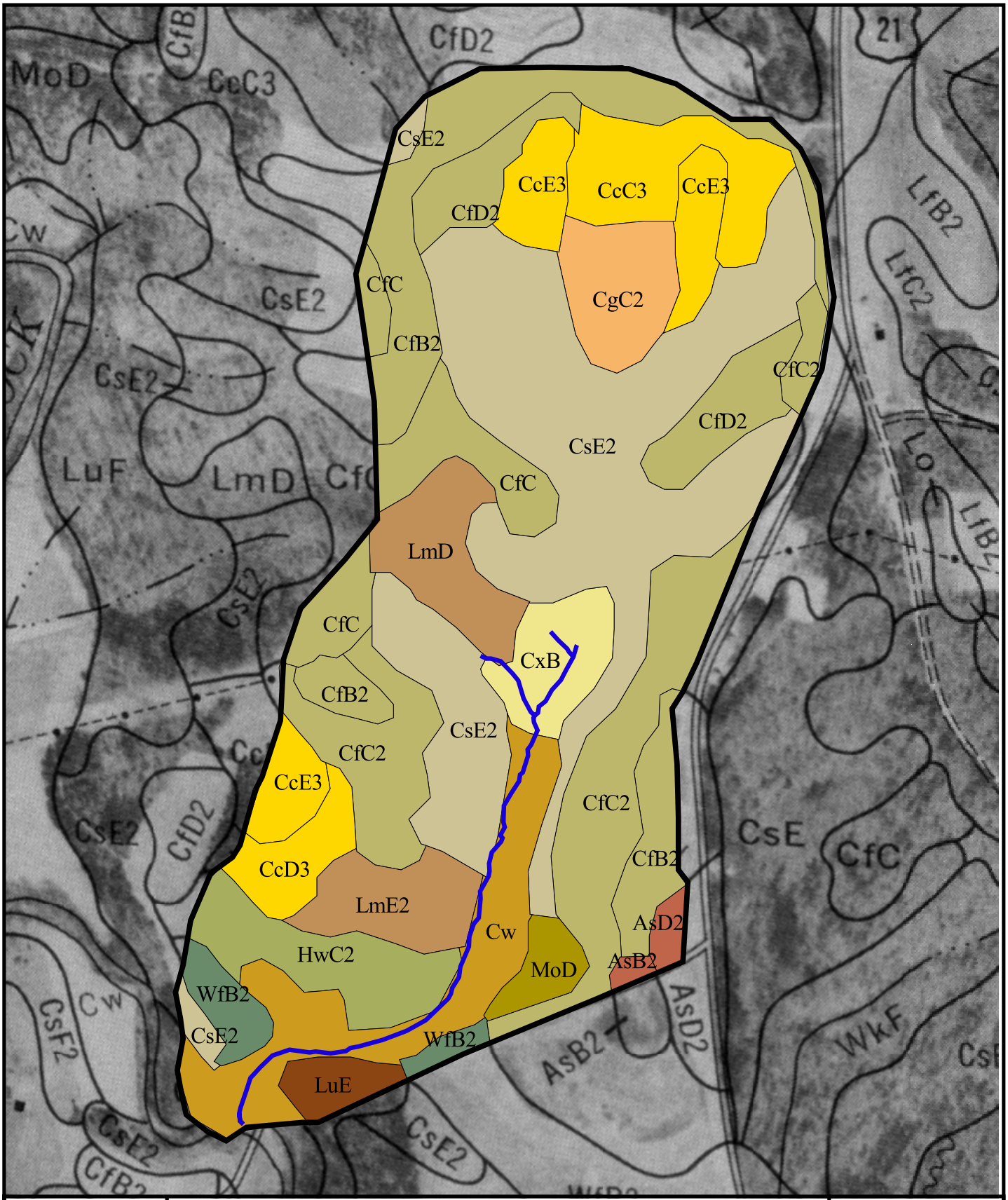

Figure 3. Watershed Soils **Johnson Site**

- Appling sandy loam (AsD2, AsB2)
- Cecil clay loam (CcC3, CcD3, CcE3)
- Cecil fine sandy loam (CfB2, CfC, CfC2, CfD2)
- Cecil gravelly fine sandy loam (CgC2)
- Cecil soils (CsE2)
- Chewacla soils (Cw)
- Colfax sandy loam (CxB)
- Hiwassee loam (HwC2)
- Lloyd loam (LmD, LmE2)
- Louisburg and Louisa soils (LuE)
- Moderately gullied land (MoD)
- Wickham fine sandy loam (WfB2)
- Project Reach Drainage
- Project Reach

N

200 0 200 400 Feet

Source: Soil Survey of Iredell County, North Carolina

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3.3 Land Use and Development Potential

An Anderson Level I classification indicates that the contributing drainage area is dominated by forest (43%) and rangeland (34%) land use / land cover (Figure 4. Land Use /Land Cover). Only 3.3% (3.7 acres) of the watershed is urban/developed and approximately 2.5% (2.8 acres) of the watershed is impervious cover. The Johnson property is zoned RU-R (rural residential district) and is surrounded by property zoned as RU-R and R-A (residential-agricultural district). Rural residential zoning is intended to ensure that residential development will occur at sufficiently low densities to provide a healthful environment, as well as to encourage the continuance of agricultural uses appropriate to a rural residential area. Rural-agricultural zoning has a similar intent, with more of an emphasis on preserving agricultural uses. Development pressures are considered low in the areas around the Johnson Property.

Table 3. Land Use of Watershed

Land Use	Acreage	Percentage
Urban/Developed	3.7	3%
Forest	48.0	43%
Agriculture/Row Crops	20.7	19%
Rangeland/Pasture	37.9	34%
Open Water	1.0	< 1%

3.4 Cultural and Archaeological Resources

To evaluate the presence of significant cultural resources on the subject property and the potential that the proposed project would impact them, KCI requested a formal review at the North Carolina Department of Cultural Resources, State Historic Preservation Office (SHPO). No historic preservation sites nor sites of archeological importance were noted on the Johnson Property (See Appendix A).

3.5 Effect on Natural Resources

Rare, Threatened, or Endangered Species (RTE)
A formal review by the North Carolina Natural Heritage Program (NHP) was requested in December 2002 to identify the presence of rare species, critical habitats, and priority natural areas on the project site and to determine the potential impact of the proposed project on these resources. In their Findings Letter (Appendix A), the NHP indicated no record of these occurrences within a one-half mile radius of the project site. Several natural areas were identified south of Hunting Creek; however, these areas would not be impacted by any proposed work on the subject property. In addition to the NHP review, the field examination did not indicate the potential presence of protected species or suitable habitats within the proposed project area.

Wetlands
A review of the Brooks Crossroads, North Carolina National Wetland Inventory (NWI) Map identified no wetlands within the project study area; the feasibility assessment also failed to identify any wetlands at the project site.

4.0 EXISTING CONDITIONS ASSESSMENT

A site field assessment was conducted in December 2002 to document existing conditions and evaluate the potential for stream and riparian buffer restoration. Observations and collected data are described below, illustrated in Figure 5 (Existing Conditions), and documented in the site photographs (Appendix B). The site was revisited from June to September 2005 several times to take further measurements, to install a stream gauge, and to collect hydrology data from the instruments.

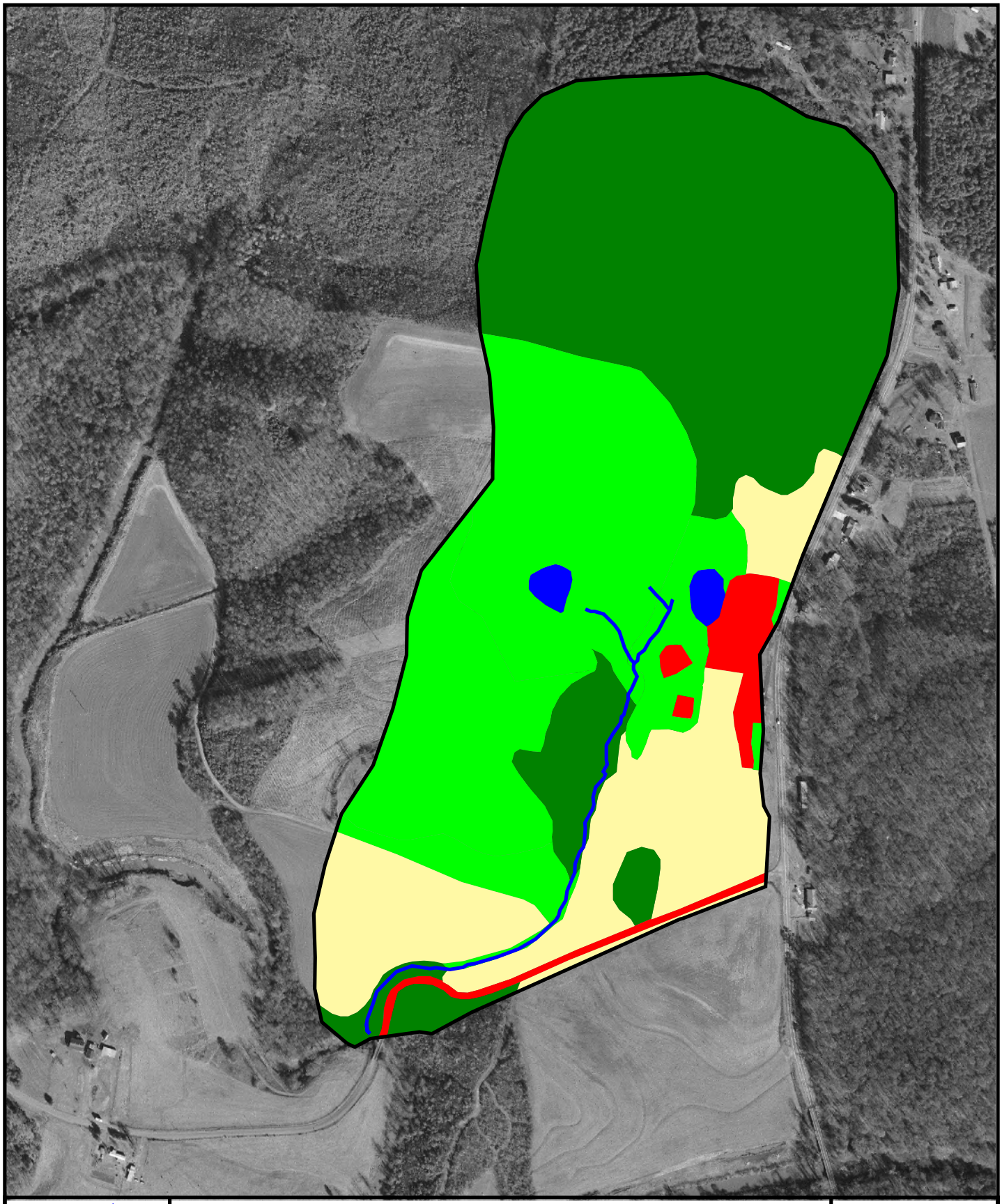

Figure 4. Land Use/Land Cover **Johnson Site**

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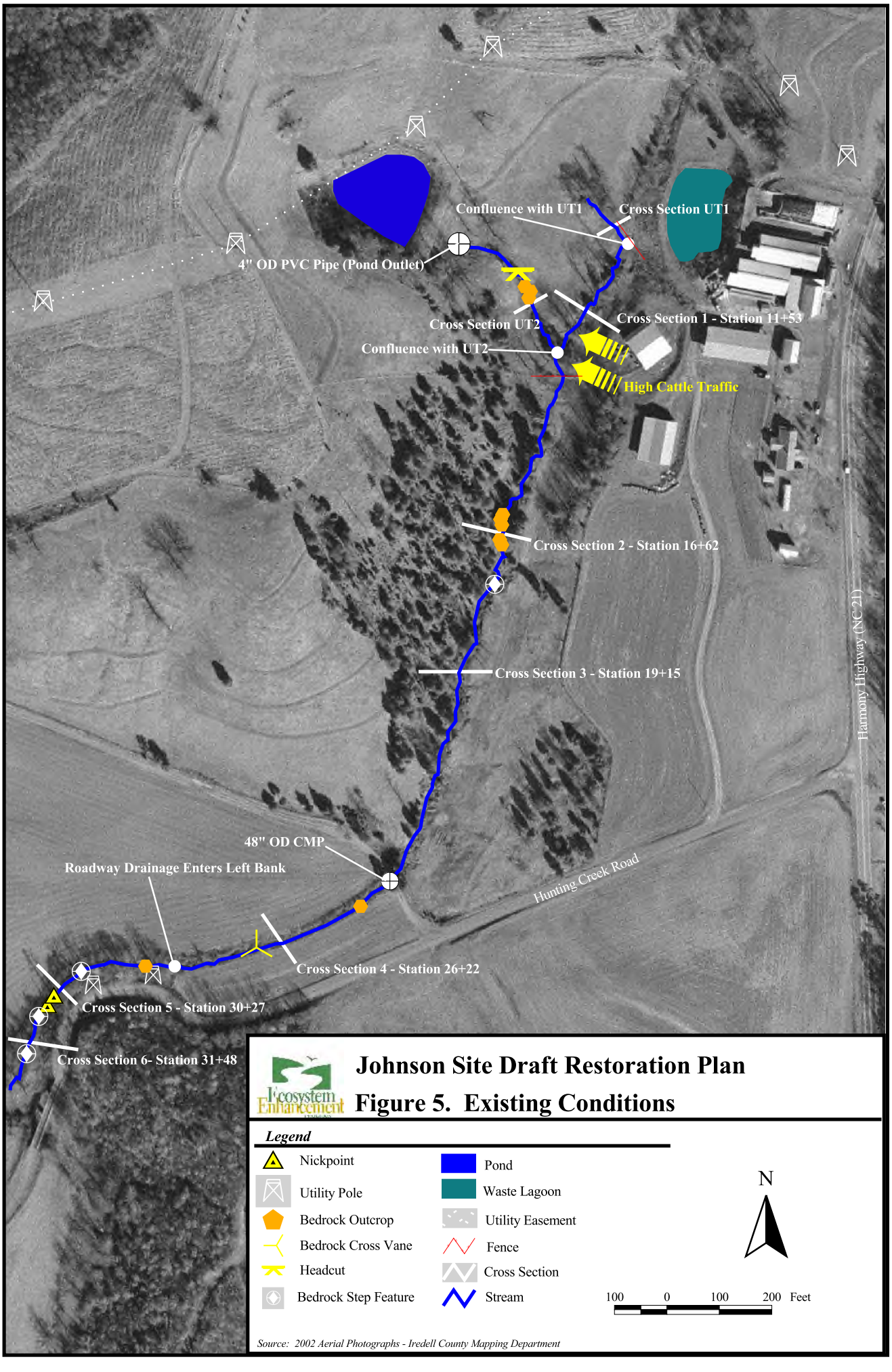
Source: 2002 Aerial Photographs - Iredell County Mapping Department



Johnson Site Draft Restoration Plan

Figure 5. Existing Conditions

Legend

- Nickpoint
- Utility Pole
- Bedrock Outcrop
- Bedrock Cross Vane
- Headcut
- Bedrock Step Feature
- Pond
- Waste Lagoon
- Utility Easement
- Fence
- Cross Section
- Stream

N

100 0 100 200 Feet

Source: 2002 Aerial Photographs - Iredell County Mapping Department

4.1 General Site Description

The UTLHC project reach includes approximately 2,260 linear feet of perennial stream channel. The reach begins at a barbed wire fence near the northern conservation easement boundary (Station 10+40.) Beyond the fence line, cattle have complete access to UTLHC. The channel is an "F5/F6" stream type. Severe bank erosion has resulted from the animal traffic. Large trees have been undercut and will fall as the channel widens. Bed degradation is evident and sedimentation from bank erosion, as well as hill slope erosion is widespread. Animal waste directly into the waterway is a major concern in this area (to Station 13+40). Two tributaries (UT1 & UT2) enter UTLHC in this reach. From the barbed wire fence UTLHC flows due south for approximately ten feet before being joined from the west by UT1. UT1 is a small, spring-fed intermittent reach that has experienced erosion from poor grazing management and overland flow. UT2 enters UTLHC approximately at station 12+40. UT2 begins from a four-inch PVC pipe (thirteen feet exposed) that serves as the overflow outlet for a farm pond that is elevated to the west of this area. Minimal riparian vegetation (several large trees) is present along either tributary.

From a barbed wire fence at Station 13+40, the stream becomes moderately entrenched as it continues in a southwest direction for approximately one thousand thirty-five feet (to Station 22+75). The stream transitions from an "F5/F6" to a "B4/5c" type. The height of the banks reduces the ability of cattle to access the channel throughout the majority of this section; however, access becomes more frequent as the valley widens near Station 21+00. UTLHC flows through a forty-eight inch corrugated metal pipe (CMP) under a small road leading to the southwest portion of the subject property. The downstream pipe invert is elevated twelve inches above the streambed, enabling water to flow under the pipe, even at low flow.

UTLHC flows west, southwest from the culvert through an actively farmed area (small grain). The stream is pinched along the toe of the roadway slope of Hunting Creek Road, then turns south before its confluence with Little Hunting Creek near Station 33+00. The stream has down cut through the majority of this reach, but several large bedrock features have slowed the bed degradation. Nonetheless, base level lowering from Little Hunting Creek has caused this section to be steeper than the other portions of UTLHC.

4.2 Geology and Soils

Local geology consists of intrusive and metamorphic rocks of the Inner Piedmont Belt. These include metamorphosed granitic rock with biotite, gneiss, and schist in nearby areas. The geology dates from 450 to 540 millions year ago (Cambrian to Ordovician).

Predominant soil types located within the project watershed include Chewacla soils (Cw), Colfax sandy loam (CxB), and various soils from the Cecil Series (CcC, CcE, CfB, CfC, CfD, CgC, CsE). Lesser areas of Lloyd loam (LmE) and Hiwassee loam (HwC) were indicated in the southwest portion of the watershed. Refer to Figure 3.

4.3 Existing Riparian Buffer and Natural Communities

The existing riparian area is predominantly in pasture or crop. These areas are largely devoid of natural habitat communities. Upstream of the UTLHC project reach, there is an intact riparian community. Mature trees sporadically line the channel throughout the project reach. There is a sparsely forested buffer on the west side of UTLHC from the confluence of UT2 with UTLHC to 400 feet below the confluence. Downstream of the 48" CMP, the west bank of UTLHC has scattered trees and shrubs including box elder (*Acer negundo*), Chinese privet (*Ligustrum sinense*), and multiflora rose (*Rosa multiflora*). It is the intent of the restoration project to salvage any valuable trees that may provide immediate shade to the restored channel.

4.4 Existing Stream Characterization

4.4.1 Morphological Description

A Rosgen Level III assessment was conducted to gather existing stream dimension, pattern, and profile data and determine the potential for restoration. Channel cross-sections and bed materials were surveyed at six representative locations along UTLHC, as well as in one location on both UT1 and UT2. Data developed from these surveys are summarized below (Table 4) with detailed data provided in Appendix C.

Table 4. Summary of Existing Channel Morphology.

LOCATION / PARAMETER	UTLHC XS-UT1	UTLHC XS-UT2	UTLHC XS-1	UTLHC XS-2	UTLHC XS-3	UTLHC XS-4	UTLHC XS-5	UTLHC XS-6
A_{bkf} (sq ft)	0.60	2.0	7.4	6.3	6.9	6.4	6.6	6.4
W_{bkf} (ft)	7.17	5.63	14.9	11.3	8.5	8.3	6.7	6.7
W_{fpa} (ft)	8.36	7.91	18.3	13.3	11.2	15.0	10.5	8.7
d_{mbkf} (ft)	0.08	0.36	0.91	0.82	1.13	1.72	1.44	1.32
D_{bkf} (ft)	0.12	0.50	0.5	0.56	0.81	0.77	0.99	0.96
W/D ratio	85.7	15.8	30.1	20.4	10.5	10.8	6.8	7.0
Entrenchment Ratio	1.17	1.40	1.2	1.2	1.3	1.8	1.6	1.3
Bank Height Ratio	32.83	7.90	4.6	9.1	6.0	2.6	3.3	5.5
Local W. S. Slope (ft/ft)	0.035	0.055	0.005	0.013	0.007	0.013	0.009	0.014
Discharge (cfs)	1	4	14	20	20	20	21	27
Stream Type	F5b/F6b	B5a/B6a	F5/F6	F5	B5c	B5c	G5c	G5c

4.4.2 Stability Assessment

Qualitative stability assessments of the existing stream conditions were developed based upon measured stream dimensional characteristics (i.e., entrenchment ratio, bank height ratio) and visual observations. Further, the assessments utilized the channel evolution model (CEM) presented by Simon (1989) to briefly characterize the active processes occurring in the subject stream and how they relate to the stability of the channel.

UTLHC exhibits characteristics of two separate stages in the CEM. Below the fence line near Station 10+40, cattle have access to the stream resulting in severe bank erosion and bed degradation. It appears the degradation in this reach has caused some bed instability upstream, as UTLHC is head cutting to the grade control point. The stream is transitioning from Stage III to Stage IV through this section as degradation is occurring above the fence line and degradation and widening are occurring in the area where the cattle are not fenced out.

The stream remains in Stage IV for approximately 1,000 feet as the stream flows through a narrowed portion of the valley. UTLHC is vertically contained through this reach with entrenchment ratios of 1.2, 1.2, and 1.3, respectively for Cross-sections 1 through 3. Bank erosion potential is high and bed degradation is occurring but has been slowed by the presence of numerous bedrock outcrops. Stream banks are extremely steep and the potential for tree loss is high. At several locations, cattle access to the adjacent hill slope, to the west, has resulted in gully formation and subsequent sediment input into the channel.

Below the road crossing at Station 23+74, the system is a moderately entrenched, B4/5c type stream. Bank heights are high and the vegetation cover is primarily vines and shallow rooted species. Erosion potential and sediment supply are high. The stream becomes steeper below a rock grade control at Station 26+50. The gradient increases to greater than 1% as the bed elevation rapidly drops before the confluence with Little Hunting Creek. The stream in this section is characterized as a G4/5c with high, nearly vertical banks and minimal or no vegetation. UTLHC has eroded into the adjacent roadway embankment, which forms the south/east stream bank. It will continue to widen (Stage IV), however the presence of bedrock will limit further bed lowering in this reach.

A BEHI evaluation performed on UTLHC found variability within the project site. Reach 1, which extended from station 10+00 to 12+75 and included UT1 and UT2, revealed the highest BEHI rating (34, High). This reach has the most significant cattle impacts with poorly formed banks, minimal herbaceous vegetation, and sparsely spaced trees. Reach 2, from station 12+75 to 23+00, had a Moderate BEHI rating (24). The third reach, from station 23+00 to 27+00, also had a Moderate BEHI rating (21). In this reach, the banks are steep, but protected by a cover of undesirable brushy vegetation. Reach 4, from station 27+00 to 31+56, had sections of Moderate and High BEHI rating. Steep unprotected banks typify this reach. The linear footage and BEHI ratings of these reaches are provided below in Table 5.

Table 5. BEHI and Sediment Export Estimates

Time Point	Segment/ Reach	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	ton/yr
Pre-Construction	Reach 1	695					695	100							78
	Reach 2	1,250							1,250	100					87
	Reach 3	400							400	100					22
	Reach 4	456					281	62	175	38					68

4.4.3 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). Thus, the determination of bankfull stage is the most critical component of the natural channel design (NCD) 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: breaks in slope, changes in vegetation, and highest scour line. The identification of bankfull stage, especially in an unstable system can be difficult. Therefore, verification measures must be taken to ensure the correct identification of the bankfull stage.

The two methods used to verify bankfull stage at UTLHC were regional hydraulic geometry relationships (regional curves) and a pressure transducer/data logger combination gauge that monitored actual water level in UTLHC throughout the study period.

Regional curves are typically utilized in ungauged areas to approximate bankfull discharge, area, width, and depth as a function of drainage area based on inter-related 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 reach. Based on the regional curves, bankfull discharge and cross-sectional areas of 14 – 25 ft^3/s and 4 – 6.5 ft^2 respectively, would be anticipated.

Stream stage data (water levels) were collected from UTLHC. Data was collected for eleven (11) months (August 2003 through December 2003, February 2004 through June 2004, and June 2005) and water levels were correlated to an estimated discharge using a rating curve generated for the gauged section. During the gauging period, fifteen storm events in excess of 5 ft^3/s were recorded. The maximum discharge event was approximately 7 ft^3/s (11/06/03). A severe storm event that included a documented tornado at the project site impacted the gauging instrumentation during the Summer 2005. KCI reinstalled the equipment and will continue to monitor the stage of UTLHC to verify the recurrence of the design discharge. Hydrograph data is provided in Appendix C.

4.5 Constraints

The presence of conditions or characteristics that have the potential to hinder restoration activities on the project site was 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. Table 6 summarizes the identified constraints related to the implementation of site restoration activities.

4.5.1 Hazardous Materials

The presence or likely presence of hazardous substances on the subject property and surrounding area under conditions that indicate a past, present or potential release into the ground, groundwater, or surface water was evaluated. The evaluation included a review of public record environmental database information and a visual site inspection.

A report meeting ASTM E1527-00 Standards for records search requirements was obtained summarizing existing federal and state database information regarding known environmental conditions for the subject property and surrounding area. No conditions of environmental concern were identified on the Johnson Site or within the specified search radii.

An environmental screening inspection was conducted on the subject and surrounding properties in December 2002 (Appendix D). The only documented environmental concern was an animal waste lagoon. The waste lagoon is located outside of the proposed restoration limits, however an overflow could adversely impact water quality in the restored stream.

4.5.2 Utilities and Easements

A chain-of-title for the subject property was not available; however, a copy of the current property deed, covering a period of more than 50 years, was obtained from the Iredell County Tax Office.

A power line easement that transects the subject property from the northeast to the west before crossing over Little Hunting Creek was also documented during the field investigation (Refer to Figure 5). The location where this easement crosses the project limits is north of the proposed restoration area. Therefore, this utility should not impact the feasibility of performing stream restoration in the specified location.

A second power line easement runs adjacent to the stream between the UTLHC and Hunting Creek Road near the southeastern portion of the project boundary (Refer to Figure 5). The EEP is evaluating the feasibility of relocating these lines away from the proposed restoration area.

4.5.3 Hydrologic Trespass

The proposed project reach is entirely contained within the Johnson Property. The restoration of the project reach is not anticipated to produce hydrologic trespass conditions on any adjacent properties.

Table 6. Summary of Design Constraints

Potential Constraint	Nature of Constraint	Proposed Resolution
Current Land Use (Specify)	Pasture (livestock grazing)	Exclusion fencing as necessary.
	Animal Waste Lagoon	Located outside of project area.
Adjacent Property Land Use	Forest, Agriculture, Low-Density Residential Development	
	Deed Restrictions/Easements	The EEP is investigating the relocation of the utility poles and lines. Otherwise, a modified planting strategy must be utilized in the area of overlapping easements.
Project Constructibility/Access	None	
Utilities	None	
Structures	48”CMP at farm road crossing that separates the project reach.	Restoration will not interfere with the function of the structure. The streambed will be built up to match the invert of the pipe outlet.
Cultural (Historical/Archaeological)	No occurrences per NCDCR review.	
Rare, Threatened, and Endangered Species	NCNHP Findings Letter indicated no record of occurrences within one-mile radius of the project site	
Natural Features (Soils, Bedrock)	Bedrock outcrops in streambed and banks	Identified bedrock incorporated into the design. Further discovery of bedrock may necessitate in-field modifications.
FEMA Regulated Area	Project area within Zones A & C (flood hazards not determined and area of minimal flooding, respectively).	Proposed restoration will not adversely affect flooding.

5.0 REFERENCE REACH ANALYSIS

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). The selection criteria included a stable reach occurring under similar hydrophysiographic, landform, and watershed land use conditions. The project site occurs in rolling to hilly terrain within the Northern Inner Piedmont ecoregion of the Piedmont physiographic province The project watershed is a small (0.17 square miles) area, primarily covered by forest and rangeland.

An Unnamed Tributary to Fisher River (UTFR), a first order rural stream located on the west side of Surry County was selected as a reference reach for the restoration of UTLHC. UTFR flows northeastward to its confluence with Fisher River. (Figure 6). It drains approximately 0.37 square miles of predominantly forest.

The selection of UTFR was based on: location in the same hydrophysiographic province, similar valley morphology, and similar sediment regime as the project site. The stream slope is slightly greater than UTLHC (1.3% compared to 1.0% respectively). The foothills of the Blue Ridge Mountains characterize local topography, which is consistent with the landforms found in the Northern Inner Piedmont ecoregion, where both streams are located.

Approximately 300 linear feet of UTFR were surveyed in June 2005 (Appendix D contains supporting documentation from the field assessment). This reach of UTFR was classified as a “B4c” channel type. The dimensionless hydraulic geometry relationships were developed from stable channel dimensions to facilitate the design of the proposed channel cross-sections for the UTLHC restoration reach. The morphological variables for this reference reach are included as part of Table 7 in the Restoration Design section of this report.

Directions to Reference Reach

-From I-77, take Exit 93.
-Travel west from I-77.
-Bear right on Fisher Valley Rd (SR 1338).
-UT to Fisher River crosses road approximately 3 miles from I-77, near street address 317 Fisher Valley Rd.

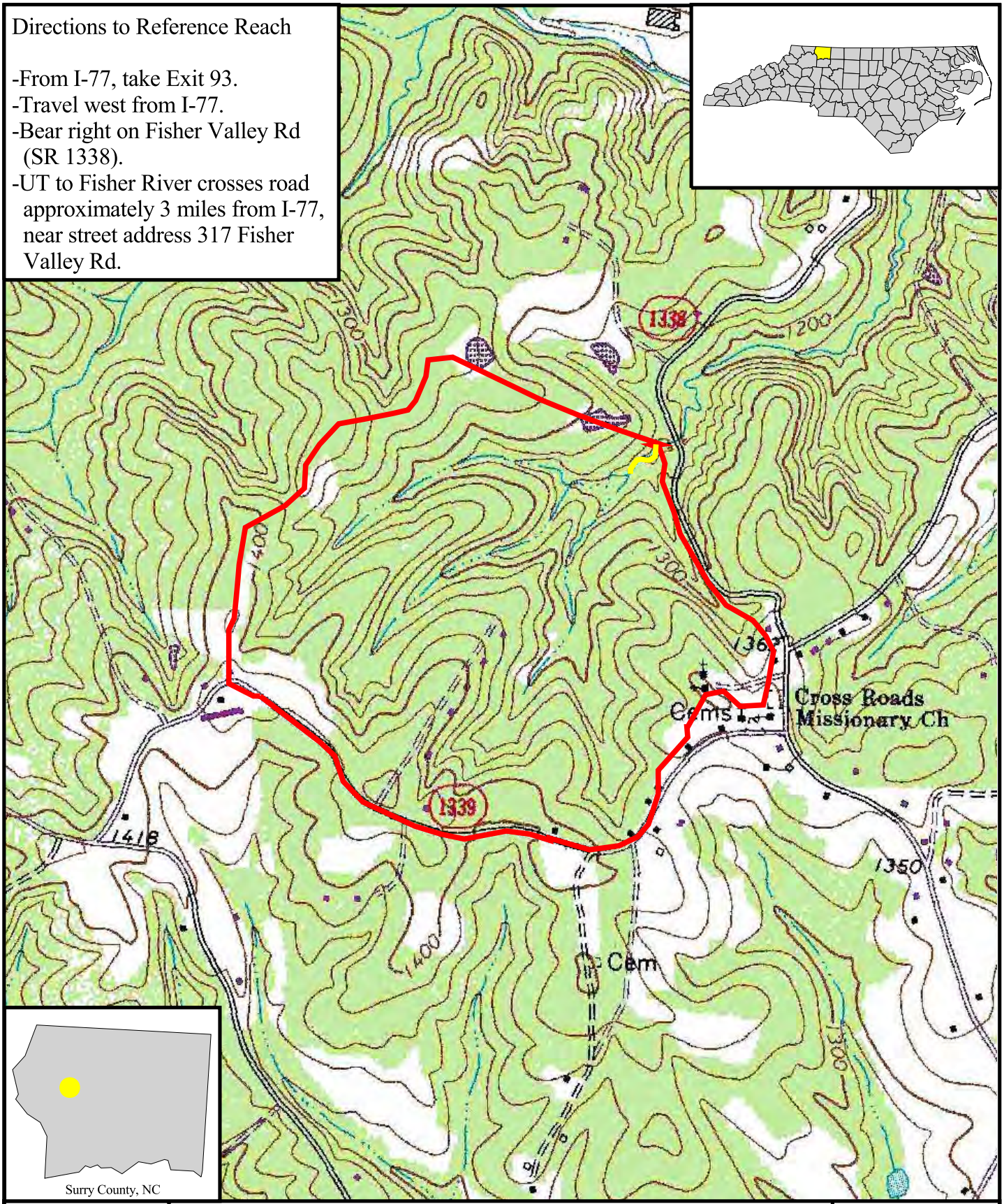


Figure 6. Reference Reach Map - UT to Fisher River

UT to Fisher River - Reference Reach

Drainage Area 0.37 Sq. Miles

N

400 0 400 800 Feet

Source: Bottom USGS 7.5' Topographic Quadrangle

KCI ASSOCIATES OF NORTH CAROLINA, PA

Ecosystem Enhancement PROGRAM

6.0 RESTORATION DESIGN

The restoration design of the UTLHC is based on a Priority Level III approach, while UT1 and UT2 will be stabilized following a Priority Level IV approach, as described in "A Geomorphological Approach to Restoration of Incised Rivers", (Rosgen, 1997). For clarity and convenience, definitions of the four restoration priorities are provided in Table 7.

6.1 Stream

The design proposes constructing 2,156 linear feet of restored channel using a Priority Level III approach. This strategy will involve restoring a "B4c" type stream, generally within the existing stream corridor/belt width through adjustments to the stream dimension and profile. The proposed stream dimension, pattern, and profile will be based on the detailed morphological criteria and hydraulic geometry relationships developed from the reference stream, see Table 8. Refer to the attached plan sheet drawings.

Cross Vanes and Rock Sill Grade Controls (Refer to Plan Sheet 2) will be used to stabilize the restored channel. These structures are designed to reduce stress in the near-bank region of stream bends and maintain the established streambed morphology. The structures further promote efficient sediment transport and produce/enhance in-stream habitat. Coir fiber matting will be used to provide temporary stabilization on the newly graded streambanks. The confluence of tributaries with the restored stream will be stabilized with grade control structures where necessary to match the proposed grade of the restored main channel.

The restoration project will also include other non-stream related components:

- Cattle exclusion fencing will be installed along the outer boundary of the restored riparian buffers and a permanent conservation easement will be recorded to protect the site in perpetuity.
- One stabilized stream crossing will be installed to provide livestock access to isolated areas. A rock ford (NRCS Heavy Traffic), fenced on either side to exclude livestock from further accessing the waterway, is the proposed measure for this crossing.
- A well to provide for offline watering will be installed with a drinker near the livestock shelters to the east of the project reach.

6.2 Riparian Buffers

Native woody and herbaceous species will be used to establish riparian buffers on both sides of the restored reach. Four hundred thirty-six (436) trees per acre (based on an average 10' x 10' spacing) will be planted to achieve a mature survivability of three hundred twenty (320) trees per acre in the riparian zone (DENR, 2001). Plant placement and groupings will be randomized during installation in order to develop a more naturalized appearance in the buffer. Woody vegetation planting will be conducted during dormancy.

There will be two zones within the riparian buffer. The first zone, closest to the stream, will be a streamside zone and may consist of the following:

American Sycamore (*Platanus occidentalis*)
Green Ash (*Fraxinus pennsylvanica*)
River Birch (*Betula nigra*)
Box Elder (*Acer negundo*)
Silky Dogwood (*Cornus amomum*)

Table 7. Priority Levels of Incised River Restoration.

Description	Methods	Advantages	Disadvantages
Priority 1 Convert G and/or F stream types to C or E at previous elevation with floodplain.	Re-establish channel on previous floodplain using relic channel or construction of new bankfull discharge channel. Design new channel for dimension, pattern, and profile characteristic of stable form. Fill in existing incised channel or with discontinuous oxbow lakes level with new floodplain elevation.	Re-establishment of floodplain and stable channel: 1) reduces bank height and streambank erosion, 2) reduces land loss, 3) raises water table, 4) decreases sediment, 5) improves aquatic and terrestrial habitats, 6) improves land productivity, and 7) improves aesthetics.	1) Floodplain re-establishment could cause flood damage to urban, agricultural, and industrial development. 2) Downstream end of project could require grade control from new to previous channel to prevent head-cutting.
Priority 2 Convert F and/or G stream types to C or E. Re-establishment of floodplain at existing level or higher, but not at original level.	If belt width provides for the minimum meander width ratio for C or E stream types, construct channel in bed of existing channel, convert existing bed to new floodplain. If belt width is too narrow, excavate streambank walls. End-haul material or place in streambed to raise bed elevation and create new floodplain in the deposition.	1) Decreases bank height and streambank erosion, 2) Allows for riparian vegetation to help stabilize banks, 3) Establishes floodplain to help take stress off of channel during flood, 4) Improves aquatic habitat, 5) Prevents wide-scale flooding of original land surface, 6) Reduces sediment, 7) Downstream grade transition for grade control is easier.	1) Does not raise water table back to previous elevation. 2) Shear stress and velocity higher during flood due to narrower floodplain. 3) Upper banks need to be sloped and stabilized to reduce erosion during flood.
Priority 3 Convert to a new stream type without an active floodplain, but containing a floodprone area. Convert G to B stream type, or F to Bc.	Excavation of channel to change stream type involves establishing proper dimension, pattern, and profile. To convert a G to B stream involves an increase in width/depth and entrenchment ratio, shaping upper slopes and stabilizing both bed and banks. A conversion from F to Bc stream type involves a decrease in width/depth ratio and an increase in entrenchment ratio.	1) Reduces the amount of land needed to return the river to a stable form. 2) Developments next to river need not be relocated due to flooding potential. 3) Decreases flood stage for same magnitude flood. 4) Improves aquatic habitat.	1) High cost of materials for bed and streambank stabilization. 2) Does not create the diversity of aquatic habitat. 3) Does not raise water table to previous levels.
Priority 4 Stabilize channel in place.	A long list of stabilization materials and methods have been used to decrease streambed and streambank erosion, including concrete, gabions, boulders, and bioengineering methods.	1) Excavation volumes are reduced. 2) Land needed for restoration is minimal.	1) High cost for stabilization. 2) High risk due to excessive shear stress and velocity. 3) Limited aquatic habitat depending on nature of stabilization methods used.

Source: Rosgen, 1997, "A Geomorphological Approach to Restoration of Incised Rivers".

Table 8. Morphological Design Criteria

Variables		Project Site Existing Channel	Reference Reach UT to Fisher River	Project Site Restored Reach
Rosgen Stream Type		F5/B5c/G5c	B4c	B4c
Drainage Area (mi^2)		0.17	0.38	0.17
Bankfull Width (W_{bkf}) (ft)		4-15	9-10	8.4
Bankfull Mean Depth (d_{bkf}) (ft)		0.5-1.0	1.1-1.2	0.8
Bankfull Cross Sectional area (A_{bkf}) (ft^2)		3.5-7.4	10.4-10.7	7.0
Width/depth Ratio (W_{bkf}/d_{bkf})		4.2-30.1	8-12	10
Maximum Depth (d_{mbkf}) (ft)		0.7-1.7	1.3-1.5	0.9-1.0
Width of flood prone area (W_{fpa}) (ft)		6.7-20.8	13.1-20.5	10.1-10.9
Entrenchment Ratio (ER)		1.1-5.4	1.3-2.3	1.3-2.3 (1.8)
Water Surface Slope (S) (ft/ft)		0.010	0.013	0.010
Sinuosity (stream length/valley length) (K)		1.1	1.2	1.2
Dimension	Pool Depth (ft)	-	1.2-1.4	0.8-1.1
	Riffle Depth (ft)	0.5-1.0	1.1-1.2	0.8
	Pool Width (ft)	-	8.4-11.6	6.7-10.9
	Riffle Width (ft)	3.9-14.9	9.0-9.9	8.4
	Pool XS Area (sf)	-	11.6-13.4	7.7-9.1
	Riffle XS Area (sf)	3.5-7.4	10.4-10.7	7.0
	Pool depth/mean riffle depth	-	1.0-1.3	1.0-1.3
	Pool width/riffle width	-	0.8-1.3	0.8-1.3
	Pool area/riffle area	-	1.1-1.3	1.1-1.3
	Max pool depth/d_{bkf}	-	1.9-2.0	1.9-2.0
	Low bank height/max bankfull depth	-	-	-
	Mean Bankfull Velocity (V) (fps)	1.9-5.2	4.1-4.5	3.1-3.6
	Bankfull Discharge (Q) (cfs)	11-27	42-46	20-24
Pattern	Meander length (L_m) (ft)	40-140	93-136	76-126
	Radius of curvature (Rd) (ft)	11-20	13-42	11-37
	Belt width (W_{blt}) (ft)	30	45	38-42
	Meander width ratio (w_{blt}/W_{bkf})	2-7.5	4.5-5.0	4.5-5.0
	Radius of curvature/bankfull width	0.7-5.0	1.3-4.4	1.3-4.4
	Meander length/bankfull width	3-35	9-15	9-15
Profile	Valley slope	0.015/0.022*	0.016	0.010-0.012
	Average water surface slope	0.010	0.013	0.010
	Riffle slope	0.007-0.086**	0.013-0.028	0.010-0.022
	Pool slope	0.000-0.002	0.000-0.001	0.0-0.001
	Pool to pool spacing	15-132	30-59	28-50
	Pool length	2-15	3-25	3-21
	Riffle slope/avg water surface slope	0.7-8.6	1.0-2.2	1.0-2.2
	Pool slope/avg water surface slope	0.0	0.0	0.0
	Run slope/avg water surface slope	1.0-11.0	0.7-1.1	0.7-1.1
	Run depth/d_{bkf}	0.1-0.6	0.8-1.2	0.8-1.2
	Pool length/bankfull width	0.1-3.8	0.3-2.5	0.3-2.5
	Pool to pool spacing/bankfull width	1.0-33.0	3.3-6.0	3.3-6.0

* Valley slopes influenced by step pool morphology
** Maximum value includes bedrock steps

The second zone, which will continue from the streamside zone to the easement boundary will be a hardwood mixed zone and may consist of the following:

Bitternut Hickory (*Carya cordiformis*)
Tulip Poplar (*Liriodendron tulipifera*)
Witch Hazel (*Hamamelis virginiana*)
Persimmon (*Diospyros virginiana*)
Southern Red Oak (*Quercus falcata*)
Pawpaw (*Asimina tribloba*)

A supplemental vegetated buffer will be located on the west side of UTLHC. This area is sparsely vegetated with red cedars and other small trees. The supplemental planting will take place among the existing trees and in unvegetated areas. Planting densities will vary depending on amounts of preexisting vegetation.

Tree species to be planted within the supplemental vegetated buffer may consist of the following:

Red Oak (*Quercus rubra*)
Tulip Poplar (*Liriodendron tulipifera*)
Black Walnut (*Juglans nigra*)
Chestnut Oak (*Quercus prinus*)
Witch Hazel (*Hamamelis virginiana*)
Silverbell (*Helsia carolina*)
Pignut Hickory (*Carya glabra*)

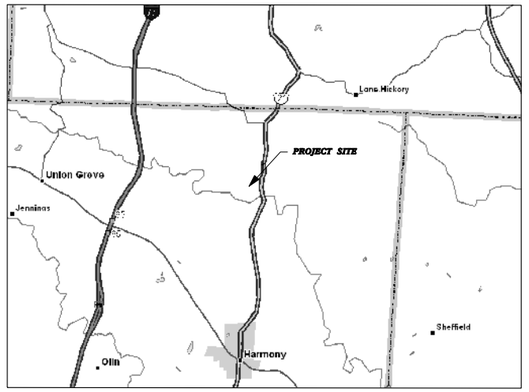
Herbaceous vegetation within the buffer shall consist of a native grass mix that may include: big bluestem (*Andropogon gerardii*), purple love grass (*Eragrostis spectabilis*), deertongue (*Panicum clandestinum*), gama grass (*Tripsacum dactyloides*), orchardgrass (*Dactylis glomerata*), river oats (*Chasmanthium latifolium*), and Virginia wildrye (*Elymus virginicus*). Rye grain (*Secale cereale*) or brown top millet (*Pennisetum glaucum*) will be used for temporary stabilization, depending upon the construction schedule.

STATE	STATE CONSTRUCTION PROJECT NO.	SHEET NO.	TOTAL SHEETS
N.C.	EP4261663	1	13

STATE OF NORTH CAROLINA

ECOSYSTEM ENHANCEMENT PROGRAM

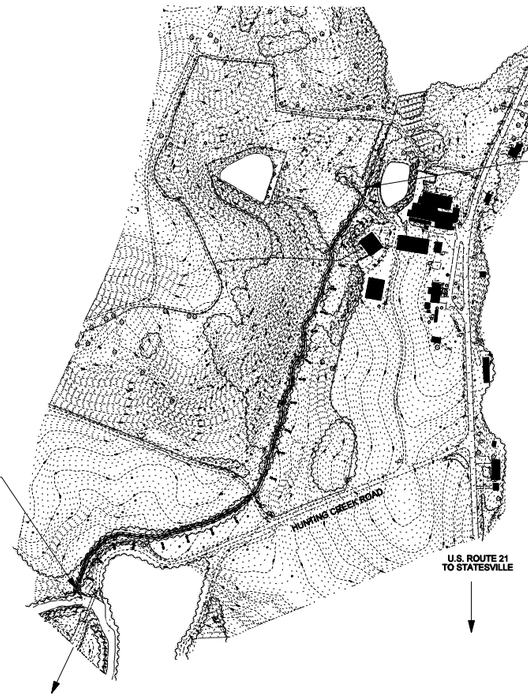
IREDELL COUNTY



VICINITY MAP
NOT TO SCALE

LOCATION: UNNAMED TRIBUTARY TO LITTLE HUNTING CREEK (JOHNSON SITE)
HAMPTONVILLE, NORTH CAROLINA

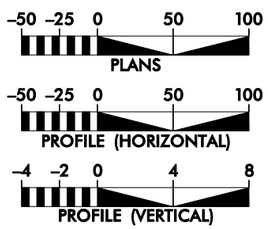
TYPE OF WORK: STREAM RESTORATION



INDEX OF SHEETS

* = SUBMITTED AS PART OF RESTORATION PLAN.

GRAPHIC SCALES



PROJECT LENGTH

STREAM RESTORATION LENGTH = 2,156 FEET

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:

JAMES W. BLAKE, PE
PROJECT ENGINEER

GARY M. MRYNCZA, PH
NATURAL CHANNEL DESIGN

PROJECT ENGINEER

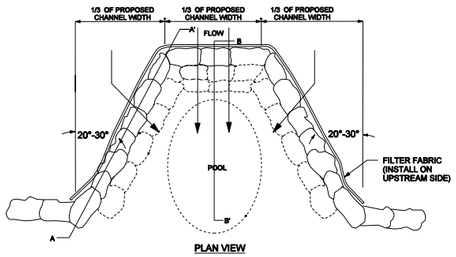
SIGNATURE: ***P.E.***

Prepared for:

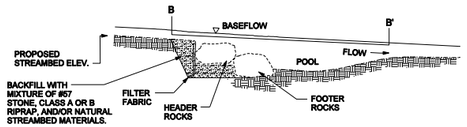
Ecosystem Enhancement PROGRAM

HARRY TSOMIDES
NCEEP CONTACT

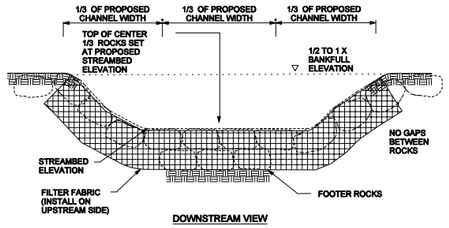
PROJECT: EP4261663



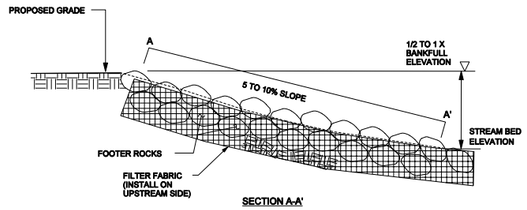
PLAN VIEW



SECTION B-B' (PROFILE VIEW)



DOWNSTREAM VIEW

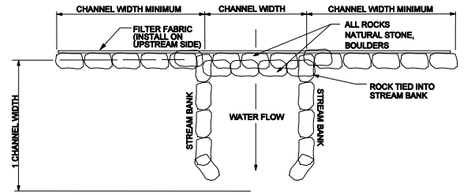


SECTION A-A'

ROCK CROSS VANE

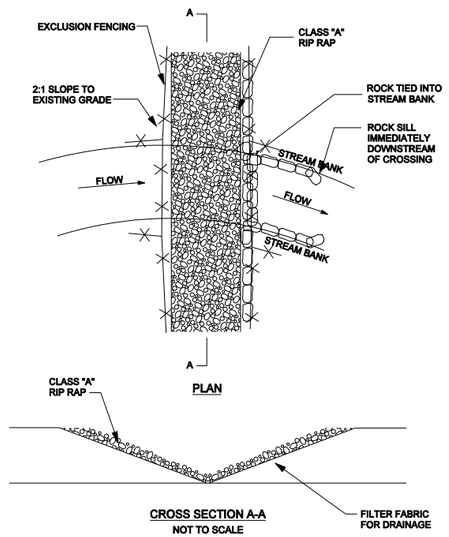
SCALE: NTS

NOTE: ALL ROCKS OR STONES IN THE VANE STRUCTURE ARE STONE, BOULDERS



ROCK SILL GRADE CONTROL

SCALE: NTS



CROSS SECTION A-A

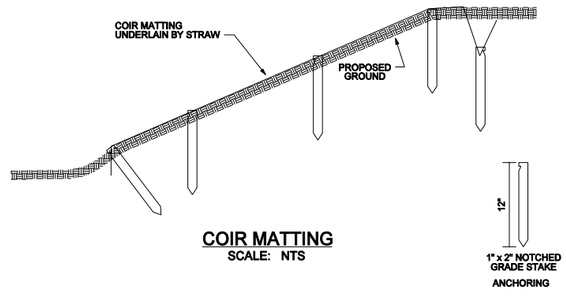
NOT TO SCALE

1. A STABILIZED PAD OF CLASS "A" RIP RAP, 18 INCHES THICK, LINED WITH FILTER FABRIC SHALL BE LOCATED WHERE FARM EQUIPMENT AND LIVESTOCK WILL BE CROSSING THE RESTORED STREAM CHANNEL.
2. EXCLUSION FENCING SHALL BE INSTALLED ON ALL APPROACHES TO AND ADJACENT TO THE CROSSING.
3. DIMENSIONS OF THE CROSSING SHALL BE SUFFICIENT TO ACCOMODATE THE LANDOWNERS LARGEST VEHICLE CROSSING THE RESTORED STREAM CHANNEL.
4. THE ENGINEER SHALL DETERMINE AN APPROPRIATE RAMP ANGLE FOR THE STREAM CROSSING ACCORDING TO THE CHANNEL MORPHOLOGY.
5. THE LOCATION OF CROSSINGS ARE DEPICTED IN THE PLANS.

HEAVY DUTY ROCK FORD

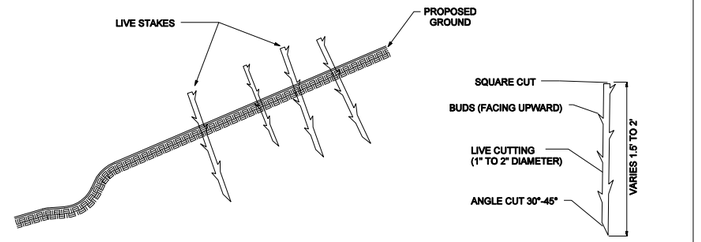
PLACE AS SPECIFIED IN THE PLANS AND APPROVED BY THE ENGINEER

NOTE: MATTING TO BE APPLIED AND STAKED IN ACCORDANCE WITH PROJECT SPECIAL PROVISIONS



COIR MATTING

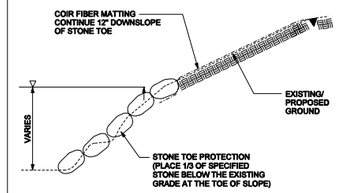
SCALE: NTS



NOTE: LIVE STAKES TO BE INSTALLED IN ACCORDANCE WITH PROJECT SPECIAL PROVISIONS AND AS DIRECTED BY THE ENGINEER.

LIVE STAKES

SCALE: NTS



STONE TOE STABILIZATION

SCALE: NTS

NO.	DESCRIPTION	DATE	APPROVED
	SUBMITTED WITH RESTORATION PLAN	2/08	

REVISIONS

Ecosystem Enhancement PROGRAM

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

JOHNSON SITE - UT TO LITTLE HUNTING CREEK
STREAM RESTORATION PROJECT

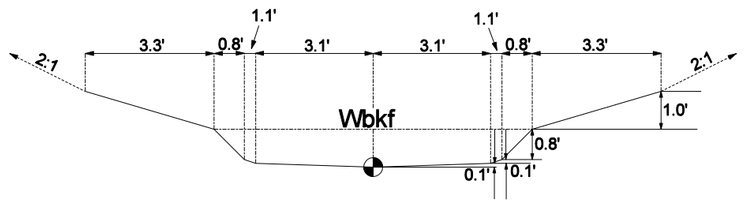
HAMPTONVILLE, IREDELL COUNTY, NORTH CAROLINA

DATE: NOV. 2005

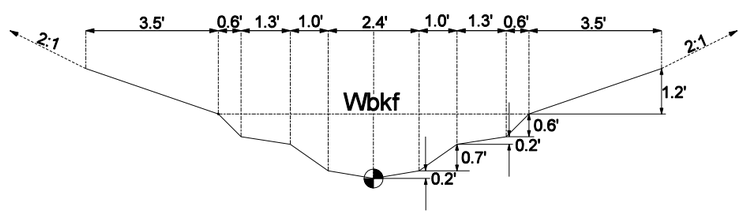
SCALE: NTS

DETAILS: STABILIZATION

TYPICAL CROSS-SECTIONS
RIFFLE & STEP POOL



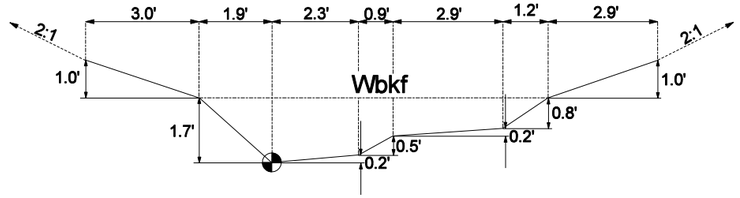
TYPICAL RIFFLE



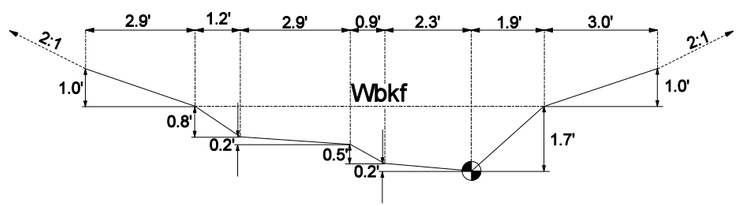
TYPICAL STEP POOL

- THALWEG LOCATION

TYPICAL CROSS-SECTIONS
MEANDER POOLS



TYPICAL POOL (LEFT MEANDER)



TYPICAL POOL (RIGHT POOL)

- THALWEG LOCATION

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVED
	SUBMITTED WITH RESTORATION PLAN	2/08	

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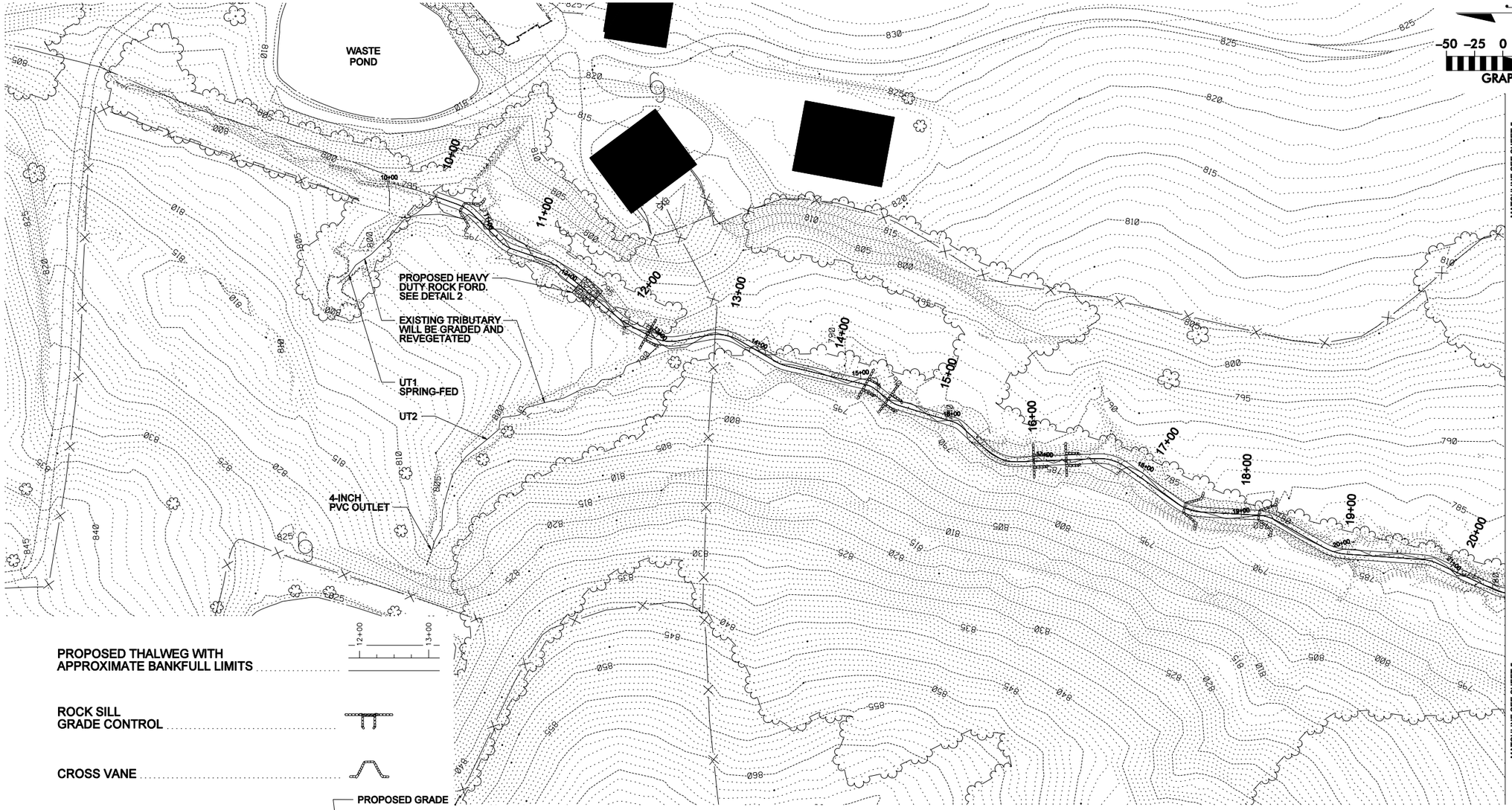
JOHNSON SITE - UT TO LITTLE HUNTING CREEK
STREAM RESTORATION PROJECT

HAMPTONVILLE, IREDELL COUNTY, NORTH CAROLINA

DATE: NOV. 2005
SCALE: 1" = 20'

DETAILS:
TYPICAL
SECTIONS



REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVED

SUBMITTED WITH RESTORATION PLAN 11/05

Ecosystem Enhancement Program

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JOHNSON SITE -UT TO LITTLE HUNTING CREEK STREAM RESTORATION PROJECT

HAMPTONVILLE, IREDELL COUNTY, NORTH CAROLINA

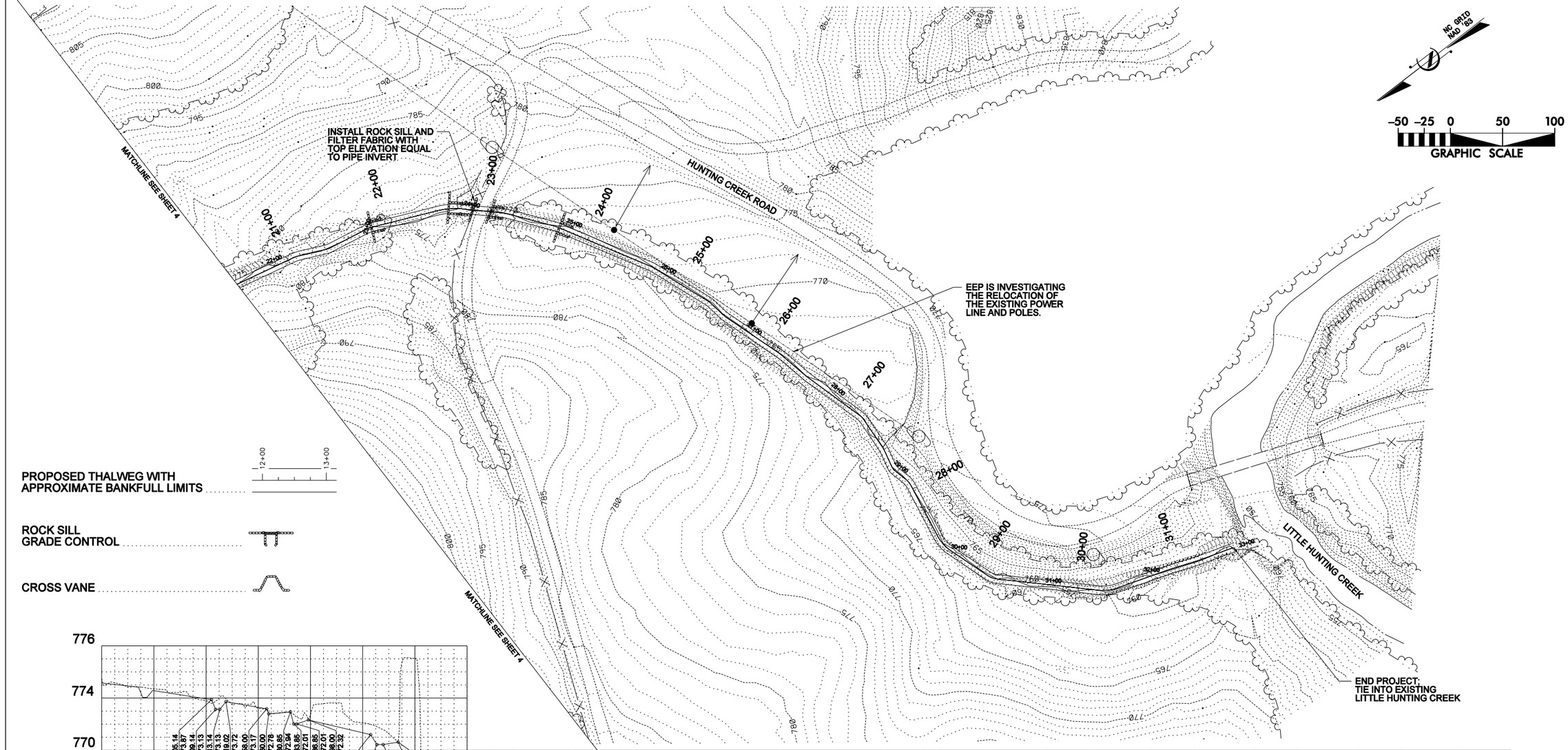
STATION 10+00 TO 20+50

DATE: NOV. 2005

SCALE: 1" = 50'

PLAN & PROFILE

SHEET 4 OF 11



		11/05	
SUBMITTED WITH RESTORATION PLAN			
	DESCRIPTION	DATE	APPROVED
SYM.	REVISIONS		

Ecosystem Enhancement PROGRAM

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RALEIGH, NORTH CAROLINA 27609

JOHNSON SITE -UT TO LITTLE HUNTING CREEK STREAM RESTORATION PROJECT

HAMPTONVILLE, IREDELL COUNTY, NORTH CAROLINA

STATION 20+50 TO 31+56

DATE: NOV. 2005

SCALE: 1" = 50'

PLAN & PROFILE

NC GRID
NAD '83

–50 –25 0 50 100
GRAPHIC SCALE

MATCHLINE SEE SHEET 11

POND

MATCHLINE SEE SHEET 11

PLANTING PLAN AND SPECIES COMPOSITION

STREAMSIDE PLANTING AREA = 1.8 ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME	% OF TOTAL	# OF PLANTS
PLATANUS OCCIDENTALIS	SYCAMORE	20	160
FRAXINUS PENNSYLVANICA	GREEN ASH	20	160
BETULA NIGRA	RIVER BIRCH	20	160
ACER NEGUNDO	BOX ELDER	20	160
CORNUS AMOMUM	SILKY DOGWOOD	20	160
		100	800

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL BE SUPPLEMENTAL PLANTED

MIXED HARDWOOD PLANTING AREA = 3.50ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

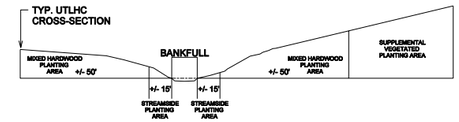
SCIENTIFIC NAME	COMMON NAME	% OF TOTAL	# OF PLANTS
LIRIODENDRON TULIPIFERA	TULIP POPLAR	20	305
DIOSPYROS VIRGINIANA	PERSIMMON	10	150
QUERCUS FALCATA	SOUTHERN RED OAK	20	305
ASIMINA TRILOBA	PAWPAW	15	230
HAMAMELIS VIRGINIANA	WITCH HAZEL	20	305
CARYA CORDIFORMIS	BITTERNUT HICKORY	15	230
		100	1,525

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL BE SUPPLEMENTAL PLANTED

SUPPLEMENTAL VEGETATED PLANTING AREA = 4.5 ACRES

12" - 18" BARE ROOT MATERIAL
218 STEMS/ACRE (15' X 15' SPACING), RANDOM SPECIES PLACEMENT AMONG EXISTING VEGETATION

SCIENTIFIC NAME	COMMON NAME	% OF TOTAL	# OF PLANTS
QUERCUS RUBRA	RED OAK	20	200
QUERCUS PRINUS	CHESTNUT OAK	20	200
LIRIODENDRON TULIPIFERA	TULIP POPLAR	15	150
JUGLANS NIGRA	BLACK WALNUT	10	100
HAMAMELIS VIRGINIANA	WITCH HAZEL	10	100
HELSIA CAROLINA	SILVERBELL	10	100
CARYA GLABRA	PIGNUT HICKORY	15	150
		100	1,000



TYPICAL PLANTING ZONES
NOT TO SCALE

SUBMITTED WITH RESTORATION PLAN	11/05

SYM.	DESCRIPTION	DATE	APPROVED

REVISIONS

Ecosystem Enhancement PROGRAM

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

JOHNSON SITE -UT TO LITTLE HUNTING CREEK STREAM RESTORATION PROJECT

HAMPTONVILLE, IREDELL COUNTY, NORTH CAROLINA

STATION 10+00 TO 20+50

DATE: NOV. 2005
SCALE: 1" = 50'

PLANTING PLAN

PLANTING PLAN

SHEET 11 OF 11

DATE: NOV. 2005

SCALE: 1" = 50'

JOHNSON SITE -UT TO LITTLE HUNTING CREEK STREAM RESTORATION PROJECT

HAMPTONVILLE, IREDELL COUNTY, NORTH CAROLINA

STATION 20+50 TO 31+56

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

Ecosystem Enhancement PROGRAM

SYM.	DESCRIPTION	DATE	APPROVED
	SUBMITTED WITH RESTORATION PLAN	11 / 05	

REVISIONS

7.0 SEDIMENT TRANSPORT ANALYSIS

A stable channel is able to move the sediment supplied by its watershed without aggrading or degrading. This ability is evaluated through two parameters: competency and capacity. Competency is the channel's ability to move particles of a certain size, expressed as units of Pascals (Pa) or lbs/ft^2. Capacity is the channel's ability to move a specific volume of sediment (sediment discharge). Sediment discharge is the amount of sediment moving through a cross section over a specified period of time, expressed in dimensionless parameters or as mass or weight units of kg/sec or lbs/sec.

7.1 Competency

There is a threshold level of bedload sediment movement that will result in a noticeable change in the channel bed. The flow associated with this threshold movement is the reference condition that sediment transport models are based on. 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.

Entrainment is the condition that initiates the movement of a selected particle size in the presence of a mix grade channel bed. 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 (the channel competency) is used in the design of the restored stream channel. The preferred method of determining this particle size and flow condition is by direct measurement, however a stream gage can be installed to measure the stream channel's response to rain events and scour chains installed to measure the depth of scour during these events. The bed material above the scour chain can be collected and sieved to determine the material sizes in transport for a known recorded flow event.

The scour chain method was attempted at the Johnson Site. In addition, the channel was sampled by the pebble count method at several sites for trend analysis. Subsurface sediment was also sampled at one scour chain site for comparison to collected scour chain data. The UTLHC streambed is compacted with gravels and sands cemented between larger cobbles. A wash load of predominantly sand covers these materials. This is reflected in the distribution of the surface samples (pebble counts). After 10 months of monitoring (separated over two contract periods), no significant scour events were recorded. Wash load is being transported as existing deposition has changed over time following several storm events. After these attempts failed to yield results, two bar samples were used to determine if a design shear stress could be calculated from the Wilcock-Crowe (2003) model.

In balanced streams, a point bar sample at the "1/3, 1/3" location can be an indicator of annual sediment transport. The bar samples were compared with the subsurface sample taken at the chain location. The model produced an average shear stress condition that would be used in stream design to move the largest particles expected to be in the sediment transport over the expected gradation of the stream channel.

This shear stress was used for the design 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)

The target shear stress value (0.48 lbs/ft^2) converted to a shear-velocity for the design cross-section was u* = 0.15 m/s. This shear velocity is sufficient to move the d_{84} particle size for each of the bar samples and subsurface sample on the UTLHC.

7.2 Capacity

A capacity analysis was not conducted for the Johnson Site, as UTLHC currently functions as a transport reach. UTLHC flushes its bed during storm events. It is not realistic to base a capacity model on a flushed bed since the bed composition cannot predict the movement of the fines that comprise the bulk of the current bedload sediment transport.

8.0 FLOODING ANALYSIS

The downstream section of UTLHC, below the 48"CMP is located within the 100-year flood zone for Little Hunting Creek. However, UTLHC is not located in a Federal Emergency Management Agency (FEMA) Detailed Flood Study Zone. It is the intent of the restoration design to maintain the 100-year flood elevation at or below the current stages following restoration. A proposed hydrology and hydraulics (H&H) summary will be submitted with a letter indicating that an increase in the 100-year flood elevation is not anticipated (No-Rise Certification).

9.0 MONITORING AND EVALUATION

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. 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."

9.1 Duration

The first scheduled monitoring will be conducted at the end of the first full growing season following project completion. Monitoring shall subsequently be conducted annually for a total period of five (5) years.

9.2 Reporting

Monitoring reports will be prepared and submitted after all monitoring tasks for each monitoring event are completed. Each report will provide the new monitoring data and compare the new data against previous findings. Data tables, cross sections, profiles, photographs and other graphics will be included in the report as necessary. Each report will include a discussion of any significant deviations from the as-built survey and previous annual measurements, as well as evaluations as to whether the changes indicate a stabilizing or de-stabilizing condition.

9.3 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, a longitudinal profile, 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 as well as 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.

9.3.1 Dimension

Seven permanent cross-sections on UTLHC will be established and used to evaluate stream dimension. Four of the cross-sections will be riffles and three will be pools. Permanent monuments will be established by either conventional survey or GPS. The cross-section surveys shall provide a detailed measurement of the stream and banks, to include points at bankfull, at all breaks in slope, and the thalweg. Subsequently, width/depth ratios and entrenchment ratios will be calculated for each cross-section.

Cross-section measurements should show little 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.

9.3.2 Pattern

Measurements associated with the restored channel pattern will include belt width, meander length, and radius of curvature.

9.3.3 Profile

A longitudinal profile of the entire restored channel will be surveyed. 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.

9.3.4 Bed Materials

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

9.4 Photograph Reference Points

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

9.4.1 Cross-section Photograph Reference Points

A photograph will be taken at each permanent cross section. The survey tape will be centered in each photograph and the water line will be located near the lower edge. Effort will be made to consistently show the same area in annual photographs.

9.4.2 Longitudinal Photograph Reference Points

Ten (10) permanent points will be established longitudinally throughout the project site to allow further photo-documentation of the restored stream channel condition.

9.4.3 Additional Photograph Locations

Additional PRPs will be located, as needed, to document the condition of specific in-stream structures such as cross vanes, as well as infrastructure associated with the stream such as the stabilized crossing and the pipe that bisects the project reach.

9.5 Vegetation Monitoring

The success of the riparian buffer plantings will be evaluated using 11 (5% of total buffer area) ten by ten meter (10m x 10m) vegetative sampling plots. 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.

10.0 REFERENCES

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. New York: W.H. Freeman and Company.

Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J. R. Everhart, and R.E. Smith, 1999. Bankfull Hydraulic Geometry Relationships for North Carolina Streams. Wildland Hydrology. AWRA Symposium Proceedings. Edited by D.S. Olsen and J.P. Potyondy. American Water Resources Association. June 30 – July 2, 1999. Bozeman, MT.

Harrelson, C.C., C.L. Rawlins, and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. General Technical Report RM-245. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

KCI Associates of NC, P.A. 2003. "Mitigation Feasibility Study", Report for the North Carolina Department of Transportation, Raleigh, NC.

NCDENR. 2001. "Guidelines for Riparian Buffer Restoration." Division of Water Quality, Wetlands Restoration Program, Raleigh, NC.

NCDENR. "Water Quality Stream Classification for Streams in North Carolina." Water Quality Section. http://h2o.enr.state.nc.us/bims/reports/basinsandwaterbodies (September, 2002).

NCGS. 1985. Geologic Map of North Carolina

Rosgen, D.L. 1994. A classification of natural rivers. Catena 22: 169-199.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, CO.

Rosgen, D.L. 1997. A geomorphological approach to restoration of incised rivers. In: Wang, S.S.Y., E.J. Langendoen, and F.D. Shields, Jr. (Eds.). Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. pp. 12-22.

Rosgen, D.L. 1998. The Reference Reach – a Blueprint for Natural Channel Design. Presented at ASCE Conference, Denver, CO – June, 1998.

Rosgen, D.L. 2002. "Natural Channel Design Methodology (40 Steps)." Natural Channel Design and River Restoration Short Course, Pagosa Springs, CO – October, 2002.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina, 3rd Approximation. North Carolina Natural Heritage Program, NCDEHNR, Division of Parks and Recreation. Raleigh, NC.

Wilcock, P., and J. Crowe. 2003. "A Surface-Based Transport Model for Sand and Gravel." *ASCE Journal of Hydraulic Engineering*, ASCE, 129(2), pp 120-128.

Appendix A
Cultural Resources Review

Job#1202084 B
Johnson Creek

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Parks and Recreation

Michael F. Easley, Governor William G. Ross, Jr., Secretary Philip K. McKnelly, Director

December 16, 2002

Ms. Kimberly A. Burton
KCI Associates of North Carolina, P.A.
Landmark Center I, Suite 200
4601 Six Forks Road
Raleigh, NC 27609

Subject: Stream Restoration Site, near Hunting Creek Road and US 21, Iredell County
KCI Job #: 1202084

Dear Ms. Burton:

The Natural Heritage Program has no record of rare species, significant natural communities, or priority natural areas at the site nor within 1/2-mile of the site. We do have several identified natural areas located south of Hunting Creek, within the 1-mile radius of the site location. These sites presumably would not be impacted by the proposed work. If you wish to obtain information about these areas, please let me know.

Although our maps do not show records of natural heritage elements in the immediate project area, it does not necessarily mean that they are not present. It may simply mean that the area has not been surveyed. The use of Natural Heritage Program data should not be substituted for actual field surveys, particularly if the project area contains suitable habitat for rare species, significant natural communities, or priority natural areas.

You may wish to check the Natural Heritage Program database website at <www.ncsparks.net/nhp/search.html> 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 919-715-8687 if you have questions or need further information.

Sincerely,

Harry E. LeGrand, Jr.

Harry E. LeGrand, Jr., Zoologist
Natural Heritage Program

HEL/hel

1615 Mail Service Center, Raleigh, North Carolina 27699-1615
Phone: 919-733-4181 \ Fax: 919-715-3085 \ Internet: www.ncsparks.net

North Carolina Department of Cultural Resources
State Historic Preservation Office
David L. S. Brook, Administrator

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

Division of Historical Resources
David J. Olson, Director

February 3, 2003

Mr. Gary M. Mryncza, HIT
Project Manager
KCI Associates of NC
Landmark Center I, Suite 200
4601 Six Forks Road
Raleigh, NC 27609

Re: Johnson Property Mitigation Site , Potential Stream Restoration Project, Hamptonville, Iredell County, ER 03-0092

Dear Mr. Mryncza:

Thank you for your letter of January 7, 2003, concerning the above project.

We have conducted a review of the proposed undertaking and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the undertaking as proposed.

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. In all future communication concerning this project, please cite the above referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for David Brook

DB:pmm

Appendix B
Site Photographs

Johnson Site Stream Restoration Plan
Photograph Log

Photograph 1 – Cattle access the stream below Station 10+40. Stream is highly unstable below "fenced out" area.

Photograph 2 – Looking upstream at Station 10+40 (fence line). Proposed stream restoration activities would begin at this location.

Photograph 3 – Tributary 1 (UT1), looking northwest. This system is fed by seeps from the hillside.

Photograph 4 – Cross section UT1-1, looking downstream. Cattle have access to each of the tributaries on the west side of UTLHC.

Photograph 5 – Elevated view of cross section 1, near Station 11+53.

Photograph 6 – Confluence of Tributary 2 (UT2) with UTLHC.

Photograph 7 – Four-inch PVC pipe drains water from pond into UT2.

Photograph 8 – UT2 looking downstream towards the confluence with UTLHC.

Photograph 9 – Fence line at Station 13+40. This fence divides the cattle groups. The group on the south side of the fence will be redirected as part of the management strategies.

Photograph 10 – Cattle access/damage to the hill slope from Station 13+40. This disturbance provides high sediment supply to the system.

Photograph 11 – Looking southwest, view of potential buffer restoration area, adjacent to the east side of UTLHC.

Photograph 12 – Cross section 2 (Station 16+62).

Photograph 13 – Bedrock outcrops and rock step sequence below cross section 2 (looking upstream).

Photograph 14 – Cross section 3 (Station 19+15). Banks are high and nearly vertical throughout this reach.

Photograph 15 – Formation of gully (gully erosion).

Photograph 16 – Proposed cattle crossing location (looking west).

Photograph 17 – Forty-eight inch CMP conveys stream flow under dirt road leading to the northwest portion of the Johnson property.

Photograph 18 – Typical view downstream of the pipe (approximately Station 24+00). Banks are greater than six feet high.

Photograph 19 – Elevated view of section immediately downstream of the pipe.

Photograph 20 – Cross section 4 (Station 26+22).

Photograph 21 – Natural bedrock feature directs flow to the center of the channel (Station 26+50).

Photograph 22 – Roadside drainage from Hunting Creek Road drains to UTLHC via rock lined channel.

Photograph 23 – Cross section 5 (Station 30+27).

Photograph 24 – Cross section 6 (Station 31+48).

Photograph 25 – Confluence of UTLHC with Little Hunting Creek. Downstream project limits.

Photograph 26 – Power poles and guy wires adjacent to the south bank of UTLHC. Locations are approximated on Figure 5 – Existing Conditions.

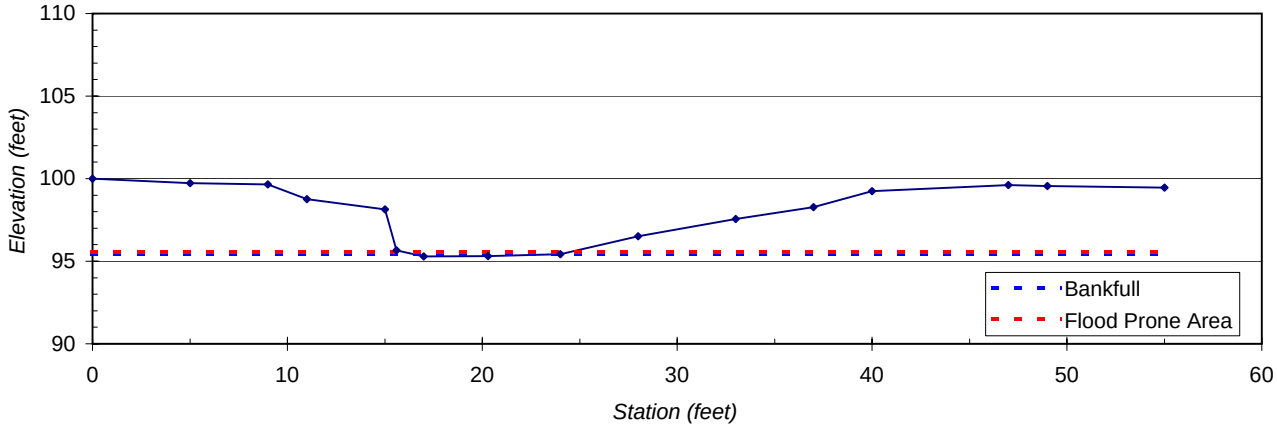
Appendix C
Existing Conditions (Streams and Hydrology)

River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS# UT1
Drainage Area (sq mi):	Less than 10 acres
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	9.86	100.00
5.0	10.14	99.72
9.0	10.21	99.65
11.0	11.10	98.76
15.0	11.72	98.14
15.6	14.21	95.65
17.0	14.56	95.30
20.3	14.55	95.31
24.0	14.43	95.43
28.0	13.34	96.52
33.0	12.30	97.56
37.0	11.59	98.27
40.0	10.62	99.24
47.0	10.25	99.61
49.0	10.30	99.56
55.0	10.40	99.46

SUMMARY DATA	
Bankfull Elevation:	95.42
Bankfull Cross-Sectional Area:	0.60
Bankfull Width:	7.17
Flood Prone Area Elevation:	95.54
Flood Prone Width:	8.36
Max Depth at Bankfull:	0.12
Mean Depth at Bankfull:	0.08
W / D Ratio:	85.7
Entrenchment Ratio:	1.17
Bank Height Ratio:	32.83
Slope (ft/ft):	0.035
Discharge (cfs)	1

Stream Type:	F5b/F6b

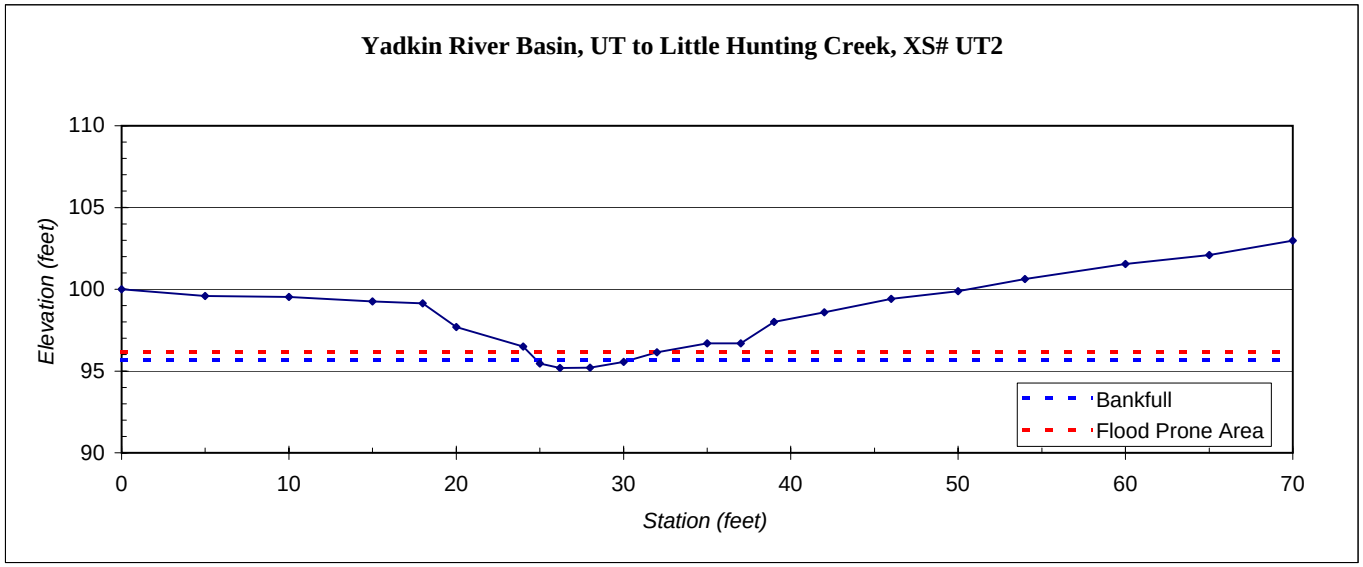


River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS# UT2
Drainage Area (sq mi):	Less than 10 acres (Impoundment)
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	4.43	100.00
5.0	4.84	99.59
10.0	4.90	99.53
15.0	5.17	99.26
18.0	5.30	99.13
20.0	6.73	97.70
24.0	7.93	96.50
25.0	8.97	95.46
26.2	9.25	95.18
28.0	9.23	95.20
30.0	8.87	95.56
32.0	8.29	96.14
35.0	7.73	96.70
37.0	7.74	96.69
39.0	6.43	98.00
42.0	5.83	98.60
46.0	5.01	99.42
50.0	4.55	99.88
54.0	3.81	100.62
60.0	2.88	101.55
65.0	2.34	102.09
70.0	1.46	102.97

SUMMARY DATA	
Bankfull Elevation:	95.68
Bankfull Cross-Sectional Area:	2.00
Bankfull Width:	5.63
Flood Prone Area Elevation:	96.18
Flood Prone Width:	7.91
Max Depth at Bankfull:	0.50
Mean Depth at Bankfull:	0.36
W / D Ratio:	15.8
Entrenchment Ratio:	1.40
Bank Height Ratio:	7.90
Slope (ft/ft):	0.055
Discharge (cfs)	4

Stream Type:	B5a/B6a

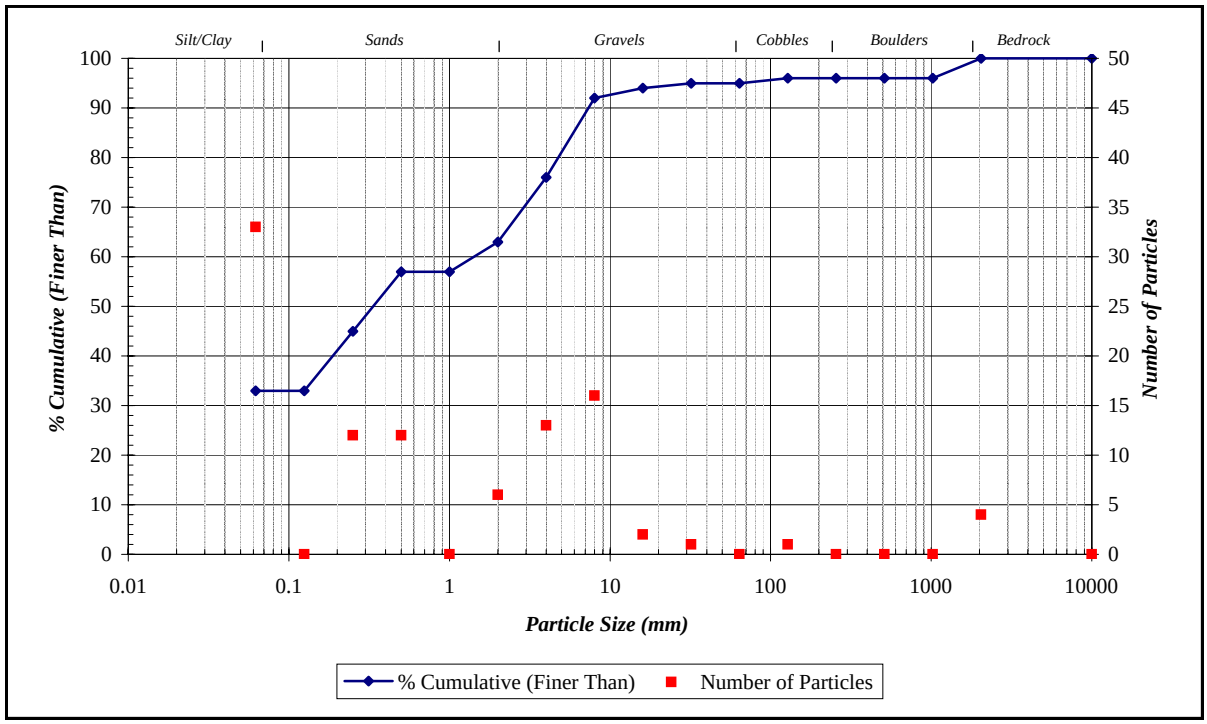


Johnson Site Stream Restoration Project

Existing Conditions

Stream:	UT to Little Hunting Creek
Location:	Cross-section # UT2
Date:	

Particle		Size Range (mm)	Total #	Item %	% Cum.
S/C	Silt/Clay	0 < 0.062	33	33	33
Sand	Very Fine Sand	0.062 < 0.125	0	0	33
	Fine Sand	0.125 < 0.25	12	12	45
	Medium Sand	0.25 < 0.50	12	12	57
	Coarse Sand	0.50 < 1.0	0	0	57
	Very Coarse Sand	1 < 2	6	6	63
Gravel	Very Fine Gravel	2 < 4	13	13	76
	Fine Gravel	4 < 8	16	16	92
	Medium Gravel	8 < 16	2	2	94
	Coarse Gravel	16 < 32	1	1	95
	Very Coarse Gravel	32 < 64	0	0	95
Cbl	Small Cobble	64 < 128	1	1	96
	Large Cobble	128 < 256	0	0	96
Bldr	Small Boulder	256 < 512	0	0	96
	Medium Boulder	512 < 1024	0	0	96
	Large Boulder	1024 < 2048	4	4	100
Bdrk	Bedrock	Bedrock	0	0	100
		Totals:	100	100	100



Size percent less than (mm)				
D16	D35	D50	D84	D95
<0.062	0.14	0.35	6.2	32

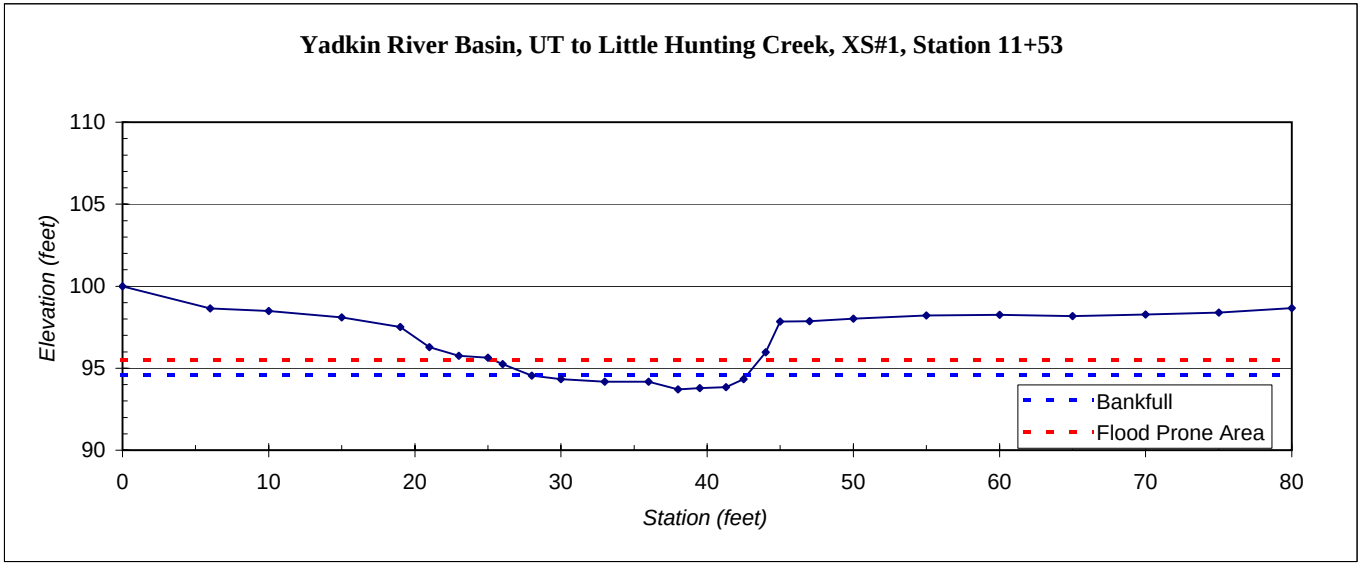
Percent by substrate type (%)					
Silt/Clay	Sand	Gravel	Cobble	Boulder	Bedrock
33	30	32	1	4	0

River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS#1, Station 11+53
Drainage Area (sq mi):	0.10
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	4.24	100.00
6.0	5.59	98.65
10.0	5.75	98.49
15.0	6.15	98.09
19.0	6.73	97.51
21.0	7.96	96.28
23.0	8.48	95.76
25.0	8.60	95.64
26.0	9.00	95.24
28.0	9.69	94.55
30.0	9.90	94.34
33.0	10.06	94.18
36.0	10.06	94.18
38.0	10.54	93.70
39.5	10.45	93.79
41.3	10.40	93.84
42.5	9.90	94.34
44.0	8.27	95.97
45.0	6.40	97.84
47.0	6.38	97.86
50.0	6.23	98.01
55.0	6.03	98.21
60.0	5.98	98.26
65.0	6.07	98.17
70.0	5.97	98.27
75.0	5.84	98.40
80.0	5.57	98.67

SUMMARY DATA	
Bankfull Elevation:	94.61
Bankfull Cross-Sectional Area:	7.40
Bankfull Width:	14.92
Flood Prone Area Elevation:	95.52
Flood Prone Width:	18.29
Max Depth at Bankfull:	0.91
Mean Depth at Bankfull:	0.50
W / D Ratio:	30.1
Entrenchment Ratio:	1.23
Bank Height Ratio:	4.55
Slope (ft/ft):	0.005
Discharge (cfs)	14

Stream Type:	F5/F6

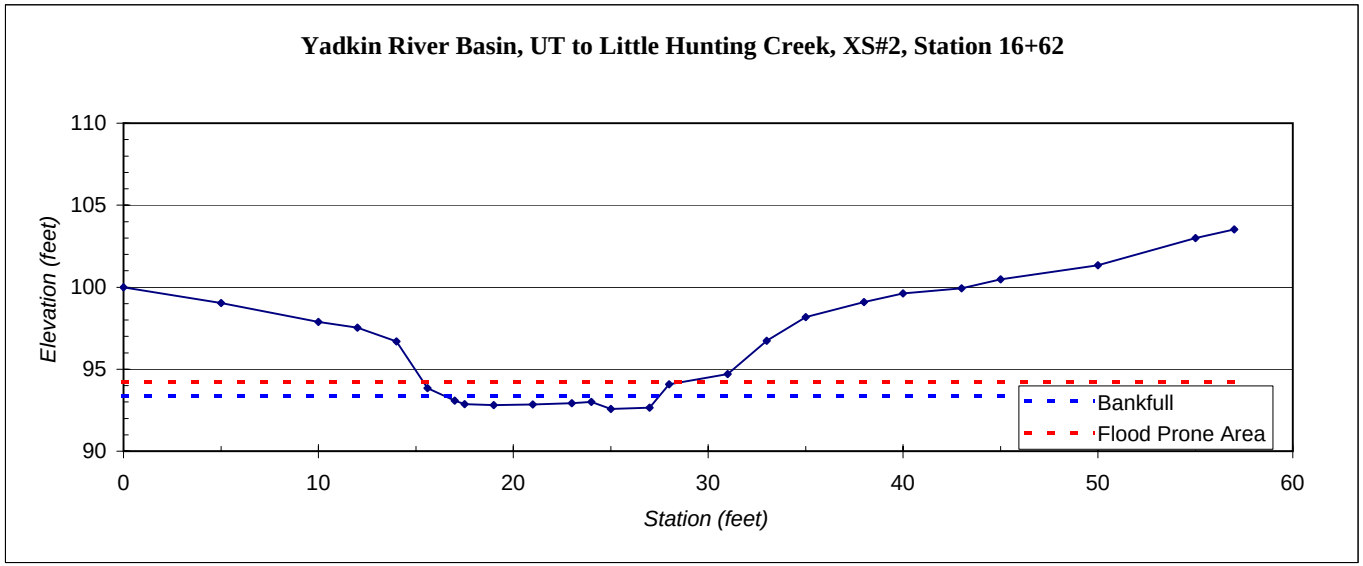


River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS#2, Station 16+62
Drainage Area (sq mi):	0.12
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	4.12	100.00
5.0	5.08	99.04
10.0	6.23	97.89
12.0	6.58	97.54
14.0	7.43	96.69
15.6	10.28	93.84
17.0	11.04	93.08
17.5	11.25	92.87
19.0	11.31	92.81
21.0	11.27	92.85
23.0	11.19	92.93
24.0	11.11	93.01
25.0	11.55	92.57
27.0	11.47	92.65
28.0	10.05	94.07
31.0	9.41	94.71
33.0	7.38	96.74
35.0	5.95	98.17
38.0	5.02	99.10
40.0	4.50	99.62
43.0	4.18	99.94
45.0	3.65	100.47
50.0	2.79	101.33
55.0	1.12	103.00
57.0	0.60	103.52

SUMMARY DATA	
Bankfull Elevation:	93.39
Bankfull Cross-Sectional Area:	6.30
Bankfull Width:	11.33
Flood Prone Area Elevation:	94.21
Flood Prone Width:	13.26
Max Depth at Bankfull:	0.82
Mean Depth at Bankfull:	0.56
W / D Ratio:	20.4
Entrenchment Ratio:	1.17
Bank Height Ratio:	9.06
Slope (ft/ft):	0.013
Discharge (cfs)	20

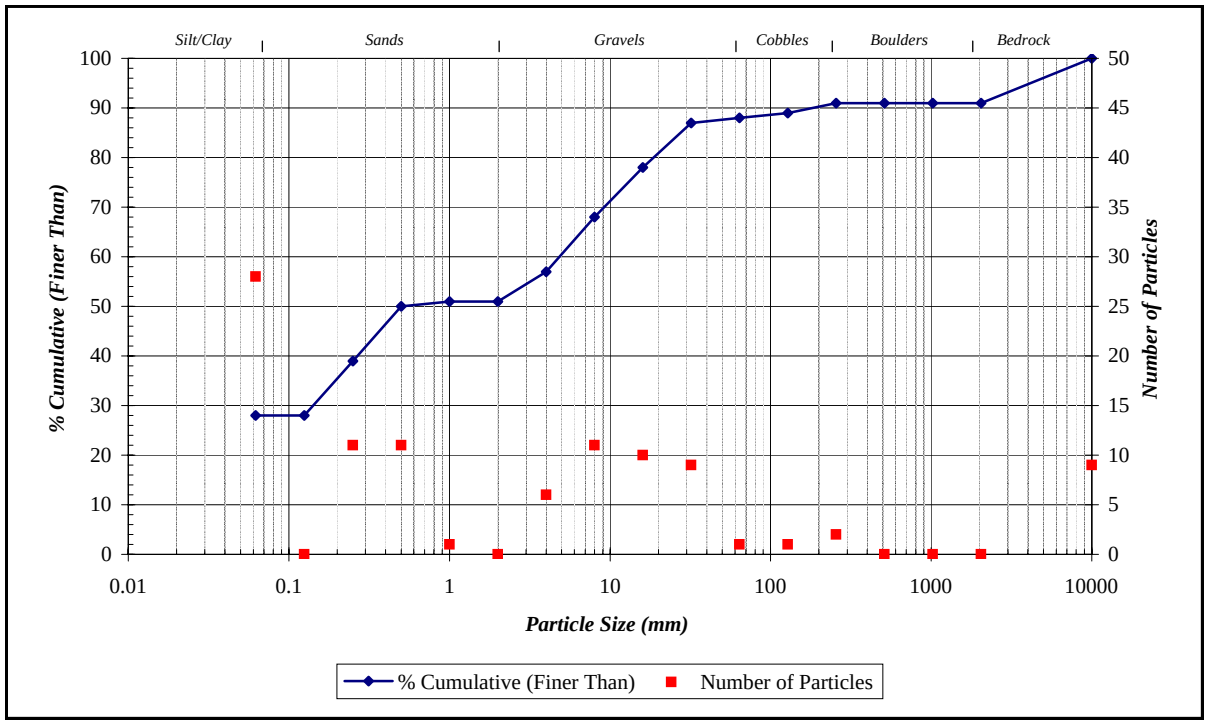
Stream Type:	F5



Johnson Site Stream Restoration Project
Existing Conditions

Stream:	UT to Little Hunting Creek
Location:	Cross-section #2 (Sta.16+62)
Date:	

Particle		Size Range (mm)	Total #	Item %	% Cum.
S/C	Silt/Clay	0 < 0.062	28	28	28
Sand	Very Fine Sand	0.062 < 0.125	0	0	28
	Fine Sand	0.125 < 0.25	11	11	39
	Medium Sand	0.25 < 0.50	11	11	50
	Coarse Sand	0.50 < 1.0	1	1	51
	Very Coarse Sand	1 < 2	0	0	51
Gravel	Very Fine Gravel	2 < 4	6	6	57
	Fine Gravel	4 < 8	11	11	68
	Medium Gravel	8 < 16	10	10	78
	Coarse Gravel	16 < 32	9	9	87
	Very Coarse Gravel	32 < 64	1	1	88
Cbl	Small Cobble	64 < 128	1	1	89
	Large Cobble	128 < 256	2	2	91
Bldr	Small Boulder	256 < 512	0	0	91
	Medium Boulder	512 < 1024	0	0	91
	Large Boulder	1024 < 2048	0	0	91
Bdrk	Bedrock	Bedrock	9	9	100
		Totals:	100	100	100



Size percent less than (mm)				
D16	D35	D50	D84	D95
<0.062	0.19	0.5	29	4000

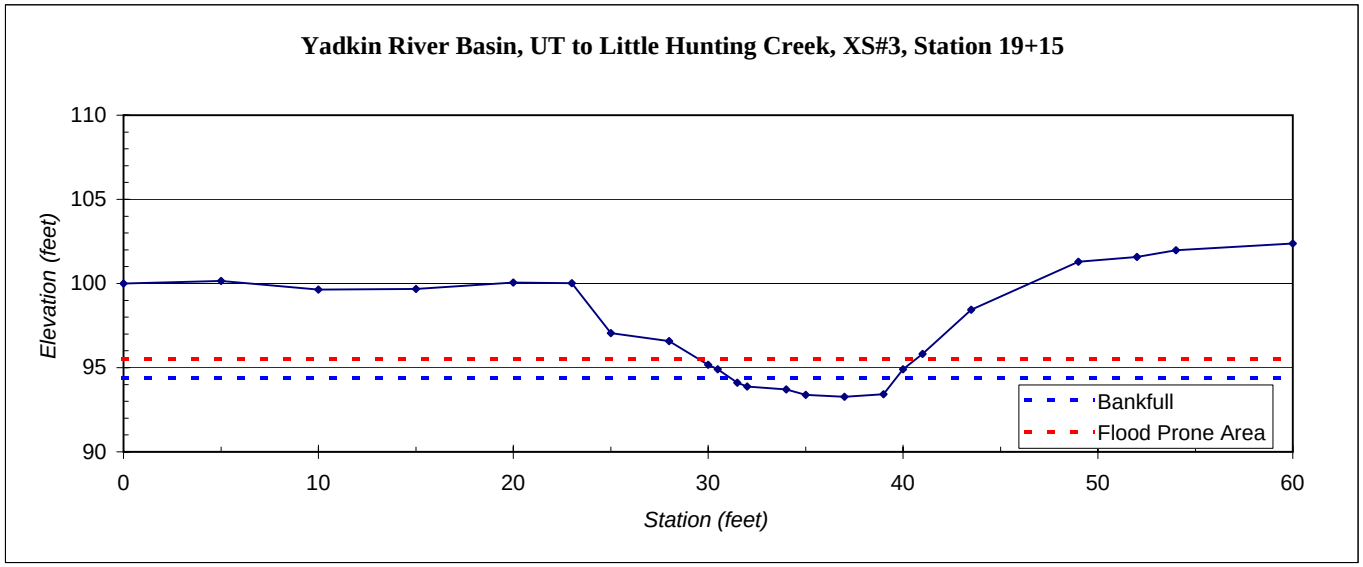
Percent by substrate type (%)					
Silt/Clay	Sand	Gravel	Cobble	Boulder	Bedrock
28	23	37	3	0	9

River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS#3, Station 19+15
Drainage Area (sq mi):	0.12
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	4.70	100.00
5.0	4.54	100.16
10.0	5.07	99.63
15.0	5.02	99.68
20.0	4.65	100.05
23.0	4.68	100.02
25.0	7.65	97.05
28.0	8.13	96.57
30.0	9.52	95.18
30.5	9.80	94.90
31.5	10.60	94.10
32.0	10.83	93.87
34.0	11.00	93.70
35.0	11.31	93.39
37.0	11.43	93.27
39.0	11.28	93.42
40.0	9.80	94.90
41.0	8.88	95.82
43.5	6.26	98.44
49.0	3.40	101.30
52.0	3.13	101.57
54.0	2.72	101.98
60.0	2.33	102.37

SUMMARY DATA	
Bankfull Elevation:	94.40
Bankfull Cross-Sectional Area:	6.90
Bankfull Width:	8.50
Flood Prone Area Elevation:	95.53
Flood Prone Width:	11.19
Max Depth at Bankfull:	1.13
Mean Depth at Bankfull:	0.81
W / D Ratio:	10.5
Entrenchment Ratio:	1.32
Bank Height Ratio:	5.97
Slope (ft/ft):	0.007
Discharge (cfs)	20

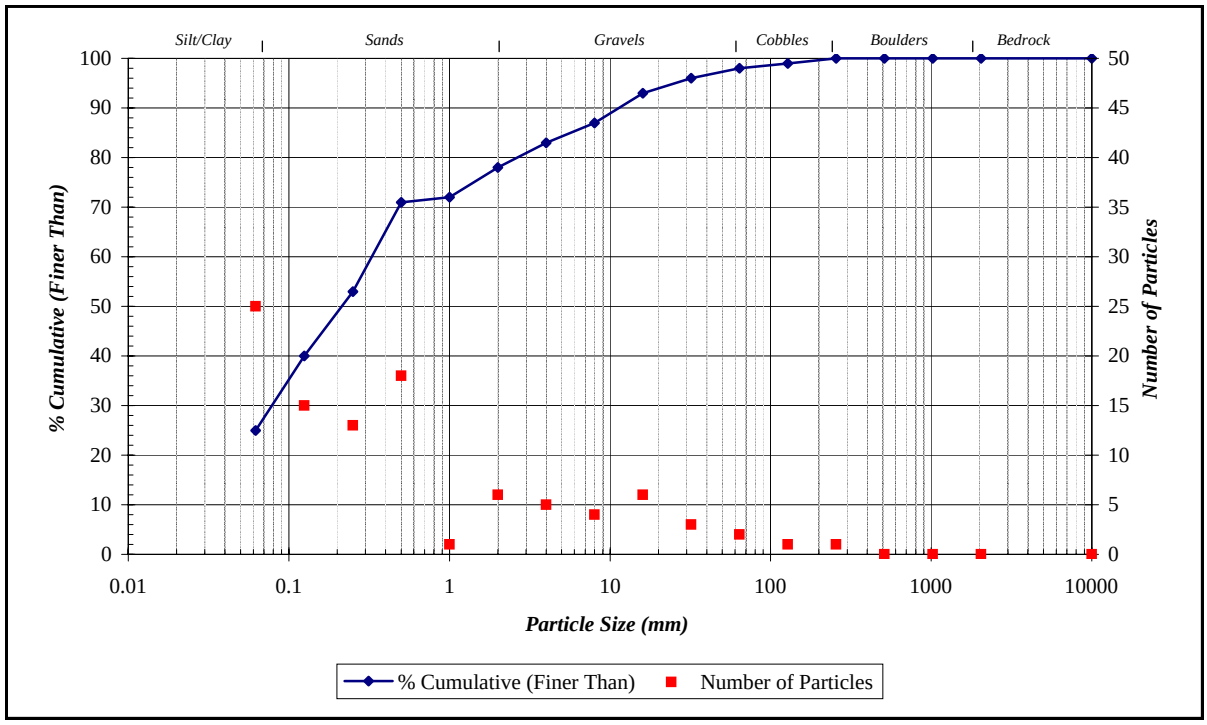
Stream Type:	B5c



Johnson Site Stream Restoration Project
Existing Conditions

Stream:	UT to Little Hunting Creek
Location:	Cross-section #3 (Sta 19+15)
Date:	

Particle		Size Range (mm)	Total #	Item %	% Cum.
S/C	Silt/Clay	0 < 0.062	25	25	25
Sand	Very Fine Sand	0.062 < 0.125	15	15	40
	Fine Sand	0.125 < 0.25	13	13	53
	Medium Sand	0.25 < 0.50	18	18	71
	Coarse Sand	0.50 < 1.0	1	1	72
	Very Coarse Sand	1 < 2	6	6	78
Gravel	Very Fine Gravel	2 < 4	5	5	83
	Fine Gravel	4 < 8	4	4	87
	Medium Gravel	8 < 16	6	6	93
	Coarse Gravel	16 < 32	3	3	96
	Very Coarse Gravel	32 < 64	2	2	98
Cbl	Small Cobble	64 < 128	1	1	99
	Large Cobble	128 < 256	1	1	100
Bldr	Small Boulder	256 < 512	0	0	100
	Medium Boulder	512 < 1024	0	0	100
	Large Boulder	1024 < 2048	0	0	100
Bdrk	Bedrock	Bedrock	0	0	100
		Totals:	100	100	100



Size percent less than (mm)				
D16	D35	D50	D84	D95
<0.062	0.1	0.23	5.2	26

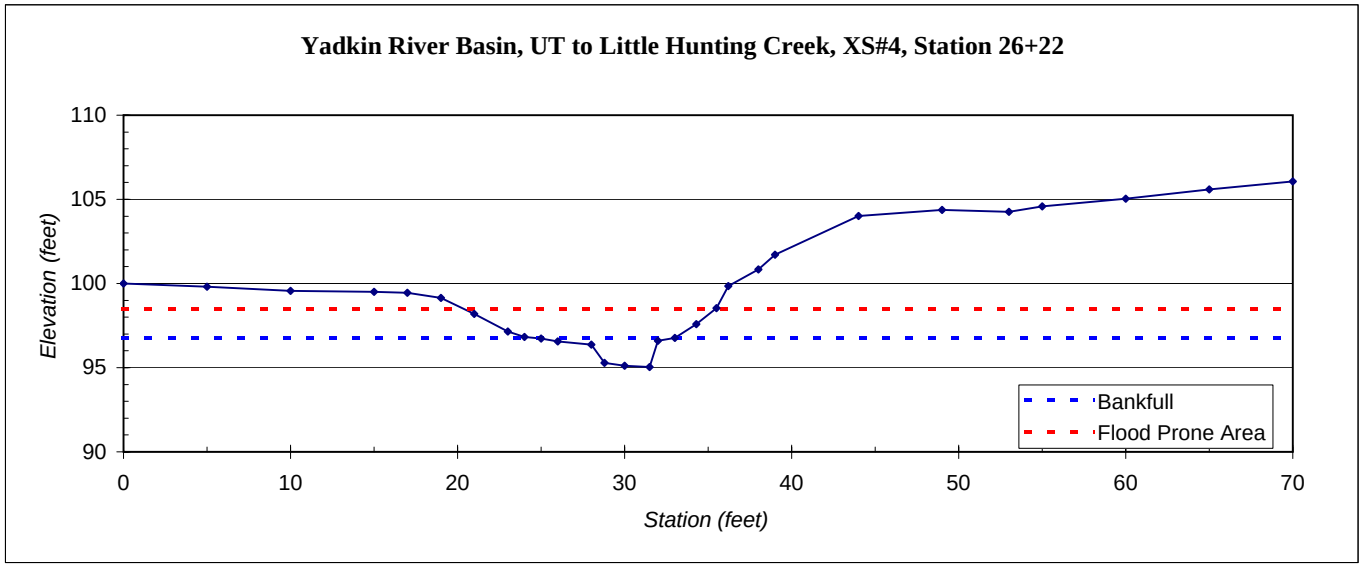
Percent by substrate type (%)					
Silt/Clay	Sand	Gravel	Cobble	Boulder	Bedrock
25	53	20	2	0	0

River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS#4, Station 26+22
Drainage Area (sq mi):	0.17
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	8.21	100.00
5.0	8.40	99.81
10.0	8.65	99.56
15.0	8.70	99.51
17.0	8.76	99.45
19.0	9.07	99.14
21.0	10.01	98.20
23.0	11.07	97.14
24.0	11.38	96.83
25.0	11.48	96.73
26.0	11.66	96.55
28.0	11.84	96.37
28.8	12.92	95.29
30.0	13.10	95.11
31.5	13.17	95.04
32.0	11.62	96.59
33.0	11.45	96.76
34.3	10.63	97.58
35.5	9.67	98.54
36.2	8.37	99.84
38.0	7.38	100.83
39.0	6.49	101.72
44.0	4.20	104.01
49.0	3.83	104.38
53.0	3.95	104.26
55.0	3.63	104.58
60.0	3.17	105.04
65.0	2.62	105.59
70.0	2.14	106.07

SUMMARY DATA	
Bankfull Elevation:	96.76
Bankfull Cross-Sectional Area:	6.40
Bankfull Width:	8.30
Flood Prone Area Elevation:	98.48
Flood Prone Width:	15.02
Max Depth at Bankfull:	1.72
Mean Depth at Bankfull:	0.77
W / D Ratio:	10.8
Entrenchment Ratio:	1.81
Bank Height Ratio:	2.56
Slope (ft/ft):	0.013
Discharge (cfs)	20

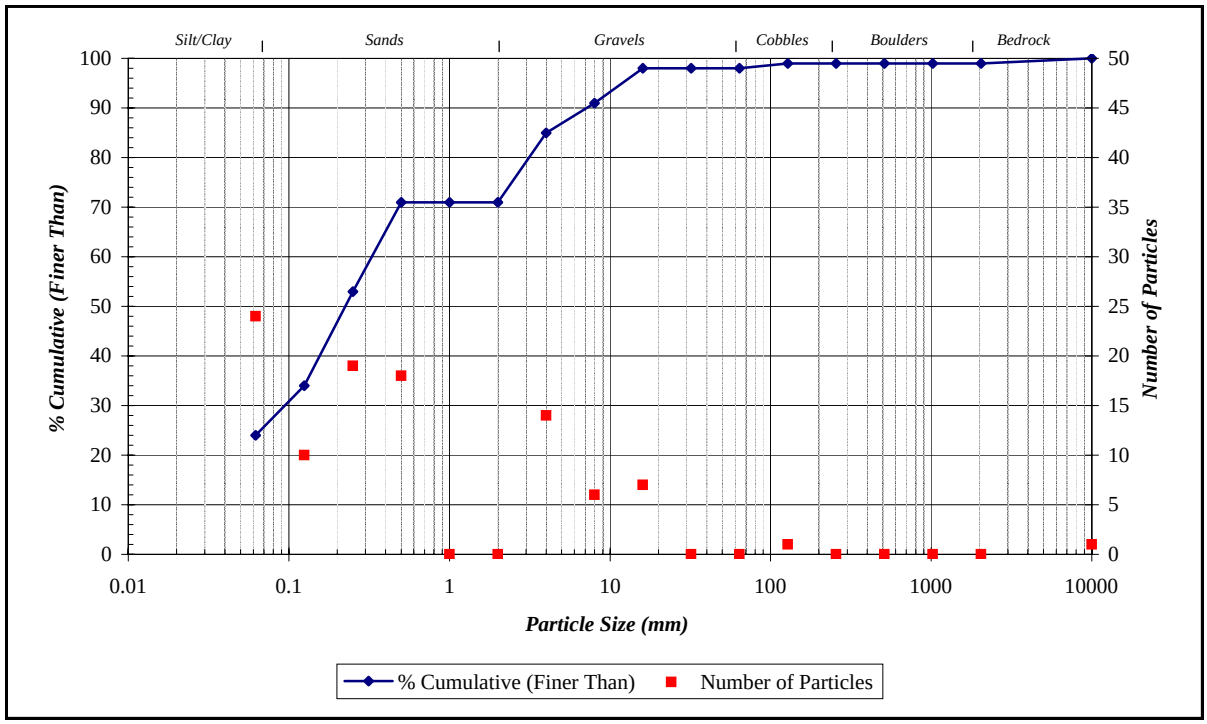
Stream Type:	B5c



Johnson Site Stream Restoration Project
Existing Conditions

Stream:	UT to Little Hunting Creek
Location:	Cross-section #4 (Sta 26+22)
Date:	

Particle		Size Range (mm)	Total #	Item %	% Cum.
S/C	Silt/Clay	0 < 0.062	24	24	24
Sand	Very Fine Sand	0.062 < 0.125	10	10	34
	Fine Sand	0.125 < 0.25	19	19	53
	Medium Sand	0.25 < 0.50	18	18	71
	Coarse Sand	0.50 < 1.0	0	0	71
	Very Coarse Sand	1 < 2	0	0	71
Gravel	Very Fine Gravel	2 < 4	14	14	85
	Fine Gravel	4 < 8	6	6	91
	Medium Gravel	8 < 16	7	7	98
	Coarse Gravel	16 < 32	0	0	98
	Very Coarse Gravel	32 < 64	0	0	98
Cbl	Small Cobble	64 < 128	1	1	99
	Large Cobble	128 < 256	0	0	99
Bldr	Small Boulder	256 < 512	0	0	99
	Medium Boulder	512 < 1024	0	0	99
	Large Boulder	1024 < 2048	0	0	99
Bdrk	Bedrock	Bedrock	1	1	100
		Totals:	100	100	100



Size percent less than (mm)				
D16	D35	D50	D84	D95
<0.062	0.126	0.23	3.9	13

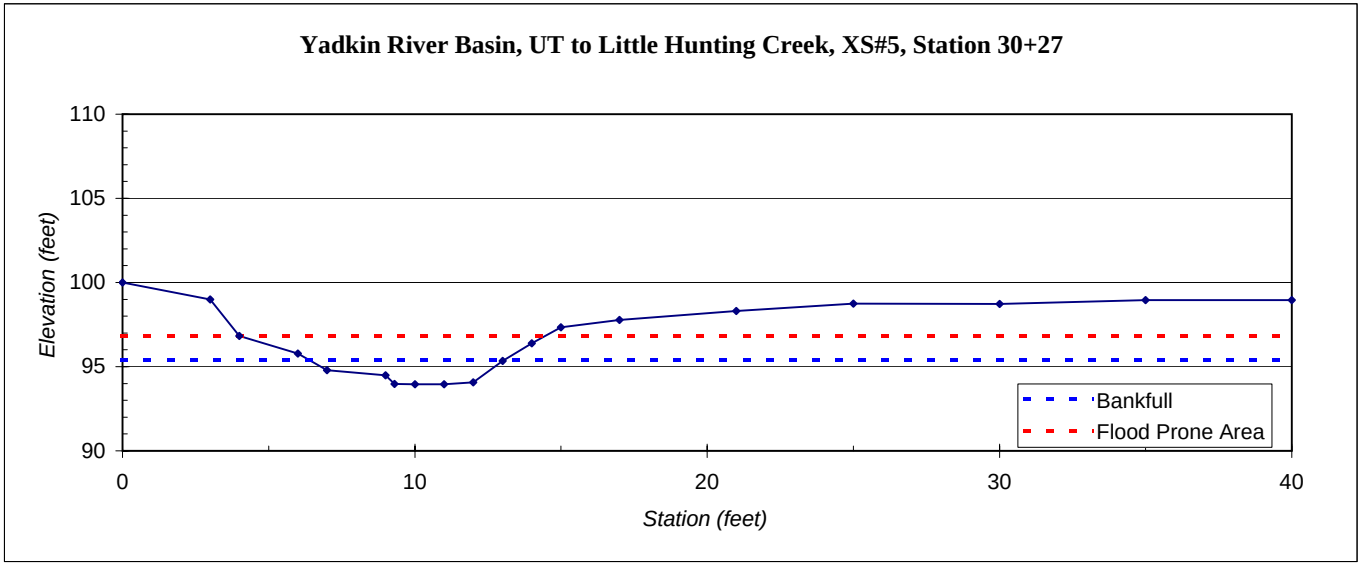
Percent by substrate type (%)					
Silt/Clay	Sand	Gravel	Cobble	Boulder	Bedrock
24	47	27	1	0	1

River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS#5, Station 30+27
Drainage Area (sq mi):	0.17
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	2.29	100.00
3.0	3.30	98.99
4.0	5.46	96.83
6.0	6.51	95.78
7.0	7.50	94.79
9.0	7.80	94.49
9.3	8.32	93.97
10.0	8.33	93.96
11.0	8.33	93.96
12.0	8.23	94.06
13.0	6.94	95.35
14.0	5.90	96.39
15.0	4.96	97.33
17.0	4.51	97.78
21.0	3.98	98.31
25.0	3.54	98.75
30.0	3.56	98.73
35.0	3.34	98.95
40.0	3.34	98.95

SUMMARY DATA	
Bankfull Elevation:	95.40
Bankfull Cross-Sectional Area:	6.60
Bankfull Width:	6.70
Flood Prone Area Elevation:	96.84
Flood Prone Width:	10.48
Max Depth at Bankfull:	1.44
Mean Depth at Bankfull:	0.99
W / D Ratio:	6.8
Entrenchment Ratio:	1.56
Bank Height Ratio:	3.33
Slope (ft/ft):	0.009
Discharge (cfs)	21

Stream Type:	G5c

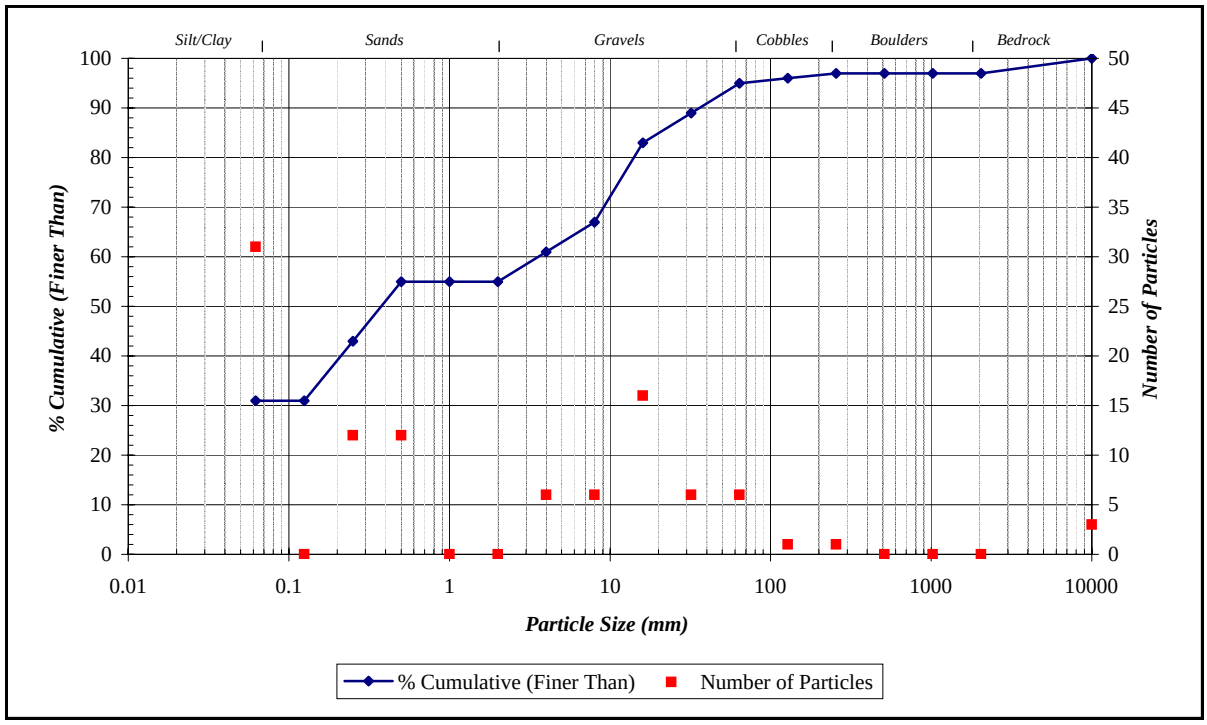


Johnson Site Stream Restoration Project

Existing Conditions

Stream:	UT to Little Hunting Creek
Location:	Cross-section #5 (Sta 30+27)
Date:	

Particle		Size Range (mm)	Total #	Item %	% Cum.
S/C	Silt/Clay	0 < 0.062	31	31	31
Sand	Very Fine Sand	0.062 < 0.125	0	0	31
	Fine Sand	0.125 < 0.25	12	12	43
	Medium Sand	0.25 < 0.50	12	12	55
	Coarse Sand	0.50 < 1.0	0	0	55
	Very Coarse Sand	1 < 2	0	0	55
Gravel	Very Fine Gravel	2 < 4	6	6	61
	Fine Gravel	4 < 8	6	6	67
	Medium Gravel	8 < 16	16	16	83
	Coarse Gravel	16 < 32	6	6	89
	Very Coarse Gravel	32 < 64	6	6	95
Cbl	Small Cobble	64 < 128	1	1	96
	Large Cobble	128 < 256	1	1	97
Bldr	Small Boulder	256 < 512	0	0	97
	Medium Boulder	512 < 1024	0	0	97
	Large Boulder	1024 < 2048	0	0	97
Bdrk	Bedrock	Bedrock	3	3	100
		Totals:	100	100	100



Size percent less than (mm)				
D16	D35	D50	D84	D95
<0.062	0.16	0.38	19	64

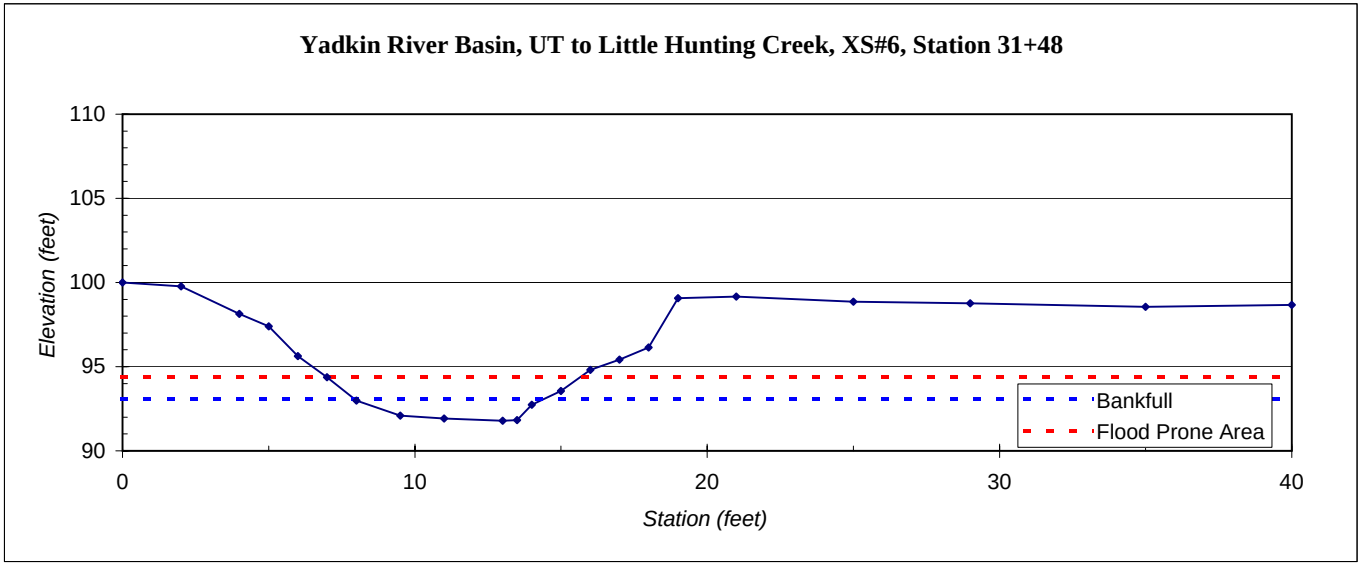
Percent by substrate type (%)					
Silt/Clay	Sand	Gravel	Cobble	Boulder	Bedrock
31	24	40	2	0	3

River Basin:	Yadkin
Watershed:	UT to Little Hunting Creek
XS ID	XS#6, Station 31+48
Drainage Area (sq mi):	0.17
Date:	Verified 6/05
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	2.85	100.00
2.0	3.07	99.78
4.0	4.72	98.13
5.0	5.45	97.40
6.0	7.22	95.63
7.0	8.48	94.37
8.0	9.87	92.98
9.5	10.75	92.10
11.0	10.93	91.92
13.0	11.07	91.78
13.5	11.02	91.83
14.0	10.12	92.73
15.0	9.29	93.56
16.0	8.04	94.81
17.0	7.44	95.41
18.0	6.70	96.15
19.0	3.79	99.06
21.0	3.69	99.16
25.0	3.99	98.86
29.0	4.09	98.76
35.0	4.29	98.56
40.0	4.18	98.67

SUMMARY DATA	
Bankfull Elevation:	93.10
Bankfull Cross-Sectional Area:	6.40
Bankfull Width:	6.70
Flood Prone Area Elevation:	94.42
Flood Prone Width:	8.73
Max Depth at Bankfull:	1.32
Mean Depth at Bankfull:	0.96
W / D Ratio:	7.0
Entrenchment Ratio:	1.30
Bank Height Ratio:	5.52
Slope (ft/ft):	0.014
Discharge (cfs)	27

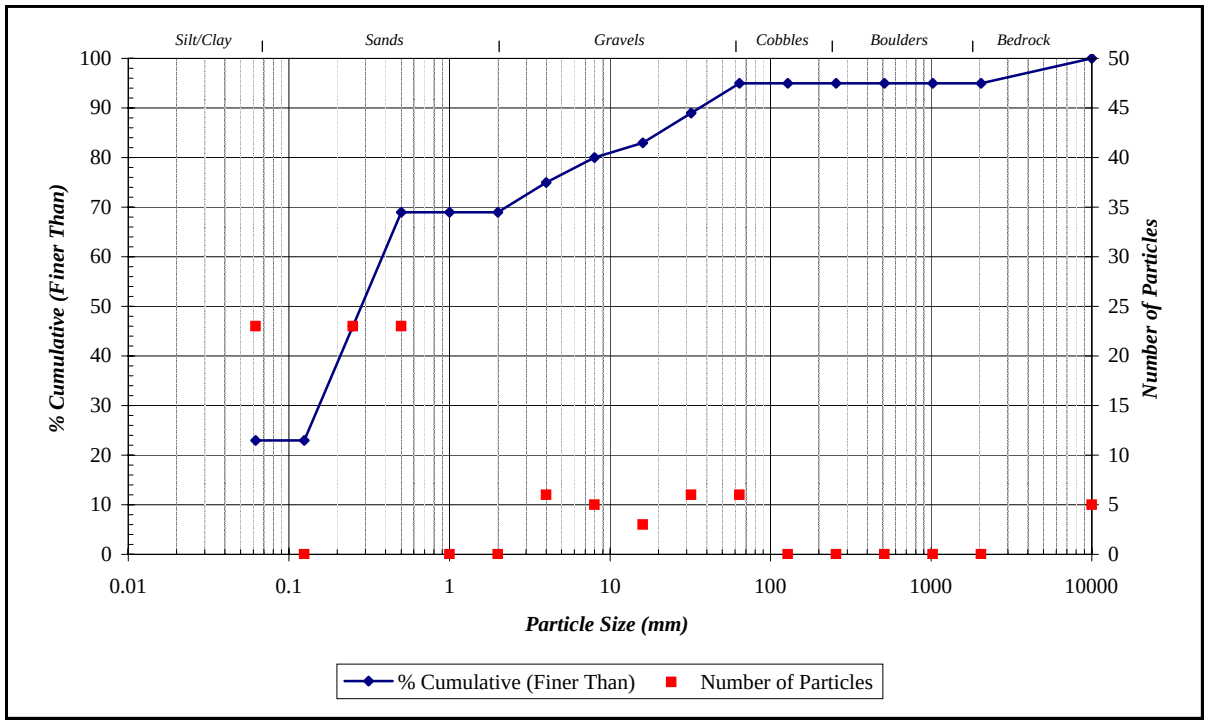
Stream Type:	G5c



Johnson Site Stream Restoration Project
Existing Conditions

Stream:	UT to Little Hunting Creek
Location:	Cross-section #6 (Sta 31+48)
Date:	

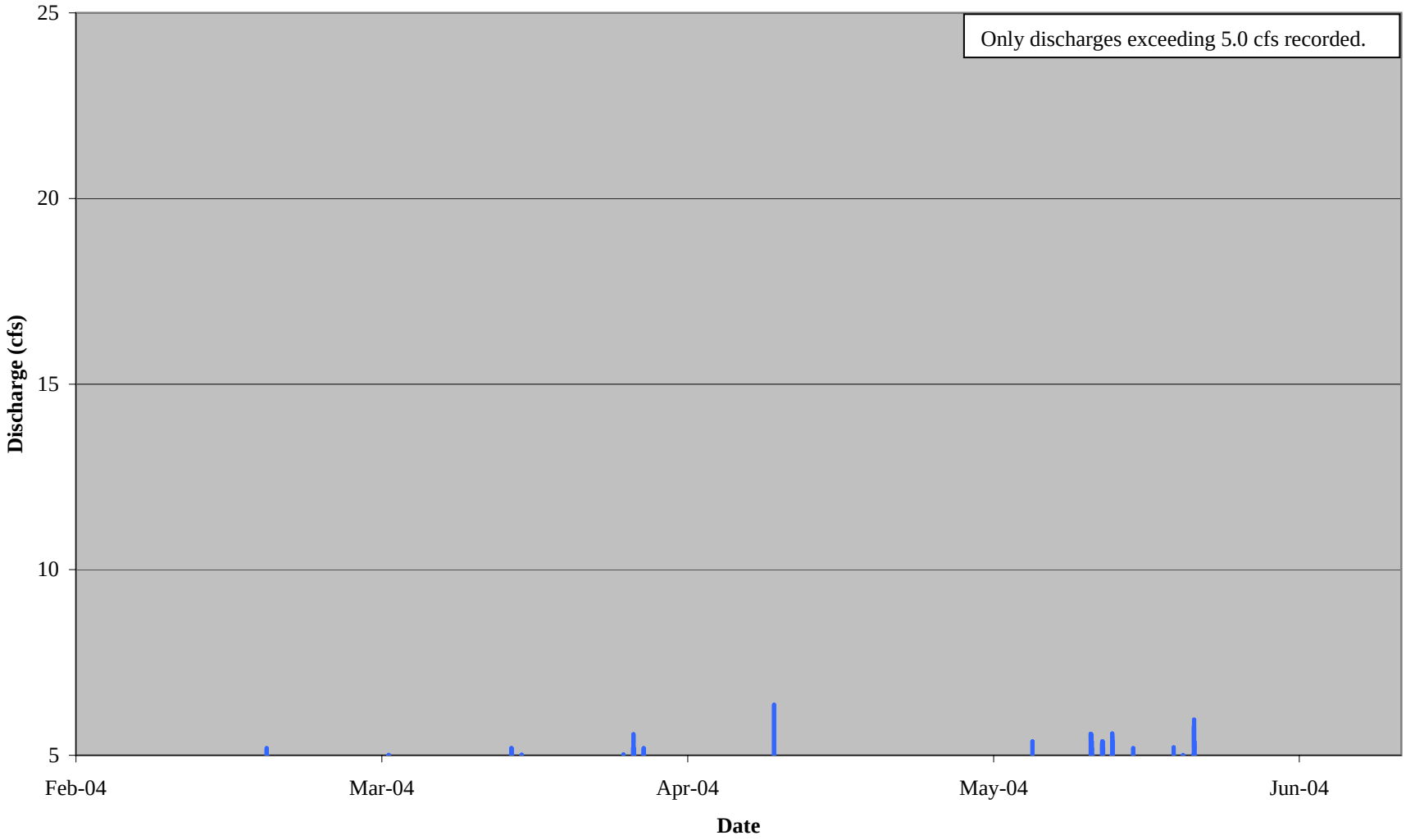
Particle		Size Range (mm)	Total #	Item %	% Cum.
S/C	Silt/Clay	0 < 0.062	23	23	23
Sand	Very Fine Sand	0.062 < 0.125	0	0	23
	Fine Sand	0.125 < 0.25	23	23	46
	Medium Sand	0.25 < 0.50	23	23	69
	Coarse Sand	0.50 < 1.0	0	0	69
	Very Coarse Sand	1 < 2	0	0	69
Gravel	Very Fine Gravel	2 < 4	6	6	75
	Fine Gravel	4 < 8	5	5	80
	Medium Gravel	8 < 16	3	3	83
	Coarse Gravel	16 < 32	6	6	89
	Very Coarse Gravel	32 < 64	6	6	95
Cbl	Small Cobble	64 < 128	0	0	95
	Large Cobble	128 < 256	0	0	95
Bldr	Small Boulder	256 < 512	0	0	95
	Medium Boulder	512 < 1024	0	0	95
	Large Boulder	1024 < 2048	0	0	95
Bdrk	Bedrock	Bedrock	5	5	100
		Totals:	100	100	100



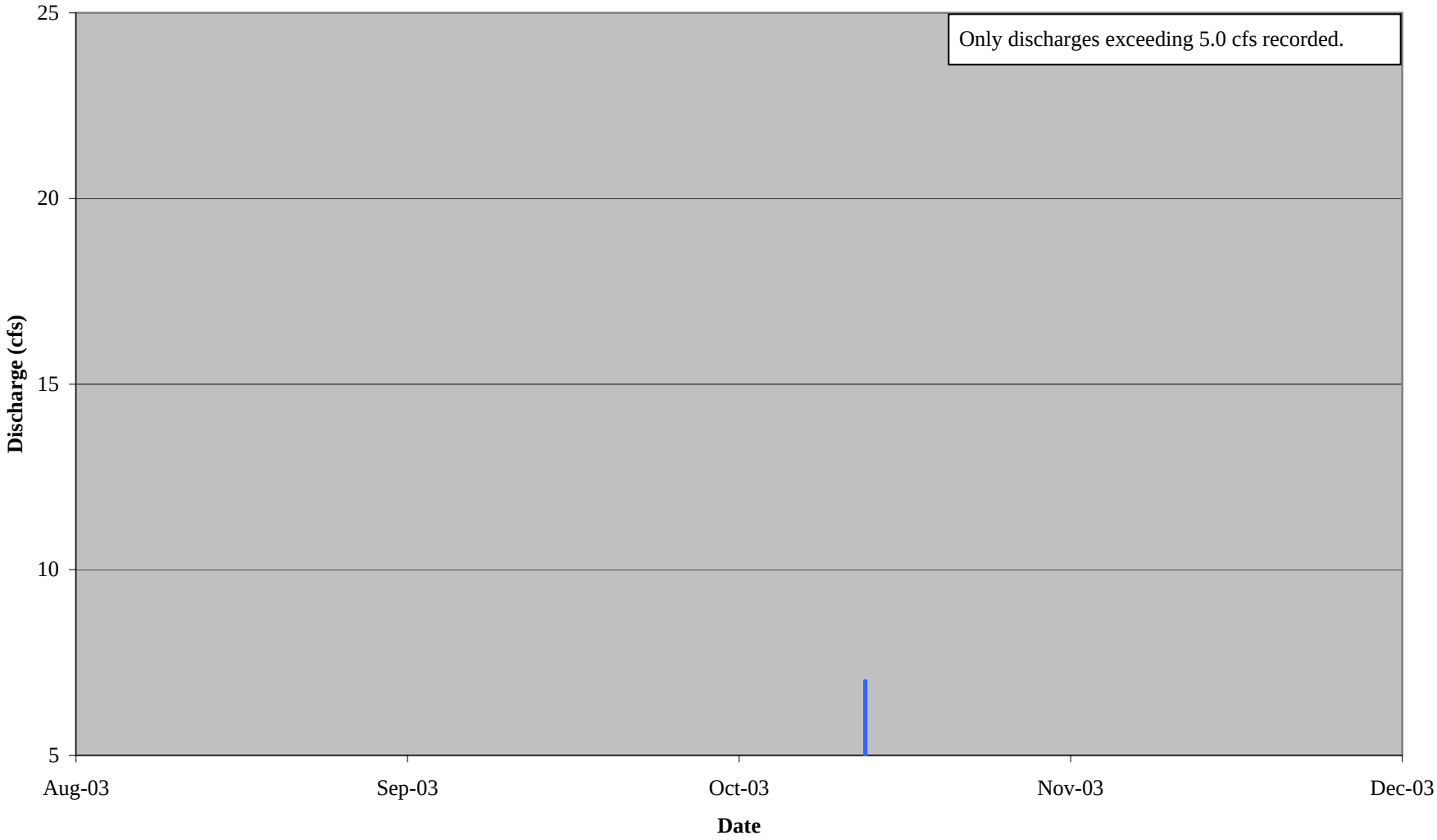
Size percent less than (mm)				
D16	D35	D50	D84	D95
<0.062	0.17	0.27	18	64

Percent by substrate type (%)					
Silt/Clay	Sand	Gravel	Cobble	Boulder	Bedrock
23	46	26	0	0	5

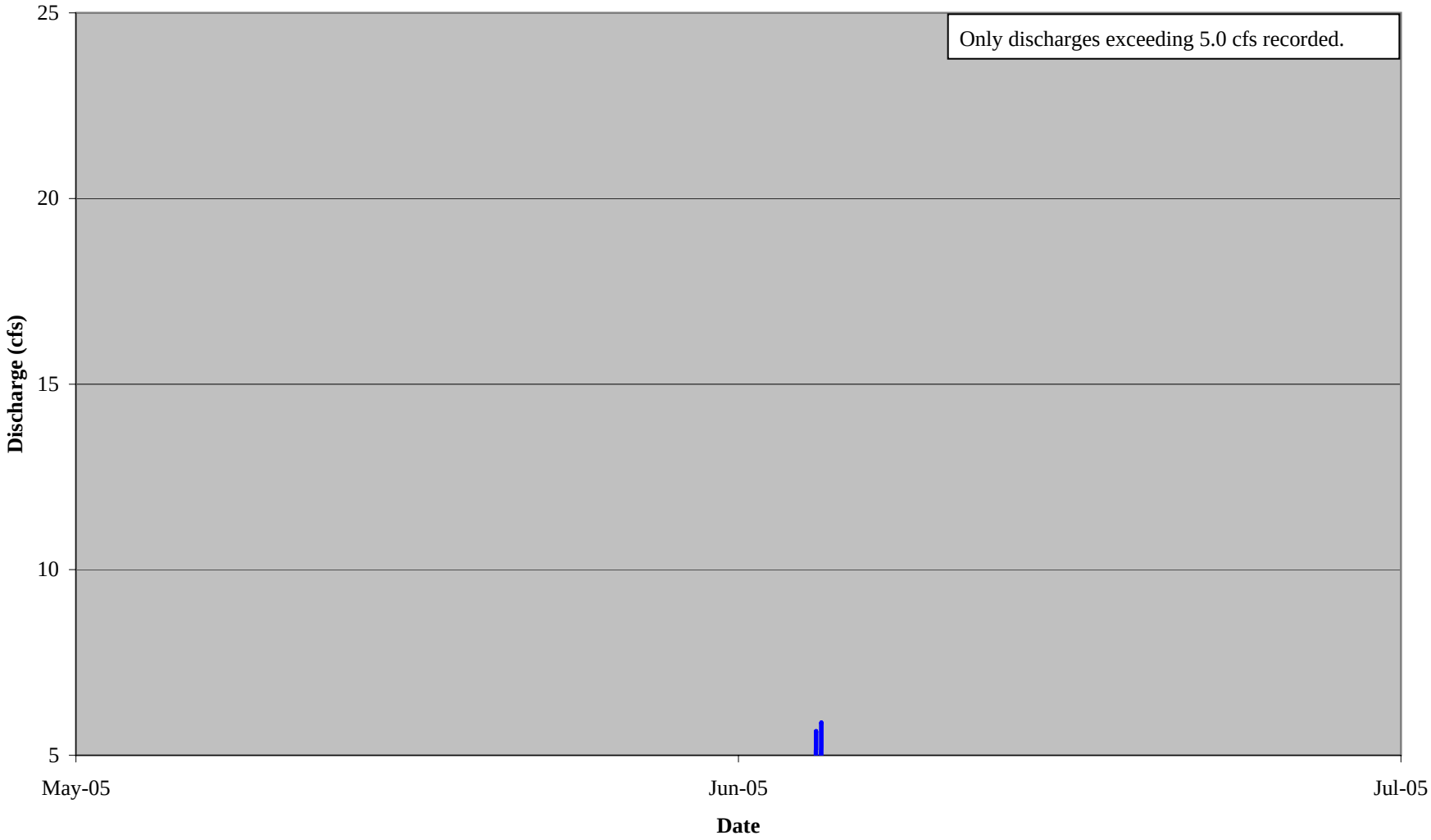
UTLHC Hydrograph - Gauge 1
2/23/2004 to 6/18/2004



UTLHC Hydrograph - Gauge 1
8/19/2003 to 12/18/2003



UTLHC Hydrograph - New Gauge
6/1/2005 to 6/20/2005



Appendix D
Environmental Screening Inspection Forms

ENVIRONMENTAL SCREENING INSPECTION (ESI) FORM

The objective of the ESI is to have an Inspector screen a property for the visual presence of the items listed on this form without making an evaluation of the conditions or history of the observed concerns.

This ESI Form defines the scope of work to be performed in a checklist format, and also serves as the report document once the Inspector has recorded the observations taken during the inspection, and has attached the site plan and photographs.

This form was completed in the field by an Inspector who conducted a non-destructive visual inspection of the subject property to document observations on-site and, to the extent possible, on the adjacent properties. The inspector did not disturb, dismantle or rearrange any materials, containers or equipment in performance of the inspection.

The entire subject property was covered in a manner conducive to observing and recording evidence of environmental concern. Photographs depicting the general overall condition of the site as well as each item of environmental concern are included.

I. Subject Site Description

Site Name: **Johnson Site**

Address/Location: 4563 Harmony Highway

City: Hamptonville County: Iredell State: North Carolina

Size: 196 acres

Current Landuse(s): dairy farming (livestock), agriculture, and forest

Number of buildings: 1 ☒ occupied 11 ☒ unoccupied

Site Improvements: ☒ undeveloped land ☐ paving & utility improvements ☒ buildings ☒ fenced

Utilities Serving the Subject Property:

☐ city sewer ☒ septic system ☒ electricity ☐ gas

☐ city water ☒ well water ☒ telephone

Initials KAB Date 12/17/02

II. On-Site Industrial/Manufacturing Activity Checklist:

The following observations were made of industrial/manufacturing activities currently in operation and/or evidence indicating such previous activities on the subject site:

1.	agricultural or horticultural production	☒	Yes	☐	No
2.	airport or aircraft maintenance	☐	Yes	☒	No
3.	analytical testing laboratories	☐	Yes	☒	No
4.	asphalt or cement plant	☐	Yes	☒	No
5.	chemical manufacturing or treatment	☐	Yes	☒	No
6.	dairy, meat or food processing	☒	Yes	☐	No
7.	dry cleaning facilities	☐	Yes	☒	No
8.	explosive manufacturing	☐	Yes	☒	No
9.	foundries, smelters or casting operations	☐	Yes	☒	No
10.	freight terminals	☐	Yes	☒	No
11.	gasoline station or convenience store	☒	Yes	☐	No
12.	herbicide or pesticide manufacturing	☐	Yes	☒	No
13.	incineration furnace or air emissions	☐	Yes	☒	No
14.	inks, dye and paint manufacturing or use	☐	Yes	☒	No
15.	junk or scrap yard	☐	Yes	☒	No
16.	landfill or open dump	☐	Yes	☒	No
17.	livestock feed lots or manure stockpiles	☒	Yes	☐	No
18.	machine shops	☐	Yes	☒	No
19.	metal fabrication or production	☐	Yes	☒	No
20.	metal plating or finishing	☐	Yes	☒	No
21.	military base	☐	Yes	☒	No
22.	mining or quarry activities	☐	Yes	☒	No
23.	motor vehicle maintenance or repairs	☒	Yes	☐	No
24.	oil and gas production or refining	☐	Yes	☒	No
25.	paper manufacturing	☐	Yes	☒	No
26.	pharmaceutical or medical production	☐	Yes	☒	No
27.	photochemical laboratories	☐	Yes	☒	No
28.	plastic or fiberglass fabrication or manufacturing	☐	Yes	☒	No
29.	power plant	☐	Yes	☒	No
30.	printing industries	☐	Yes	☒	No
31.	railroad yard or spur	☐	Yes	☒	No
32.	treatment, storage & disposal (TDS) facility	☐	Yes	☒	No
33.	vehicle or equipment de-greasing or washing	☐	Yes	☒	No
34.	waste treatment process	☐	Yes	☒	No
35.	wood preservation or finishing	☐	Yes	☒	No
36.	fertilizer manufacturing	☒	Yes	☐	No

Description of the overall appearance of the subject property and observed industrial/manufacturing activities (if any):

The subject property has one occupied residential structure and 11 other buildings that house livestock, feed, farm machinery and manure/mulch. There is an animal waste disposal pond on the property and two gasoline/diesel pumps. A large amount of the property is in agricultural use.

Initials KAB Date 12/17/02

III. <u>On-Site Inspection Checklist</u>:

Evidence of the following operations/conditions was observed on the subject property:

1.	floor drains, septic systems	☒	Yes	☐	No
2.	damaged/leaking transformers	☐	Yes	☒	No
3.	heavy equipment, tankers, spray rigs, paint booths	☐	Yes	☒	No
4.	storage containers, drums	☒	Yes	☐	No
5.	chemical, petroleum, foul odors	☐	Yes	☒	No
6.	dumping, disturbed soil, direct burial activity, injection wells, other disposal activities	☐	Yes	☒	No
7.	surface impoundments/holding ponds (other than storm water retention)	☒	Yes	☐	No
8.	waste water discharges	☐	Yes	☒	No
9.	sumps, hydraulic lifts/equipment	☐	Yes	☒	No
10.	ASTs, USTs, fill pipes, vent pipes, vaults, UST manhole covers, pumping equipment, patched areas of asphalt or concrete indicative of previous UST locations or repairs	☒	Yes	☐	No
11.	monitoring wells, piezometers, other subsurface monitoring devices, remedial activities	☐	Yes	☒	No
12.	stained/discolored soil	☒	Yes	☐	No
13.	leachate or seeps	☐	Yes	☒	No
14.	chemically distressed, discolored, stained vegetation	☒	Yes	☐	No
15.	chemical spills/releases	☐	Yes	☒	No
16.	petroleum sheens on water (excluding parking lot ponding)	☐	Yes	☒	No
17.	other	☐	Yes	☒	No

Description of identified environmental concerns (if any):

Item 4- There were approximately 5-10 55-gallon plastic drums on the subject property. Two of the drums were filled with grease containers; others were filled with hoses. The other drums were covered and closed. *Item 7*- There is a non-regulated waste lagoon monitored by federal/state entities. *Item 10*- There are two 500-gallon USTs on the subject property near NC 21. These contain diesel fuel and gasoline. There is an AST (oil tank) behind a mobile home residence. *Item 14*-A 55-gallon plastic drum had dark residue on the top and stained vegetation and soil adjacent to it as a result of spillage or a leak.

NOTES: Power lines extend through the property from the northeast corner through the middle of the property to the west. Power poles also parallel Hunting Creek Road through the subject property.

Initials KAB Date 12/17/02

IV. Adjacent/Abutting Property Checklist:

The inspector has observed and documented land uses, business operations, and conditions of concern on all adjacent/abutting properties, from the boundaries of the subject property and from public streets, alleys, sidewalks, etc. An "abutting property" means those sites that share a common property boundary with the subject site, while "adjacent property" means those sites separated from the subject site by an easement, such as a street, highway, railroad, etc.

A. The adjacent property(s) to the north (direction) is:
☒ uphill from ☐ downhill from ☐ level with the subject site.

Current use(s) forest and agriculture ☐ occupied ☒ unoccupied

Observed concerns:	☐ chemical spills/releases	☐ chemical odors
☐ underground storage tanks	☐ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: No environmental concerns were identified

B. The adjacent property(s) to the east (direction) is:
☐ uphill from ☒ downhill from ☒ level with, the subject site.

Current use(s) forest, residential & electric sub-station ☒ occupied ☒ unoccupied

Observed concerns:	☐ chemical spills/releases	☐ chemical odors
☐ underground storage tanks	☒ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: No access to the electric sub-station.

Initials KAB Date 12/17/02

C. The adjacent property(s) to the south (direction) is:
☐ uphill from ☒ downhill from ☐ level with, the subject site.

Current use(s) forest and agriculture ☐ occupied ☒ unoccupied

Observed concerns:	☐ chemical spills/releases	☐ chemical odors
☐ underground storage tanks	☐ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: No environmental concerns were identified

D. The adjacent property(s) to the west (direction) is:
☐ uphill from ☐ downhill from ☒ level with, the subject site.

Current use(s) agriculture and forest ☐ occupied ☒ unoccupied

Observed concerns:	☐ chemical spills/releases	☐ chemical odors
☐ underground storage tanks	☐ aboveground storage tanks	☐ stained soil
☐ impoundments/holding ponds	☐ drums/containers	☐ dumping
☐ remediation/clean-up activity	☐ landfill/burial activity	☐ monitoring wells
☐ industrial/manufacturing activity	☐ wastewater discharge	☐ air emissions

Comments: No environmental concerns were identified. Little Hunting Creek bounds conditions on properties to the west of the subject property.

Inspected by: **Kimberly A. Burton** Signature: _____

Company: **KCI Associates of NC** Inspector's Phone Number: **(919) 783-9214**

Inspection Date: **12/17/02** Time: **PM**

Appendix E
Reference Reach Data

Johnson Site Stream Restoration Project

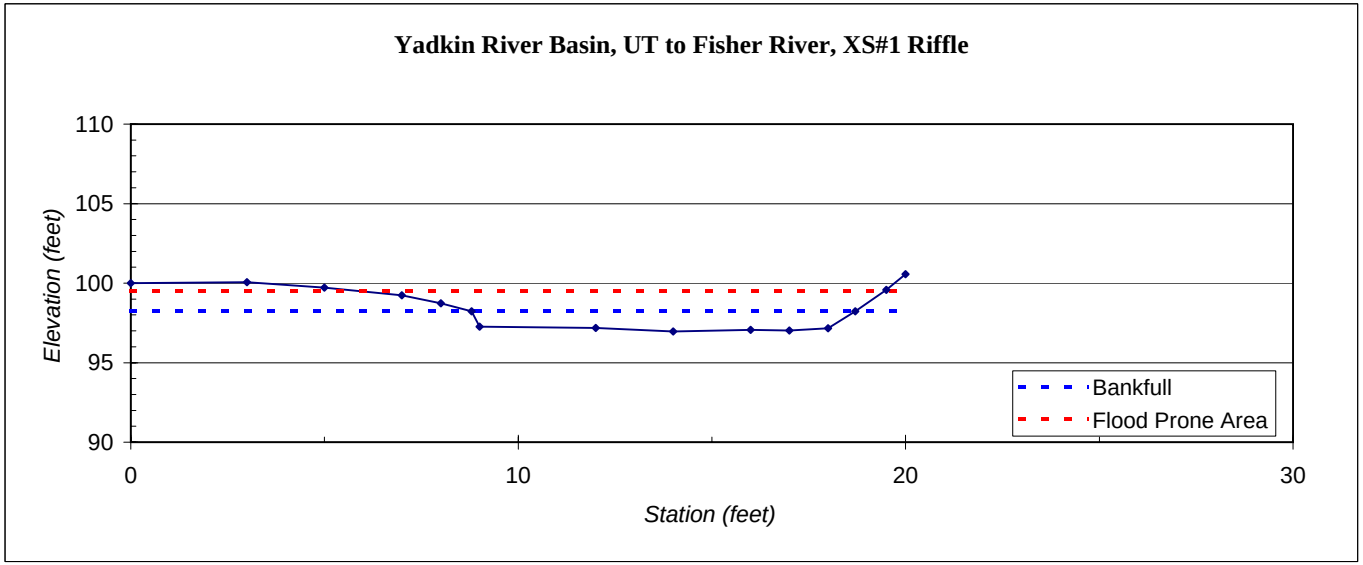
Reference Reach

River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#1 Riffle
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	2.22	100.00
3.0	2.15	100.07
5.0	2.50	99.72
7.0	2.98	99.24
8.0	3.49	98.73
8.8	4.00	98.22
9.0	4.96	97.26
12.0	5.03	97.19
14.0	5.25	96.97
16.0	5.16	97.06
17.0	5.20	97.02
18.0	5.06	97.16
18.7	4.00	98.22
19.5	2.65	99.57
20.0	1.66	100.56

SUMMARY DATA	
Bankfull Elevation:	98.22
Bankfull Cross-Sectional Area:	10.40
Bankfull Width:	10.00
Flood Prone Area Elevation:	99.47
Flood Prone Width:	13.10
Max Depth at Bankfull:	1.25
Mean Depth at Bankfull:	1.04
W / D Ratio:	9.6
Entrenchment Ratio:	1.30
Bank Height Ratio:	2.08
Slope (ft/ft):	0.013
Discharge (cfs)	42

Stream Type:	B4c



Johnson Site Stream Restoration Project

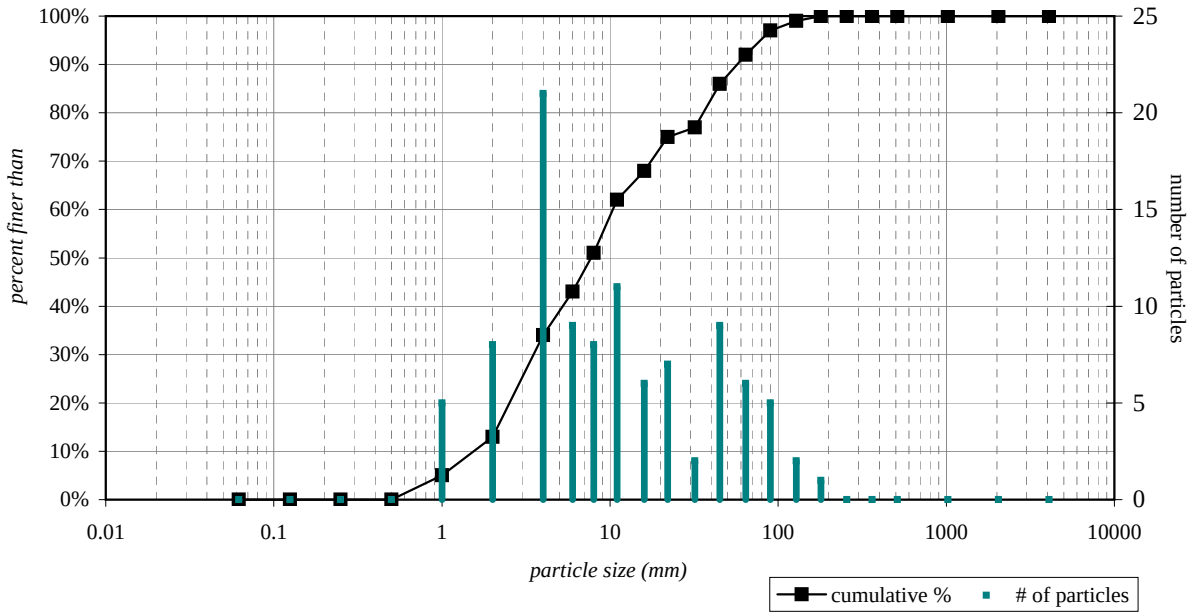
Reference Reach

Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**0**	##
very fine sand	0.062	0.13	**0**	##
fine sand	0.13	0.25	**0**	##
medium sand	0.25	0.5	**0**	##
coarse sand	0.5	1	**5**	##
very coarse sand	1	2	**8**	##
very fine gravel	2	4	**21**	##
fine gravel	4	6	**9**	##
fine gravel	6	8	**8**	##
medium gravel	8	11	**11**	##
medium gravel	11	16	**6**	##
coarse gravel	16	22	**7**	##
coarse gravel	22	32	**2**	##
very coarse gravel	32	45	**9**	##
very coarse gravel	45	64	**6**	##
small cobble	64	90	**5**	##
medium cobble	90	128	**2**	##
large cobble	128	180	**1**	##
very large cobble	180	256	**0**	##
small boulder	256	362	**0**	##
small boulder	362	512	**0**	##
medium boulder	512	1024	**0**	##
large boulder	1024	2048	**0**	##
very large boulder	2048	4096	**0**	##
		total particle count:	100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100

	UT to Fsher River
	Surry County, NC
	Riffle #1 (Sta. 01+00)
Note:	



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	2.208	4.18	7.7	13	42	79	4.5	9.6	4.3

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	0%	13%	79%	8%	0%	0%	0%	0%	0%

Johnson Site Stream Restoration Project

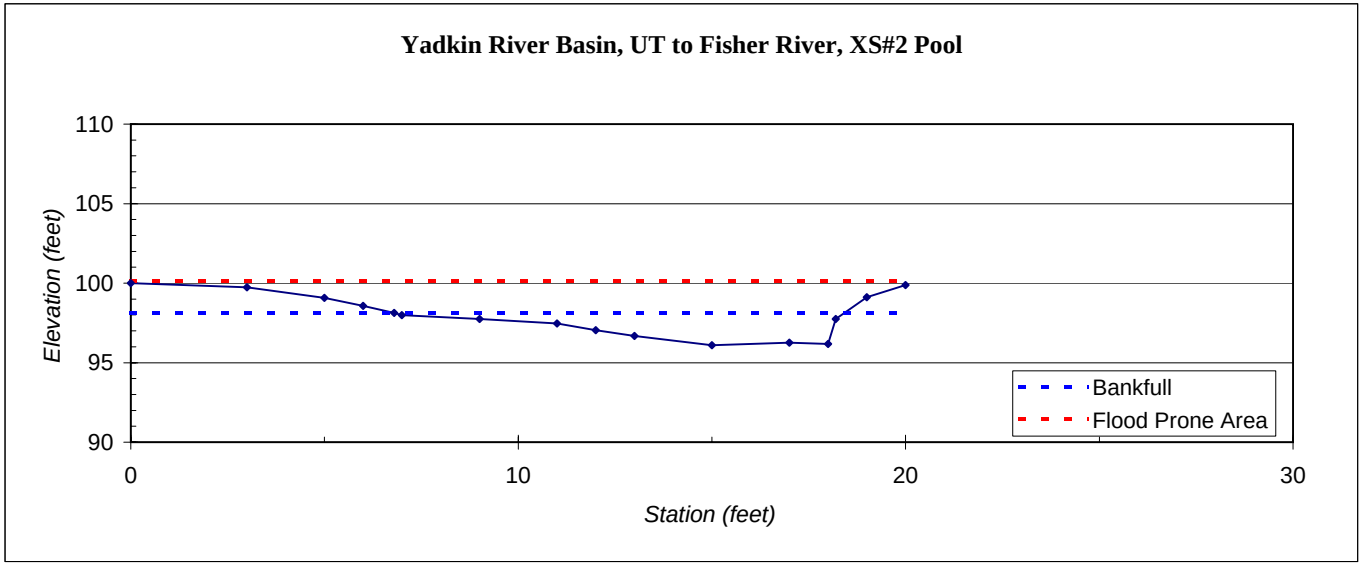
Reference Reach

River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#2 Pool
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	2.68	100.00
3.0	2.94	99.74
5.0	3.61	99.07
6.0	4.10	98.58
6.8	4.56	98.12
7.0	4.70	97.98
9.0	4.94	97.74
11.0	5.21	97.47
12.0	5.64	97.04
13.0	6.00	96.68
15.0	6.59	96.09
17.0	6.42	96.26
18.0	6.50	96.18
18.2	4.93	97.75
19.0	3.56	99.12
20.0	2.80	99.88

SUMMARY DATA	
Bankfull Elevation:	98.12
Bankfull Cross-Sectional Area:	13.40
Bankfull Width:	11.62
Flood Prone Area Elevation:	100.15
Flood Prone Width:	
Max Depth at Bankfull:	2.03
Mean Depth at Bankfull:	1.15
W / D Ratio:	10.1
Entrenchment Ratio:	
Bank Height Ratio:	0.81
Slope (ft/ft):	0.001
Discharge (cfs)	56

Stream Type:	B4c



Johnson Site Stream Restoration Project

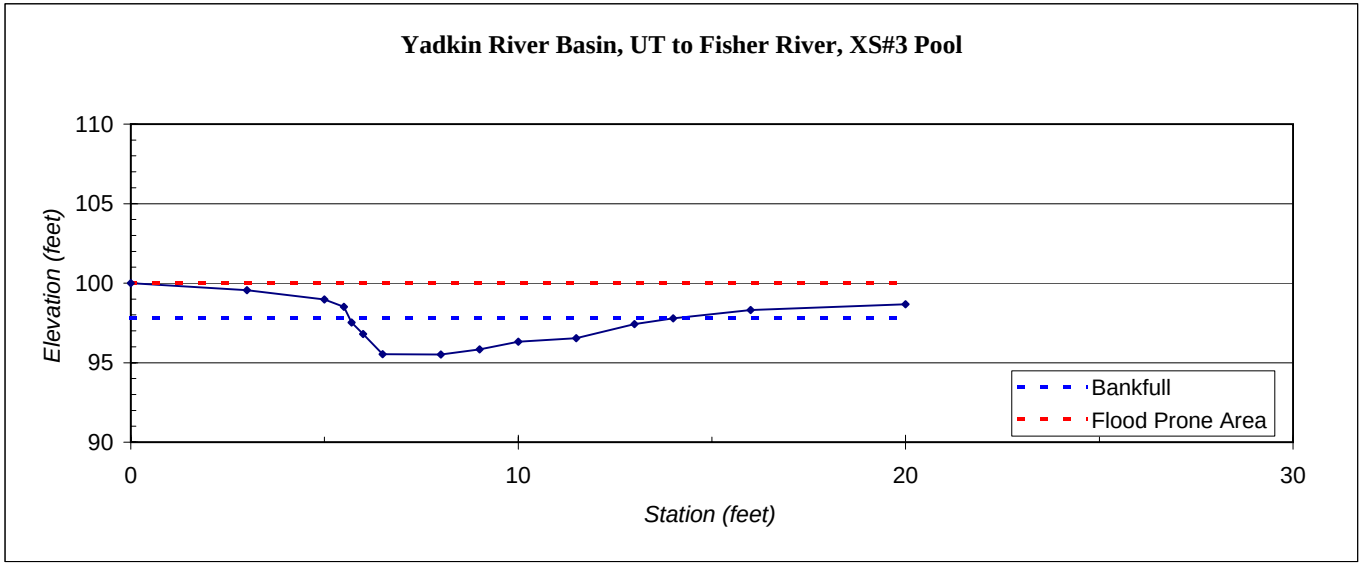
Reference Reach

River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#3 Pool
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	1.33	100.00
3.0	1.78	99.55
5.0	2.35	98.98
5.5	2.82	98.51
5.7	3.81	97.52
6.0	4.52	96.81
6.5	5.79	95.54
8.0	5.82	95.51
9.0	5.50	95.83
10.0	5.02	96.31
11.5	4.80	96.53
13.0	3.90	97.43
14.0	3.55	97.78
16.0	3.03	98.30
20.0	2.66	98.67

SUMMARY DATA	
Bankfull Elevation:	97.78
Bankfull Cross-Sectional Area:	11.60
Bankfull Width:	8.35
Flood Prone Area Elevation:	100.05
Flood Prone Width:	
Max Depth at Bankfull:	2.27
Mean Depth at Bankfull:	1.39
W / D Ratio:	6.0
Entrenchment Ratio:	
Bank Height Ratio:	0.85
Slope (ft/ft):	0.001
Discharge (cfs)	52

Stream Type:	B4c



Johnson Site Stream Restoration Project

Reference Reach

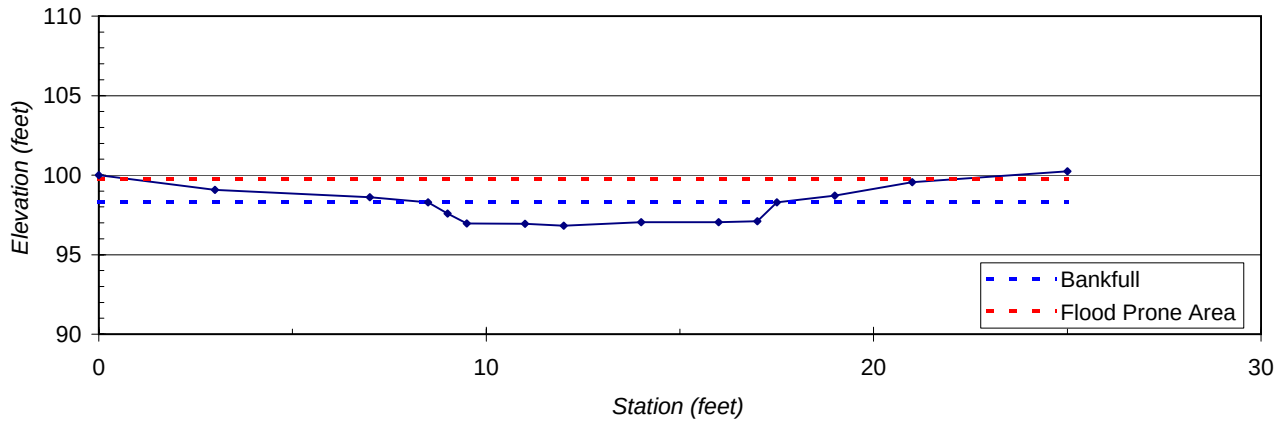
River Basin:	Yadkin
Watershed:	UT to Fisher River
XS ID	XS#4 Riffle
Drainage Area (sq mi):	0.38
Date:	6/9/2005
Field Crew:	G. Mryncza, A. Spiller

Station	Rod Ht.	Elevation
0.0	4.62	100.00
3.0	5.54	99.08
7.0	6.01	98.61
8.5	6.34	98.28
9.0	7.04	97.58
9.5	7.66	96.96
11.0	7.67	96.95
12.0	7.79	96.83
14.0	7.58	97.04
16.0	7.57	97.05
17.0	7.51	97.11
17.5	6.34	98.28
19.0	5.90	98.72
21.0	5.06	99.56
25.0	4.37	100.25

SUMMARY DATA	
Bankfull Elevation:	98.28
Bankfull Cross-Sectional Area:	10.70
Bankfull Width:	9.00
Flood Prone Area Elevation:	99.73
Flood Prone Width:	20.50
Max Depth at Bankfull:	1.45
Mean Depth at Bankfull:	1.19
W / D Ratio:	7.6
Entrenchment Ratio:	2.30
Bank Height Ratio:	1.00
Slope (ft/ft):	0.013
Discharge (cfs)	46

Stream Type:	B4c

Yadkin River Basin, UT to Fisher River, XS#4 Riffle



Johnson Site Stream Restoration Project

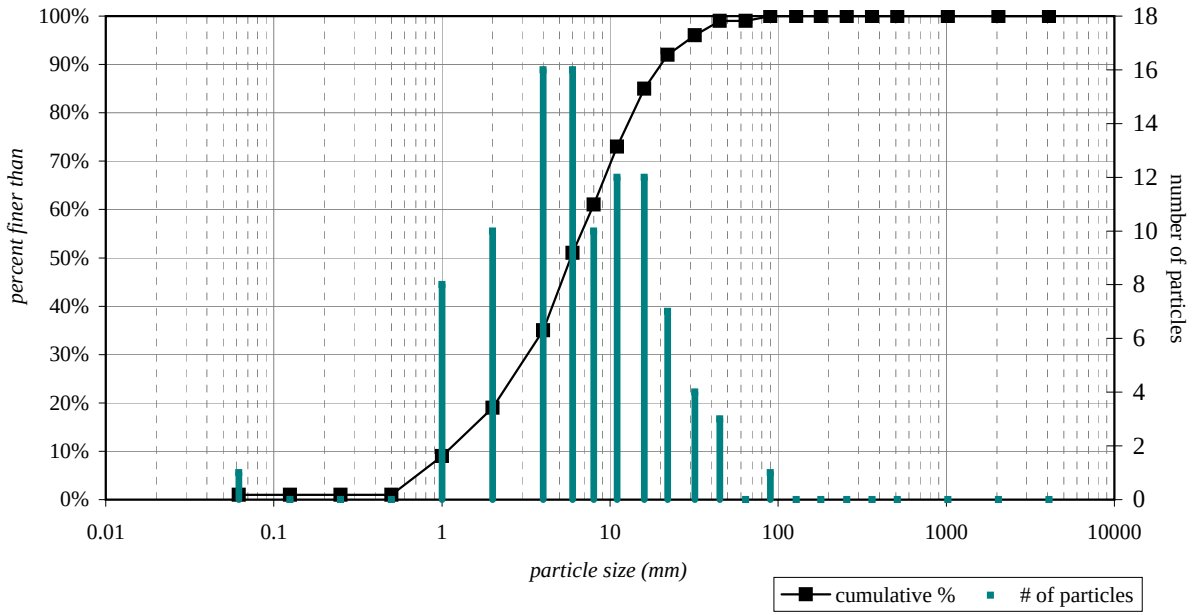
Reference Reach

Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**1**	##
very fine sand	0.062	0.13	**0**	##
fine sand	0.13	0.25	**0**	##
medium sand	0.25	0.5	**0**	##
coarse sand	0.5	1	**8**	##
very coarse sand	1	2	**10**	##
very fine gravel	2	4	**16**	##
fine gravel	4	6	**16**	##
fine gravel	6	8	**10**	##
medium gravel	8	11	**12**	##
medium gravel	11	16	**12**	##
coarse gravel	16	22	**7**	##
coarse gravel	22	32	**4**	##
very coarse gravel	32	45	**3**	##
very coarse gravel	45	64	**0**	##
small cobble	64	90	**1**	##
medium cobble	90	128	**0**	##
large cobble	128	180	**0**	##
very large cobble	180	256	**0**	##
small boulder	256	362	**0**	##
small boulder	362	512	**0**	##
medium boulder	512	1024	**0**	##
large boulder	1024	2048	**0**	##
very large boulder	2048	4096	**0**	##
	total particle count:		100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100

	UT to Fsher River
	Surry County, NC
	Riffle #2 (Sta. 02+55)
Note:	



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	1.625	4.00	5.8	9	16	29	3.1	5.0	3.1

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	1%	18%	80%	1%	0%	0%	0%	0%	0%

Johnson Site Stream Restoration Project

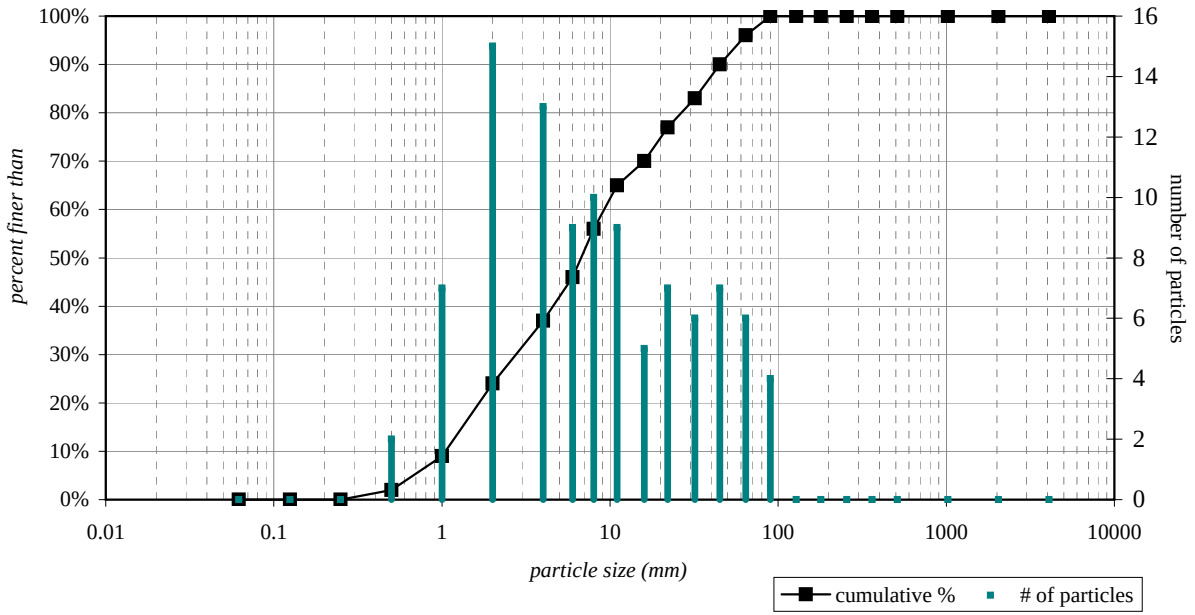
Reference Reach

Pebble Count

Material	Size Range (mm)		Count	
silt/clay	0	0.062	**0**	##
very fine sand	0.062	0.13	**0**	##
fine sand	0.13	0.25	**0**	##
medium sand	0.25	0.5	**2**	##
coarse sand	0.5	1	**7**	##
very coarse sand	1	2	**15**	##
very fine gravel	2	4	**13**	##
fine gravel	4	6	**9**	##
fine gravel	6	8	**10**	##
medium gravel	8	11	**9**	##
medium gravel	11	16	**5**	##
coarse gravel	16	22	**7**	##
coarse gravel	22	32	**6**	##
very coarse gravel	32	45	**7**	##
very coarse gravel	45	64	**6**	##
small cobble	64	90	**4**	##
medium cobble	90	128	**0**	##
large cobble	128	180	**0**	##
very large cobble	180	256	**0**	##
small boulder	256	362	**0**	##
small boulder	362	512	**0**	##
medium boulder	512	1024	**0**	##
large boulder	1024	2048	**0**	##
very large boulder	2048	4096	**0**	##
		total particle count:	100	

bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100

	UT to Fsher River
	Surry County, NC
	Reach
Note:	



based on sediment particles only	size percent less than (mm)						particle size distribution		
	D16	D35	D50	D65	D84	D95	gradation	geo mean	std dev
	1.382	3.60	6.7	11	34	60	4.9	6.8	4.9

based on total count	percent by substrate type								
	silt/clay	sand	gravel	cobble	boulder	bedrock	hardpan	wood/det	artificial
	0%	24%	72%	4%	0%	0%	0%	0%	0%