MITIGATION PLAN

FULL DELIVERY PROJECT TO PROVIDE STREAM RESTORATION
NEUSE RIVER BASIN CATALOGING UNIT 03020201

LOWELL MILL DAM-LITTLE RIVER WATERSHED
RESTORATION SITE
Johnston County, North Carolina

PREPARED FOR:

NCDENR - ECOSYSTEM ENHANCEMENT PROGRAM
1652 Mail Service Center
Raleigh, North Carolina 27699-16152

JUNE 2006

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JOHNSTON COUNTY, NORTH CAROLINA

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EXECUTIVE SUMMARY

Introduction

In order to provide stream channel restoration in the Neuse River Basin (Hydrologic Unit 03020201), Restoration Systems, LLC (RS) has removed Lowell Mill Dam located on the Little River in Johnston County, North Carolina (Figures 1 and 2, Appendix A). The Lowell Mill Dam-Little River watershed has been identified as a high priority restoration resource for stream and aquatic ecosystem restoration within the Neuse River Basin by the North Carolina Dam Removal Task Force (DRTF), a coalition of federal and state government agencies. The dam removal project was planned and designed according to constructs outlined in Determining Appropriate Compensatory Mitigation Credit for Dam Removal Projects, March 22, 2004 (USACE Public Notice 3/23/04). This guidance was developed by the U.S. Army Corps of Engineers (USACE), Fish and Wildlife Service (FWS), Environmental Protection Agency (USEPA), N.C. Division of Water Quality (NCDWQ), and the N.C. Wildlife Resource Commission (NCWRC).

The site of the former Lowell Mill Dam is approximately 0.3 mile downstream (south) of Interstate 95 on the Little River between the towns of Micro and Kenly (Figure 1, Appendix A). Approximately 36,875 linear feet of the Little River and certain tributaries (Little Buffalo Creek and an unnamed tributary) were impounded by the dam (Figure 3, Appendix A). Adverse impacts to water quality, the distribution of rare species, migration of anadromous fish, and natural streamflows of the affected reaches resulted from the dam and its impoundment. Impacts to water quality within the former Site Impoundment were manifested in the form of lower dissolved concentrations, higher temperatures, and increased sedimentation. The low dissolved oxygen concentrations prompted NCDWQ to add portions of the Little River, lying within the former Site Impoundment, to the 303(d) list of impaired water bodies in the state. The character of the aquatic communities within the former Site Impoundment shifted from that representative of a free-flowing (lotic) river system towards an impounded (lentic) condition. Rare and endangered mussel and fish habitat was extirpated or greatly diminished within areas of the river impounded by the former dam. As a consequence, no species listed by the FWS were found in reaches impounded by the dam. The dam structure also impeded the passage of anadromous fish to approximately 40 miles of second-order or higher, free-flowing tributaries upstream of the former Site Impoundment.

Many ecological benefits are anticipated as a result of the dam removal. The reintroduction of the characteristic lotic flow to the former Site Impoundment is expected to increase dissolved oxygen concentrations and enhance sediment transport, thereby improving water quality. Aquatic communities within formerly impounded reaches are expected to transition towards those typically found in lotic conditions. Rare and endangered species habitat is expected to expand and improve within previously impounded areas, and anadromous fish passage will be greatly expanded in the Little River watershed and its associated tributaries upstream of the former dam site.

Dam Removal

The Lowell Mill Dam was removed in a manner that minimized impacts to water resources both upstream and downstream of the dam. Gradual dewatering and phased sediment management practices were implemented to avoid or minimize erosion and sedimentation from embankment slopes within the Site Impoundment, thereby eliminating or minimizing the introduction of anoxic water and nutrient-rich

sediments into downstream reaches of the Little River. Controlled blasting was performed to fracture the concrete dam into sections easily removed by heavy mechanized equipment, thus preventing excess debris from entering the channel.

Numerous construction practices were undertaken to avoid impacts to aquatic species in the vicinity of the dam site throughout the removal process. Temporary water control devices (coffer dams and an Aqua-dam©) and sediment fencing were generously employed throughout the construction zones to minimize sediment erosion into the water column. Oil adsorption booms were installed downstream of active construction areas to prevent machine oil from washing downstream. Following removal of the dam and associated grading activities, both sides of the river were stabilized with coir fiber matting, live-staked, and hydro-seeded to minimize bank erosion. In addition, large (1-2.5 inch caliper) trees were planted on the north bank.

Mitigation Goals
The primary goals of the Lowell Mill Dam removal are to:

- **Restore approximately 36,875 linear feet of free-flowing river** and stream channels formerly inundated under the Site Impoundment.
- **Restore the natural flow** and corresponding sediment transport functions of stream systems impacted by the dam.
- **Improve water quality and aquatic communities** within the former Site Impoundment.
- **Restore rare and endangered species habitat** within the rivers and streams formerly inundated by the Site Impoundment.
- **Restore anadromous fish passage**, foraging, and spawning opportunities within 36,875 linear feet within the former Site Impoundment, as well as an additional 204,920 linear feet of main stem stream and river channels within the Functional Benefit Area (FBA).
- **Produce significant new academic data** regarding the effects of dam removal projects on aquatic and terrestrial ecosystems.
- **Provide public recreation opportunities**, including the establishment of a park and canoe/kayak launch at the dam site.
- **Generate a minimum of 36,875 linear feet of Stream Mitigation Units (SMUs) for use by the Ecosystem Enhancement Program (EEP) to offset impacts to streams in the specific Neuse River hydrologic unit** (see Table 1 for details). Additional SMUs may also be generated for use by the EEP, depending upon results of post-project monitoring.

Monitoring Plan
The project will be monitored annually for 5 years following dam removal. Primary success criteria of the project include documented improvements to 1) rare and endangered aquatic species (i.e., measurable improvements to suitable aquatic habitat), 2) water quality, 3) the aquatic community (i.e., a shift from lentic to lotic character), and 4) anadromous fish passage within the former Site Impoundment (Table 1). Reserve success criteria, to be used if primary success criteria are not achieved (and to generate additional potential credit), include: 1) anadromous fish passage above the former Site Impoundment, 2) downstream benefits below the dam, and 3) human values (Table 1).

A monitoring plan has been developed that will evaluate the project for the criteria specified above. Monitoring stations have been established within the former Site Impoundment and in upstream and

downstream reference areas (Figure 4, Appendix A). Cross-sectional surveys, channel substrate analyses, and habitat assessment will be performed at each monitored station to verify anticipated improvements in aquatic habitat. Benthic macroinvertebrate stations and aquatic species (fish, mussels, and snails) survey sites have also been established within the former Site Impoundment and in reference areas to catalog changes in the aquatic community. Anadromous fish survey sites have been established within and above the former Site Impoundment. NCDWQ Ambient Monitoring Station (AMS) data will be collected to demonstrate improvements in water quality. Annual Monitoring Reports summarizing project monitoring data will be generated after each monitoring year for review.

Table 1. Stream Mitigation Units (SMUs)[1] to be generated by removal of the Lowell Mill Dam.

	Channel Restored (feet)	**Mitigation Ratio**	**SMUs**
Primary success criteria:			
1) Re-introduction of rare and endangered aquatic species 2) Improved water quality 3) Improved aquatic community 4) Anadromous fish passage (under crest pool)	36,875 feet of free-flowing river and tributaries **under the crest pool**	1:1	36,875
Reserve success criteria:			
Anadromous fish passage (**above crest pool**)	Up to 204,920 feet of second order or higher, free-flowing tributaries	5:1	40,984
Downstream benefits below the dam	500 feet below dam	1:1	500
Human values 1) Scientific value 2) Human recreation	-----	Up to 20 percent bonus	7,375
Total potential additional SMUs			48,859
Committed SMUs			**36,875**

[1] Primary success criteria will be monitored to verify and confirm positive changes to each functional criterion as outlined in this report and in the Dam Removal Guidance. Reserve criteria will be monitored for possible augmentation of the primary SMUs.

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Photo 1. American shad (*Alosa sapidissima*) caught below Lowell Mill Dam (in background)

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LOWELL MILL—LITTLE RIVER WATERSHED
RESTORATION SITE

1.0 INTRODUCTION

In order to provide compensatory mitigation credit in the Neuse River Basin (Hydrologic Unit 03020201), Restoration Systems, LLC (RS) has removed Lowell Mill Dam in Johnston County, North Carolina (Figures 1 and 2, Appendix A). To successfully accomplish the goals of the project, RS enlisted the services of several firms, which provide scientific and engineering expertise. These firms include EcoScience Corporation (ESC), Backwater Environmental (BE), The Catena Group (TCG), and Milone & MacBroom, Inc. (MMI) of Connecticut.

The North Carolina Dam Removal Task Force (DRTF), a coalition of federal and state government agencies, recommends large-scale dam removal as an appropriate and desirable form of compensatory stream mitigation. DRTF participants have prioritized dams in North Carolina to identify those dam removal projects that would result in the greatest ecological benefit. The Lowell Mill Dam was designated as the highest priority dam for removal in North Carolina (DRTF 2001). The dam was targeted for removal by natural resource coalitions due primarily to migratory fish blockage, limits on the distribution of endangered species, water quality degradation, and its location within the Neuse River watershed. In portions, the Neuse River watershed has been identified as an impaired system by various regulatory agencies and is the focus of numerous water quality initiatives.

The removal of Lowell Dam was planned and designed according to the guidelines and protocols outlined in Determining Appropriate Compensatory Mitigation Credit for Dam Removal Projects, March 22, 2004 (USACE Public Notice 3/23/04). This guidance was developed cooperatively by the U.S. Army Corps of Engineers (USACE), Fish and Wildlife Service (FWS), Environmental Protection Agency (USEPA), N.C. Division of Water Quality (NCDWQ), and the N.C. Wildlife Resource Commission (NCWRC).

1.1 Project Location

The project location includes the site of the former Lowell Mill Dam and mill works situated within the Little River, approximately 0.3 miles south (downstream) of Interstate Highway 95 (I-95, Exit 105), between the towns of Micro and Kenly (Figure 1, Appendix A). For the purposes of this document, the former dam site and immediate adjacent areas will hereafter be referred to as the "Site." All construction activities discussed in this report occurred on-Site unless specifically noted otherwise.

Approximately 36,875 linear feet of the Little River, Little Buffalo Creek, and an unnamed tributary were impacted by the Lowell Mill Dam impoundment. These stream reaches collectively comprise the "Site Impoundment."

The effects of the dam extended well beyond the footprint of its impoundment. The dam served to obstruct the upstream movement of fish and other aquatic organisms. One of the most harmful ecological legacies of river dams can be found in their effects on migratory fish. The functional benefit area (FBA) for this restoration project is defined as the maximum watershed lying upstream of the dam, which could serve as anadromous fish spawning habitat. This area includes approximately 204,920 linear feet (38.8 miles) of main stream channel along the Little River, Buffalo Creek, Little Buffalo Creek, and Long Branch in Johnston County (Figure 3, Appendix A). The FBA begins at the Site and extends upstream along these waterways to include relatively free-flowing (i.e., unimpeded) tributaries in the watershed. Its upper limit is defined by dams (Atkinson Mill, Lake Wendell) or stream headwaters.

1.2 Pre-existing Conditions

1.2.1 Watershed Characteristics

The former Site Impoundment and most of the FBA are located in the Southeastern Plains physiographic region of North Carolina (Griffith 2002). The FBA boundary resides within two ecoregions: Rolling Coastal Plain and Southeastern Floodplains and Low Terraces (Griffith 2002). The Rolling Coastal Plain ecoregion is characterized by flat topography, relatively broad interstream divides, and low-gradient, sinuous stream channels within gently sloping, terraced valleys. The Southeastern Floodplains and Low Terrace comprise low-lying areas adjacent to larger riverine systems. The region includes large sluggish rivers and backwaters with ponds, swamps and oxbow lakes. Elevations within the former Site Impoundment vicinity range from a high of 200 feet mean sea level (MSL) along high ridges to a low of 140 MSL along floodplains of larger drainages. Annual precipitation within the project vicinity is approximately 48 inches per year (USDA 1994).

The FBA contains approximately 38.8 miles of streams and river channels along the Little River, Buffalo Creek, Little Buffalo Creek, and Long Branch (Figure 3, Appendix A). Land use within the watershed is highly variable. Major land use categories include agriculture (52 percent), bottomland hardwood forest (28 percent), pine forest (10 percent), and early successional forest (6 percent). The remaining areas consist of bodies of water, and residential areas of varying density including portions of Wendell and Zebulon. Agricultural land uses include several chicken farm operations, cow pasture, and row crops including corn, tobacco, and soybeans. As a result of the Raleigh metropolitan area's eastward expansion, higher-density residential areas have steadily encroached into the upper Little River basin along the US Highway 64 (US 64) corridor. In order to provide an additional municipal source of water for the Raleigh metropolitan area, a reservoir on the Little River is being planned near Zebulon in Wake County. This project will likely have stream mitigation requirements that potential additional credits generated by the Lowell Mill Dam removal may help to satisfy (see Table 1).

The headwaters of the Little River extend northward to just east of Youngsville in Franklin County, NC, approximately 36 miles north of the former Lowell Mill Dam. Little Buffalo Creek's headwaters are in Johnston County in the vicinity of Stancils Chapel, approximately 7.5 miles north of the stream's confluence with the Little River. The headwaters for Long Branch lie approximately 6.5 miles northwest of its confluence with the Little River. Buffalo Creek's headwaters are in Wake County, just south of Rolesville, approximately 29 miles northwest of its confluence with the Little River.

1.2.2 Dam and Impoundment

Lowell Mill Dam was a mass concrete gravity dam and spillway located within the Little River channel and across a small portion of the adjacent river floodplain. The dam and spillway measured approximately 190 feet in length and 10 feet in height. At the south abutment, the concrete foundation of the mill and associated sluice gate was located between the end of the spillway and the bedrock contact.

In the two years preceding its removal, the dam was managed by RS in a partially drained condition, by way of a sluice gate along the former south abutment. This management approach was used to facilitate the pre-removal vegetation response in preparation for staged demolition of the dam, as well as to mitigate the high hazard conditions associated with the mill works. Two drownings occurred in the last decade; the most recent in August 2000. The drownings occurred within the "truculent hydraulic jump" at the base of the dam and within the sluice gate structure in the mill works. River flow was allowed to pass through the sluice gate at an elevation prescribed by RS. In addition, the structure aged past the functional life-span (approximately 50 years) for a mass concrete gravity dam by more than 50 years. Without major repairs, replacement, or removal, the dam would have likely failed, or been subject to costly and risky piecemeal repair to maintain the integrity of the dam.

The contributing drainage area at the Site encompasses approximately 215 square miles. The mean annual discharge is estimated at 250 cubic feet per second (cfs) with the 10-year flood exceeding 5,700 cfs. Before removal, the spillway crest elevation of the dam resided at 130.75 feet MSL. Prior to dewatering (see Section 2.2), the depth of water flowing over the spillway measured greater than 0.4 feet with the crest pool surface elevation behind the dam estimated at between 130.8 feet and 131.2 feet above MSL.

The former Site Impoundment occurred within the bankfull channel of the Little River and downstream portions of Little Buffalo Creek and its floodplain (Figure 3, Appendix A). Floodplain gradients perpendicular to the impounded reaches of the Little River were typically low, with the exception of steeper bluffs that occasionally occurred along the south banks. The river banks were primarily forested with riparian vegetation characteristic of the region, including box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), musclewood (*Carpinus caroliniana*), and hawthorn (*Crataegus* spp.). The lentic character of the Site Impoundment resulted in slow velocities near the water surface and stagnant flows at deeper depths. Water depths within the former Site Impoundment ranged from 3-5 feet in the farthest upstream extents to 8-10 feet near the dam. Using the classification system described by Cowardin *et al*. (1979), the former Site Impoundment could be classified as a lacustrine, limnetic water body with an unconsolidated bottom characterized by sand (L1UB2).

The upstream limit of the Site Impoundment was located *in situ* based on interpolation of remote sensing data generated specifically for this project by GeoData Corporation (Site Impoundment limits depicted in Figure 3, Appendix A). The GeoData mapping products (hi-resolution mapping) consist of custom hi-resolution color-infrared, stereoscopic photography (dated January 2005) and 1-foot interval hypsographic contours that were generated from the aerial photography. The hi-resolution mapping was generated and verified using multiple ground control stations, which were further used to calculate water surface elevations throughout the Site Impoundment. Through interpretation of the channel depth from cross-section data collected by ESC, channel bed elevations were tied into the hi-resolution mapping

using sub-meter Global Positioning System (GPS) coordinates, and the upstream limits of waters affected by the dam were determined. The upper limits of selected waters were visited, field verified, and photographed to verify these methods of determining the limits of the impoundment. The findings are corroborated by the initial findings of Eddy Engineering (2001) and Federal Emergency Management Agency (FEMA) studies.

Based on these studies, the dam crest pool (taken as 131 feet MSL) extended approximately 27,680 feet up the Little River valley to a bed elevation point approximately 500 linear feet below State Road 1934 (SR 1934, Old Beulah Road) and up the Little Buffalo Creek tributary along an estimated 8,260 feet of perennial stream channel to a point approximately 500 feet downstream of NC Highway 42 (NC 42, Figure 3, Appendix A). An additional 935 linear feet of an unnamed tributary to the Little River has also been identified for impacts due to the dam (Figure 3, Appendix A). As a result, the natural flow of approximately 36,875 linear feet (7.0 miles) of river and tributary stream channel were impacted by the impounding effects of the Lowell Mill Dam. Given the dynamics of such a river system like the Little River, the crest pool backwater effect may have shifted even further upstream from this elevation, dependent upon rainfall, temperature, runoff, flow, and sediment loading conditions.

1.2.3 Little River Above and Below Impoundment

Extensive waterborne reconnaissance of the Little River was performed both upstream and downstream of the Lowell Mill Dam to assess the reference lotic conditions of the Little River. Upstream, the reconnaissance started at the bridge crossing at SR 2130 and terminated at the bridge crossing at SR 1934 (Old Beulah Road), a travel distance of approximately 4.2 river miles. Throughout this reach, a meandering channel with a substrate of primarily sand and small gravel characterizes the Little River. However, the channel bed is frequently situated on erosion-resistant bedrock. Through this reach, the channel slope averages approximately 0.033 percent, with bank heights varying from approximately 5 to 7 feet above the base flow elevation. An active floodplain is evident on one or both sides of the river. The bank materials consist mostly of cohesive silt and clay that are relatively resistant to erosion. The banks typically have partial to complete mature tree cover that enhances bank stability. Backwater and a few ponded areas were observed adjacent to the channel and floodplain in some locations. While the watershed hydrology is influenced by certain aspects of Coastal Plain geology, the stream morphology is more characteristic of that found in the Piedmont (i.e., generally coarser substrate and higher channel slope).

Downstream, the reconnaissance started at Lowell Mill Dam and terminated at the site of the former Rains Mill dam at SR 2320, a travel distance of approximately 11 river miles. Throughout this reach, a meandering channel with a substrate of primarily sand and small gravel similarly characterizes the Little River. However, exposed bedrock along the banks and river bottom appear more frequently. Additionally, several reaches are characterized as rapids with bed material that includes small boulders. The channel slope averages approximately 0.038 percent through this reach of the river, with bank heights that vary from approximately 5 to 6 feet above the base flow elevation. Through much of this reach, the channel meanders along bluffs that rise to greater than 40 feet above the valley floor. An active floodplain is evident on one or both sides of the river. The river banks typically have partial to complete mature tree cover that enhances bank stability. Very little backwater and ponding were observed adjacent to the channel or within the floodplain.

1.2.4 Water Resources

1.2.4.1 Best Usage Classifications

The project watershed is situated in the USGS Hydrologic Unit 03020201 of the Neuse River Basin (Figure 2, Appendix A). The watershed encompasses a majority of Neuse River Sub-basin 03-04-06 as designated by the NCDWQ (NCDWQ 2005). The Little River is classified as **WS-V NSW**, denoting freshwaters used as a source for water supply (Stream Index Number 27-57). **NSW** denotes nutrient sensitive waters that require additional nutrient management due to excessive growth of microscopic and macroscopic vegetation. Buffalo Creek, Little Buffalo Creek, and Long Branch are classified as **C NSW**, a usage classification designating waterways used for secondary recreation that also require nutrient management programs (Stream Index Numbers 27-57-16, 27-57-17, 27-57-15) (NCDWQ 2002).

The Site Impoundment exhibits low dissolved oxygen concentrations below the confluence of Little Buffalo Creek with the Little River. In addition, declining fish communities have been documented within the watershed (NCDWQ 2002). As a result, the former Site Impoundment from US Route 301 (US 301) to the Lowell Dam is listed as an Impaired Water by the NCDWQ (NCDWQ 2004). Due to the water quality problems and development pressures on the upper watershed, parts of the Little River were designated as a Targeted Local Watershed for stream restoration as designated by the N.C. Department of Environment and Natural Resources' Ecosystem Enhancement Program (EEP).

1.2.4.2 Water Quality

Prior to dam removal, the Little River exhibited development pressures, declining fish communities, and associated problems due primarily to low dissolved oxygen, in great part, from Lowell Dam backwater effects and the minor municipal point source discharge located directly below US 301. As a result, the Little River is listed on the State's 303(d) list because of low dissolved oxygen (NCDWQ 2004). The impaired reach includes approximately 20 miles, extending from the confluence with Little Buffalo Creek to 4.2 miles upstream of NC Highway 581 (NC 581). The "Impaired Water" designation includes approximately 7,800 linear feet (1.5 miles) of the formerly impounded portions of the Little River. This impaired reach has been placed into a Category 5 assessment designation, according to guidance from the USEPA (USEPA 2001). A Category 5 assessment consists of waters that are impaired for one or more designated uses by a pollutant(s) and requires a Total Maximum Daily Load (TMDL). The term pollutant as defined by USEPA means "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into the water" (NCDWQ 2004).

Buffalo Creek, a larger tributary to the Little River above the former Site Impoundment (Figure 3, Appendix A), also exhibits impaired biological integrity likely due to sedimentation and nutrient inputs associated with agriculture, construction, and potential Lowell Dam backwater effects. As a result, Buffalo Creek has also been listed on the State's 303(d) list for impaired biological integrity (Category 6) (NCDWQ 2004). Buffalo Creek is also a Targeted Local Watershed for stream restoration as designated by EEP (Subbasin 6, Watershed 80050).

1.3 Restoration Summary

Site restoration efforts consisted primarily of the physical removal of the Lowell Mill Dam and the associated mill works. The dam removal process is detailed in Section 2.0 ("Dam Removal"). Construction activities associated with the removal of the dam were phased in order to minimize impacts to aquatic resources upstream, downstream, and in the immediate vicinity of the dam structure. Furthermore, throughout the dam removal process, numerous construction practices were undertaken to minimize potential impacts to aquatic resources (see Section 2.5, "Impacts to Water Resources").

Following dam removal, the formerly impounded reaches of the Little River, Little Buffalo Creek, and the unnamed tributary were restored to free-flowing, lotic streams. Monitoring activities that were initiated in advance of dam removal will continue for up to five years beyond the dam removal and will target changes in water quality, aquatic habitats, and shifts in biological diversity among benthic and vertebrate communities. In addition, these monitoring efforts will examine changes in habitat specifically needed for the reestablishment of rare mussel populations, and will document the return of anadromous fish to approximately 40 miles of river and major tributaries previously unreachable due to the presence of the Lowell Dam (Figure 3, Appendix A).

1.4 Project Mitigation Goals

The goals of the Lowell Mill Dam removal are the restoration of impounded reaches of the Little River and affected tributaries to their natural lotic conditions. To demonstrate the achievement of this goal, the affected water bodies will be monitored for successful reestablishment of several functional attributes, which include lotic flow and habitat improvements for aquatic communities that are characteristic of a coastal plain lotic environment. Additionally, efforts will be made to confirm that anadromous fish species have been restored to their historical spawning grounds and that species favoring lotic habitats, including rare or endangered species, are able to re-colonize these restored habitats. The specific goals of this project are to:

- **Restore approximately 36,875 linear feet of free-flowing river** and stream channels formerly inundated under the spillway crest pool elevation of Lowell Mill Dam.

- **Restore the natural flow** and corresponding sediment transport relationships through and well beyond the approximately 36,875 linear feet of former impoundment.

- **Improve water quality and aquatic communities within impaired (303[d]) rivers** and streams degraded by stagnated flow within the former Site Impoundment. A minimum of 36,875 feet of river and stream channel will be converted from impeded, lentic conditions into restored, lotic streams and rivers supporting a more diverse aquatic community characteristic of pre-impoundment conditions.

- **Restore rare and endangered species habitat** within rivers and streams formerly lost within the Site Impoundment. Twenty documented rare and endangered aquatic species will directly benefit from restoration of a continuous, free-flowing river, including dwarf wedgemussel and the only documented population of Tar River spinymussel in the Neuse River Basin.

- **Restore anadromous fish passage**, foraging, and spawning opportunities within 36,875 linear feet within the former Site Impoundment, as well as an additional 204,920 linear feet of main stem stream and river channels within the FBA.

- **Provide new academic research and data** regarding the effects of dam removal on aquatic and terrestrial ecosystems.

- **Provide public recreation opportunities**, including the establishment of a park and canoe/kayak launch facilities at the Site.

- Generate a minimum of **36,875 linear feet of Stream Mitigation Units (SMUs) for use by the Ecosystem Enhancement Program (EEP) to offset impacts to streams in the specific Neuse River hydrologic unit** (see Table 1 for details). Additional SMUs may also be generated for use by the EEP, dependent upon results of post-project monitoring programs.

Table 1. Stream Mitigation Units (SMUs)[1] to be generated by removal of the Lowell Mill Dam.

	Channel Restored (feet)	Mitigation Ratio	SMUs
Primary success criteria:			
1) Re-introduction of rare and endangered aquatic species 2) Improved water quality, 3) Improved aquatic community 4) Anadromous fish passage (under crest pool)	36,875 feet of free-flowing river and tributaries **under the crest pool**	1:1	36,875
Reserve success criteria:			
Anadromous fish passage (**above crest pool**)	Up to 204,920 feet of second order or higher, free-flowing tributaries	5:1	40,984
Downstream benefits below the dam	500 feet below dam	1:1	500
Human values 1) Scientific value 2) Human recreation	-----	Up to 20 percent bonus	7,375
Total potential additional SMUs			48,859
Committed SMUs			**36,875**

[1] Primary success criteria will be monitored to verify and confirm positive changes to each functional criterion as outlined in this report and in the Dam Removal Guidance. Reserve criteria will be monitored for possible augmentation of the primary SMUs.

The removal of the Lowell Mill Dam as a large-scale compensatory mitigation project is consistent with state and national regulatory support for environmentally beneficial dam removal. Several downstream

dams along the Little River have already been removed, which left Lowell Mill Dam the furthest downstream barrier to anadromous fish passage. The Quaker Neck and Cherry Hospital Dams were removed in 1998, and the Rains Mill Dam was removed in 1999. Mike Wicker, the sponsor of the Quaker Neck dam removal project received the 2001 Governor's Conservationist of the Year award and the project was widely publicized nationwide for its environmental benefits. Support from state and federal resource agencies for the removal of Lowell Mill Dam was extensive.

2.0 DAM REMOVAL

With the exception of Sections 2.1 ("Pre-Removal Aquatic Species Surveys") and 2.5 ("Impacts to Water Resources"), information for the text in this section was provided by MMI. MMI was responsible for construction plan development, including phased dewatering and construction activities, for the Lowell Mill Dam removal. Text for section 2.1 was provided largely by TCG, with modifications by ESC for inclusion in this document. ESC has edited section 2.5 with information provided largely by BWE.

2.1 Pre-Removal Surveys

2.1.1 Precautionary Aquatic Surveys for Federally Protected Species

Precautionary aquatic surveys for federally protected species were performed at the Site by TCG (Figure 3, Appendix A). Surveys were performed to catalog protected species immediately downstream of the Site, and to identify other aquatic species expected to re-colonize the former Site Impoundment upon dam removal and subsequent restoration of lotic flow. Sampling methodologies for fish, mussels, and snails are outlined in Sections 3.2.5, 3.2.6, and 3.2.7. Table 2 displays aquatic species surveyed during pre-removal monitoring activities at the Site.

The sampling station was established on the Little River immediately downstream of the former Lowell Mill Dam and extends approximately 400 meters downstream. The 400 meter survey length was recommended by the FWS to ensure mussel and snail species were thoroughly sampled. A narrow riparian strip bordered by an agricultural field is adjacent to the right bank (referenced looking downstream), while a moderately sized forested riparian buffer is along the left bank. The stream banks are fairly stable beyond the scoured area just below the dam. Habitat consists of a series of long riffles and runs with a gravel and sand dominated substrate. A total of 18 person hours of visual survey and 1,274 seconds of electro-shocking time were employed during sampling.

Several rare mussel species, including the Carolina slabshell (*Elliptio congarea*), yellow lance (*Elliptio lanceolata*), Roanoke slabshell (*Elliptio roanokensis*), yellow lampmussel (*Lampsilis cariosa*), Eastern lampmussel (*Lampsilis radiata*), and creeper (*Strophitus undulatus*) were identified during sampling. One rare fish species, the ironcolor shiner (*Notropis chalybaeus*), was also identified. None of these species are Federally Threatened or Endangered.

Table 2: Lowell Mill Dam site: aquatic species found.

Scientific Name	Common Name	Abundance/CPUE
Freshwater Mussels	~	**CPUE**
Elliptio congarea	Carolina slabshell	0.28
Elliptio lanceolata	yellow lance	*
Elliptio roanokensis	Roanoke slabshell	0.39
Elliptio spp.	elliptio mussels	458.67
Elliptio viridula	green lance	2.0
Lampsilis cariosa	yellow lampmussel	0.06
Lampsilis radiata	eastern lampmussel	0.06
Pyganadon cataracta	eastern floater	0.22
Strophitus undulatus	creeper	0.17
Utterbackia imbecillis	paper pondshell	*
Freshwater Snails and clams	~	**Relative Abundance**
Campeloma decisum	pointed campeloma	Uncommon
Corbicula fluminea	Asian clam	Very Abundant
Elimia catenaria	gravel elimia	Uncommon
Freshwater Fish	~	**Relative Abundance**
*Alosa sapidissima***	American shad	Uncommon
*Alosa mediocris***	hickory shad	Abundant
Anguilla rostrata	American eel	Very Abundant
Aphredoderus sayanus	pirate perch	Common
Cyprinella analostanus	satinfin shiner	Rare
Esox niger	chain pickerel	Uncommon
Etheostoma olmstedi	tesseslated darter	Very Abundant
Etheostoma vitreum	glassy darter	Uncommon
Gambusia holbrookii	eastern mosquitofish	Common
Hypentelium nigricans	northern hogsucker	Uncommon
Lepomis macrochirus	bluegill	Common
Micropterus salmoides	largemouth bass	Common
Notropis amoenus	comely shiner	Uncommon
Notropis chaylbaeus	ironcolor shiner	Common
Notropis hudsonius	spottail shiner	Abundant
Notropis procne	swallowtail shiner	Abundant
Noturus gyrinus	tadpole madtom	Rare
Noturus insignis	margined madtom	Uncommon
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Abundant
Aquatic salamanders	~	**Number**
None	~	~

** Found during subsequent quantitative surveys (January 2006) at site 11, not found during initial qualitative surveys, thus not factored into CPUE (catch per unit effort)*

*** Present during the 6-18-05 and 7-01-05 surveys, but not present during the 7-25-05 survey*

Numerous measures were taken during the dam removal process to minimize potential impacts to water resources (Section 2.5), including rigorous sediment and erosion control methods in both the terrestrial and aquatic environments at the Site. It is anticipated that habitat for the above listed species will be substantially enhanced and expanded as a result of the dam removal at the Site, and that these species will be free to colonize the upstream Little River and contributing tributary reaches previously impeded by the dam.

2.1.2 Precautionary Sediment Analyses

The FWS agreed to provide expertise in developing protocols for sampling and analyzing sediments within the former Site Impoundment and from downstream reference areas. The purpose of sediment sampling was to screen sediments for toxic content potentially hazardous to aquatic resources. Tom Augspurger, Ph.D., a noted environmental toxicologist with FWS, managed sediment sample collections from the Little River bed and prepared a report summarizing his findings (FWS 2005, Appendix B).

Results indicated that none of the sediment samples exceeded the probable effects concentrations (PECs, concentrations above which adverse effects to sediment dwelling organisms may be expected) for any elemental contaminant analyzed as a part of the study (Appendix B). Thus, potential contamination of the sediments present within the former Site Impoundment is unlikely to be of concern, either *in situ* or upon mobilization.

2.2 Dewatering

The Site Impoundment was dewatered prior to dam removal. Dewatering was conducted in order to 1) augment sediment transport from the upper reaches of the former Site Impoundment through the Little River, 2) mitigate hazardous conditions at the Site, and 3) allow natural riparian recruitment of vegetation along the river banks within the former Site Impoundment to mitigate potential bank erosion.

Phased and controlled lowering of an impoundment behind a dam is typically the safest and most environmentally sound practice in pre-dam removal activities. When gates and other water control devices are present at a dam site, phased dewatering can often be accomplished without the need to breach the dam spillway. This was the approach pursued at the Lowell Mill Dam.

The Site Impoundment was dewatered beginning in March of 2004. The initial dewatering was undertaken in order to lower the Site Impoundment to allow exposed banks upstream of the Site to vegetate through natural recruitment before the dam was removed. Dewatering also facilitates sediment consolidation, increasing its shear strength. This aided in the natural stabilization of the river banks that were exposed once the dam was removed.

The initial dewatering was accomplished by removing a steel plate that was obstructing water passage through the east (downstream) wall of the south water chamber of the mill works concrete foundation (Photo 2). Additionally, a large hole was cut in the east water room concrete wall to provide greater cross-sectional area to increase flow capacity. The south head gate was then removed from the mill foundation. This allowed the impounded river water to flow through the mill foundation and discharge into the Little River directly below the dam.

Photo 2. Removal of steel plate restricting water passage through the mill works foundation (March 2004)

The dewatered condition was maintained until May 10, 2005, when BE uncovered the former turbine draft tube in the north water chamber of the mill foundation. The floor of the north chamber contained debris that blocked the draft tube and impounded water in the mill works foundation. The north head gate was then raised and propped open to allow water to flow through the mill works foundation, down the draft tube before exiting into the Little River below the dam.

Photo 3. Unnamed tributary at confluence with Little River following dewatering (summer 2004)

By June 1, 2005, the water surface elevation of the Site Impoundment had reached its lowest level and the dam was no longer influencing the river stage during normal flow conditions. A June 2005 reconnaissance of approximately 4.9 miles of the former Site Impoundment from Old Beulah Road (SR 1934) to the Lowell Mill Dam revealed that the intended natural stabilization of the river banks through natural recruitment had taken place (Photo 3). Both head gates remained open, and flow discharged through the mill water rooms into the Little River below the dam until the start of dam demolition.

2.3 Substrate Management

A fluvial depositional area formed within the bankfull channel of the Little River over the decades since the dam was constructed. This fluvial formation lies directly upstream of the former dam on the north side of the river. Material from this depositional area was sampled in the spring of 2005 and was determined by MMI to be potentially erodible and subject to suspension into the water column during high flow events once the dam spillway was demolished.

In order to minimize potential erosion, a substrate management plan was developed to excavate portions of the depositional area, designated "Island Substrate" by MMI (Sheet 9, Appendix C). The excavated material was used to cap concrete dam debris deposited within the designated disposal areas (Photo 4). The relatively fine material (i.e., sand, silt, and clay) comprising the Island Substrate was used to fill voids within fractured concrete debris, thereby enhancing the stability of the disposal areas. When the elevation of the concrete debris and depositional material placed in Disposal Area #1 reached approximately 1.0 foot below the elevation of the remaining section of the northern end of the spillway, the area was graded to the final elevations (Sheet 11, Appendix C).

Photo 4. Debris disposal areas viewed from south bank—note remaining section of dam (January2006)

To minimize potential impacts to aquatic communities during excavation of the fluvial depositional area, construction activities were restricted to the portions of the area above the Little River stage. Favorable weather conditions kept the Little River stage very low at the Site during dam removal, and BE was able to excavate the depositional area to a lower grade than initially planned. MMI anticipates that this will benefit the long-term stability of the north river bank upstream of the remaining portion of the dam spillway.

2.4 Dam Removal

The Lowell Mill Dam was constructed as a 190-foot-long mass concrete ogee-crested (S-shaped) spillway approximately 10 feet high. The spillway was positioned on a bedrock outcrop underlying the Little River channel. A grist mill was located at the dam's south abutment. The mill likely consisted of a wood-frame structure with a concrete foundation situated against a bedrock outcrop located on the south bank.

The mill works consisted of a head structure that housed trash racks and head gates, two water rooms, and turbine draft holes leading to an exit race to the Little River. No internal mechanical works were present in the mill works. In the years preceding the dam's removal, the mill work's concrete walls had considerably weakened, exposing reinforcing steel bar.

Pre-demolition activities included a survey of the dam structure by a licensed blasting firm prior to finalization of the demolition plans. The survey confirmed the feasibility of cracking of the spillway through controlled drilling, size and placement of charge, and ignition timing. Cracking the spillway internally allowed the dam structure to be fractured *in situ* in appropriate-sized segments for subsequent removal. This approach was preferable to creating a rubble pile and a high amount of small-sized pieces that could potentially be transported downstream by the river during demolition.

Dam removal activities began in December 2005, after BE installed Site erosion and sedimentation control measures. A primary construction equipment access was established from the south via Bagley Road and Lowell Mill Road (Sheet 4, Appendix C). A secondary construction access was established from the north through an adjacent property. A construction staging area was established on the south bank, directly adjacent to the mill works, with direct access to the river and spillway established immediately downstream. At this location, the river bank grade was less steep than above the spillway, requiring less preparatory grading. This minimized the potential for impacts to aquatic communities due to erosion and siltation. A stabilized rip-rap, access ramp was constructed immediately downstream of the dam.

The secondary access from the north was used to approach the north abutment from the north side of the river. This access was also used for soil excavation and disposal operations, and to remove heavy equipment. Equipment was removed from the river channel on a daily basis in case of unexpected high river flow events.

The dam spillway demolition began when the spillway was drilled on December 23, 2005 to set the explosive charges to crack the mass concrete structure. A test blast was conducted on December 27, 2005

to determine the proper charge loading that would achieve the desired amount of fracturing of the mass concrete.

Demolition continued on December 28, 2005 with repeated explosive blasting and fracturing of the spillway structure to prepare for subsequent debris removal with conventional construction equipment. The blasting occurred without incident and the fractured structure remained essentially intact and in place as intended, thereby minimizing impacts to aquatic wildlife and habitat.

Demolition of the submerged portions of the mill works occurred in January 2006. Blasted concrete debris from both the mill works and spillway was placed by heavy equipment in designated debris disposal areas adjacent to the north dam abutment (Sheet 5, Appendix C). Disposal areas were generally established as specified in the Site engineering plans, and were oriented to incorporate a remaining part of the northern portion of the dam spillway (Sheet 11, Appendix C). The remaining portion of the spillway was left to stabilize the debris disposal areas and to impart the historic character of the dam for the park planned at the Site.

The spillway and mill works were completely demolished and removed by January 18, 2006. Within the designated disposal areas, concrete debris was compacted and capped with sediment excavated from a fluvial depositional area adjacent to the northern upstream side of the spillway (see Section 2.4, "Substrate Management"). Approximately 415 cubic yards of concrete from the spillway and 125 cubic yards from the mill works were removed and placed in designated disposal areas. Portions of the concrete spillway were used to construct toe protection along the south bank in the vicinity of the south abutment and along the north bank adjacent to debris disposal areas (Sheet 11, Appendix C).

Photo 5. Concrete spillway debris placed as toe protection along re-graded south bank—note hydro-seeding (January 2006)

2.5 Site Stabilization

Following dam removal, over-steepened and disturbed banks of the Little River were graded to stable slopes and matted with coir fiber erosion control matting. The banks were also hydro-seeded and live-staked once construction activities ceased (Photo 5). The disposal areas were graded slightly to facilitate surface runoff, and also matted, hydro-seeded, and planted (Sheet 11, Appendix C).

Larger concrete slabs blasted from the spillway were used to create toe protection to stabilize the banks immediately above and below the spillway along both riverbanks (Photo 5). Material excavated from the fluvial depositional area upstream of the northern portion of the spillway was used to grade debris disposal areas. All planted areas within debris disposal areas received a minimum of 2 to 3 feet of suitable topsoil veneer above the concrete debris to facilitate re-vegetation.

The river bank adjacent to the former mill foundation was re-graded for public safety and aesthetic value in anticipation of a future picnic area to be located in the planned on-Site park (Sheet 11, Appendix C and Photo 5). No rock outcrops were left exposed on the south bank.

2.6 Impacts to Water Resources

Throughout the dam removal process, several construction practices were undertaken to minimize potential impacts to water resources. All appropriate terrestrial sediment and erosion control measures, including silt fencing and rock outlets, were installed in the upland portions of the Site.

Within the active Little River channel, coffer dams were installed adjacent to fill and excavation areas to prevent sediment from entering the channel to the maximum extent practicable. Additionally, just downstream of the active construction area, a sediment containment boom was installed across the Little River to retain and/or slow down sediment, thereby preventing it from remaining suspended in the water column downstream of the project area.

Oil adsorption booms were placed around the perimeter of areas within the channel where heavy equipment was used. The booms are effective in retaining any oil and fuel spillage and partitioning spills from the water column. Additionally, marine-grade hydraulic oil, which is approved for use in the ocean, was used in equipment on-Site to minimize any impacts to the river in the event of a spill. No spills were reported by BE or observed during dam removal.

Coir fiber matting was installed along re-graded/exposed bank areas to minimize erosion into the channel. These areas were hydro-seeded and live-staked to further enhance stability.

3.0 MONITORING PLAN

The former Site Impoundment and associated reference areas will be monitored to verify that the primary success criteria (Table 1) are achieved. Additionally, anadromous fish passage will be monitored throughout the FBA (Figure 5, Appendix A) to evaluate success in fulfilling the anadromous fish passage (above crest pool) reserve monitoring criterion (Table 1). Monitoring will be performed over a five-year period following dam removal or until success criteria are met. At the end of each monitoring year, RS will generate an Annual Monitoring Report detailing monitoring protocols, data, and results.

The primary components of the monitoring plan were developed to be able to demonstrate post-dam removal improvements in water quality, the aquatic community, rare and endangered species habitat, and to verify anadromous fish passage within the former Site Impoundment and the entire FBA. Demonstrating the successful achievement of these goals via project monitoring will ensure that the project provides at least 36,875 SMUs to EEP within the Neuse River Basin (Hydrologic Unit 03020201). Successful documentation of anadromous fish passage above the crest pool within the FBA (Figure 3, Appendix A) may potentially generate additional SMUs for this project that are not currently committed to EEP.

3.1 Baseline Monitoring

Prior to dam removal, the Site Impoundment and nearby reference areas were monitored for the physical and biological parameters (with attendant methodology) outlined in Section 3.2 ("Monitoring Methods") to establish baseline conditions. Baseline data will be compared with subsequent monitoring data collected over the course of the five-year monitoring period. Please refer to Section 5.0 ("Mitigation Success Criteria") for additional discussion.

3.2 Monitoring Methods

3.2.1 Channel Cross-Sections

Nineteen (19) permanent channel cross-sections have been established at locations throughout the Site Impoundment and on tributaries where functional restoration is expected to occur. Four (4) permanent cross-sections have been established in reference reaches above and below the Site Impoundment to facilitate comparison between previously impounded and un-impounded reference reaches. One cross-section has been established immediately downstream of the Site to monitor changes in bankfull channel dimension to assess the "downstream benefits below the dam" reserve success criterion. Figure 4 (Appendix A) displays channel cross-section locations. Each cross-section station has been surveyed prior to dam removal and will be re-surveyed annually throughout the five-year monitoring period. Pre-removal survey data will be compared to post-removal data to assess changes in the channel dimensions as the natural, lotic condition returns to the river.

3.2.2 Sediment Grain Size Distribution

One measure of habitat quality is found in the particulate nature of the stream substrate. Sediment grain size distribution will be assessed at each channel cross-section location. For water depths less than 3 feet (i.e., areas which are wadeable), 100-count pebble counts will be performed consistent with the Wolman method (Rosgen 1994).

For deeper water areas, the bulk material method will be used to assess sediment grain size distribution. This method entails using a Ponar (or similar) dredge to take five sediment samples evenly spaced along each monitoring cross-section. Sediment from each of the five dredge samples will be combined in one composite sample and sorted using sieves to determine the sediment grain size distribution by weight.

3.2.3 Photography and Videography

Digital photography and videography will be used to qualitatively assess improvements in aquatic community habitat, rare and endangered aquatic species habitat, and stream channel stability.

Photography and videography is proposed annually throughout the five-year monitoring period at each channel cross-section location.

At each cross-section station, four photographs will be taken: one facing upstream from the cross-section center (typically the midpoint of the wetted channel width), one facing downstream, one from the left bank towards the right bank, and one from the right bank towards the left bank. Videography will consist of a brief narrated panorama at each cross-section center.

Throughout the course of project pre-monitoring, several large depositional areas (i.e., mid-channel bars) were observed within the former Site Impoundment after dewatering. These areas were photographed and the upstream and downstream limits were located with GPS technology. These areas will also be photographed annually during project monitoring to assess the anticipated enhanced sediment transport dynamics within the Little River as a result of dam removal.

3.2.4 Benthic Macroinvertebrate Sampling

Changes in the benthic community within the former Site Impoundment are anticipated as the natural lotic flow returns to the Little River and its previously impounded tributaries. Benthic macroinvertebrate sampling will be conducted annually to track changes in benthic community composition throughout the five-year monitoring period. The benthic macroinvertebrate communities within the Little River and Little Buffalo Creek will be sampled using NCDWQ protocols outlined for the Standard Qualitative Method in the Standard Operating Procedures for Biological Monitoring (NCDWQ 2003). Figure 4 (Appendix A) displays benthic macroinvertebrate sampling station locations within the former Site Impoundment as well as reference station locations. During pre-removal-monitoring, benthic macroinvertebrate sampling was conducted at three stations within the former Site Impoundment and at two reference stations (one upstream and one downstream of the former Site Impoundment). For the five-year post-removal monitoring period, four benthic sampling stations within the former Site Impoundment and two reference stations have been added to the sampling scheme, yielding a total of seven stations within the former Site Impoundment and four reference stations (two upstream and two downstream of the former Site Impoundment).

Samples collected from each station will be shipped to a NCDWQ-certified lab for processing and identification. The lab will provide standard community data including total number of organisms, total number of taxa, Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, EPT: Chironomidae (midge) ratio, and biotic index assigned values (BIAV).

3.2.5 Fish Sampling

Pre-removal fish sampling was performed by TCG, and their personnel have provided the ensuing text in this sub-section with minor modification by ESC for inclusion in the document. During the pre-removal Year 2005 sampling period, fish surveys were conducted at 14 sampling stations: seven within the former Site Impoundment, three upstream of the Site Impoundment, and four downstream of the former dam site (Figure 4, Appendix A). The methodology outlined below will be used by TCG in each subsequent monitoring event that occurs during the five-year monitoring period.

Sampling stations were accessed by canoe or by foot when stations were near road crossings. The length of river channel surveyed at each sampling station was 200 meters, but was 400 meters at the sampling station immediately downstream of the former dam (Section 2.1.1). The midpoint of each station was recorded using GPS technology. Specific visual surveys were conducted for fish. Survey personnel spread out across the river channel into survey lanes, which provided total width coverage as they surveyed in an upstream direction (Photo 6). All appropriate habitat types within a given survey reach were searched thoroughly via visual surveys using primarily mask/snorkel and occasionally glass bottom buckets (batiscopes) in shallow water habitats. SCUBA was used in deepwater habitats (i.e., sampling stations within the lower reaches of the Site Impoundment near the dam). Tactile methods were also employed when appropriate. Where SCUBA was used, one of the multi-person survey team members provided surface support to divers.

Active surveys for more cryptic species (e.g., Neuse River waterdog [*Necturus lewisi*] and Carolina madtom [*Noturus furiosus*]) were conducted by turning over rocks and lifting submerged rootmats. Each person conducting visual surveys also used small hand-held dip nets or mesh bags to capture species. All fish species captured or observed using these methods were identified and recorded with notes made regarding their relative abundances.

At each station, a combination of electro-fishing, hand-held dip netting, and seine netting was used to capture fish. These methods were used at each of the sampling stations, with the exception of the two stations within the Site Impoundment nearest the dam (Figure 4, Appendix A). Fish surveys were not conducted at these two stations as water depths were prohibitively deep to employ similar methodologies as those used at the other stations. Additionally, it was determined in conjunction with the FWS that these lentic areas contained a predictable suite of impoundment-adapted species and therefore would not require a pre-removal inventory. Fish species observed while conducting visual surveys were recorded and assigned a relative abundance value based on the number of individuals observed at the sampling station.

As with the visual surveys, the survey team began at the downstream point of the sampling station and proceeded upstream. Two back-pack electroshocking units were used in most reaches. One person with a dip net accompanied each shocker and a straight haul seine net was positioned downstream of the shockers. The two shockers often work in concert to herd fish towards the seine net. As with visual surveys, all habitat types present in the survey reach were sampled using this method, moving upstream at 3 to 4 meter intervals until the entire length of the habitat type (riffle/run, pool) was sampled. This process was performed in the middle of the channel and close to each bank in order to survey the entire habitat. The method was effective in riffle and run habitats of shallow to moderate depths, but was fairly ineffective in deep runs and wide pools.

The use of kick-seining was also employed to capture fish. This was most effective in capturing darter and shiner species in shallow riffles and runs, as well as in shallow pools. This method was not as effective in deeper pools or runs and riffles with a very strong current. As with the electroshocking method, each habitat type was sampled at least once. Seine hauls were performed with two people dragging the net upstream through the riffle/run with two others positioned upstream of the net, kicking up the substrate to herd the fish towards the net. At times, two seine nets were pulled in lieu of one when

deemed more effective based on habitat conditions. Pools were sampled by making fast pulls in a downstream direction, herding fish towards the banks or sand/gravel bars. As above, fish were identified, counted, and released. These methods often provide more accurate estimates on abundance of some species than more traditional methods, such as mark and recapture and depletion (Hankin and Reeves 1988, TCG personal observations).

Photo 6. Pre-removal fish sampling by TCG—note oil adsorption boom in foreground (winter 2005)

All captured fish were placed into a water bucket until they could be identified, counted, and released. The length of time necessary to identify, count, and release the fish depended on the number of fish in the bucket and their condition. Any fish that did not recover from the electroshocking were preserved in 95 percent ethanol. In addition to fish, aquatic salamanders were also captured using these methods and released after identification. Habitat notes were recorded at each collection site. A relative abundance was assigned to each species captured or observed at each site.

Hook and line fishing with spinner baits was also employed at a few locations. This was not a primary method of sampling and was mainly used for recreation while accessing survey sites and during the time between visual and active capture methods. This method did not produce any species that were not detected using other sampling methods.

3.2.6 Mussel Sampling

Pre-removal mussel sampling was performed by TCG, and their personnel have provided the ensuing text in this sub-section with minor modification by ESC for inclusion in the document. Mussel sampling was performed at each of the 14 stations where fish sampling occurred (Figure 4, Appendix A). The methodology outlined below will be used by TCG in each monitoring event during the five-year monitoring period.

As in fish sampling, specific visual searches were conducted for mussels. Survey personnel spread out across the river channel into survey lanes, which provided total width coverage as they surveyed in an upstream direction. All appropriate habitat types within a given survey reach were searched thoroughly via visual surveys using primarily mask/snorkel and occasionally glass bottom buckets (batiscopes) in shallow water habitats. SCUBA was used in deepwater habitats (i.e., sampling stations within the lower reaches of the Site Impoundment). Tactile methods were also employed when appropriate. Where SCUBA was used, one of the multi-person survey team members provided surface support to divers.

All species of freshwater bivalves were recorded and returned to the substrate. Searches were also conducted for relict shells, and the presence of a shell was equated with presence of that species, but not factored into the Catch Per Unit Effort (CPUE), which is defined as the number of individuals found per person per hour of search time. All species that are monitored by the North Carolina Natural Heritage Program (NCNHP) were measured (total length). Dip nets were used where appropriate to sift through leaf packs.

3.2.7 Snail Sampling

Pre-removal snail sampling was performed by TCG, and their personnel have provided the ensuing text in this sub-section with minor modification by ESC for inclusion in the document. Snail sampling was performed at each of the 14 stations where fish and mussel sampling occurred (Figure 4, Appendix A). The methodology outlined below will be used by TCG in each subsequent monitoring event during the five-year monitoring period.

As in fish and mussel sampling, specific visual searches were conducted for snails. Survey personnel spread out across the river channel into survey lanes, which provided total width coverage as they surveyed in an upstream direction. All appropriate habitat types within a given survey reach were searched thoroughly via visual surveys using primarily mask/snorkel and occasionally glass bottom buckets (batiscopes) in shallow water habitats. SCUBA was used in deepwater habitats (i.e., sampling stations within the lower reaches of the Site Impoundment). Tactile methods were also employed when appropriate. Where SCUBA was used, one of the multi-person survey team members provided surface support to divers.

As with mussels, all species of freshwater snails were recorded and returned to the substrate. Searches were also conducted for relict shells, and the presence of a shell was equated with presence of that species, but not factored into the CPUE. All species that are monitored by the NCNHP were measured (total length). Snails were handpicked from rocks and woody debris. Dip nets were used where appropriate to sift through leaf packs. Following each timed search, collected snails were identified to the species level and each species was assigned a relative abundance rating to correspond to the sampling station.

3.2.8 Habitat Assessment

Prior to dam removal, aquatic habitat was assessed at 23 monitoring cross-section stations (excluding the cross-section established immediately downstream of the Site) to provide a baseline of comparison for subsequent monitoring years to help demonstrate anticipated improvements in habitat quality and quantity. NCDWQ Habitat Assessment Forms (most recent version), which evaluate the quality,

character, and abundance of habitat niches, were completed to provide a score that describes the habitat availability and quality at each station. Habitat Assessment Forms will be completed annually at all monitoring cross-section stations throughout the five-year monitoring period and compared to pre-removal baseline and reference data. Improvements in Habitat Assessment Form scores are anticipated as the restoration of the natural lotic flow to the Little River and its previously impounded tributaries diversifies aquatic habitat.

3.2.9 Water Quality Assessments

As noted in Section 1.2.4.2 ("Water Quality"), a reach of the Little River (within the former Site Impoundment), extending from its confluence with Little Buffalo Creek downstream to a point approximately 4.2 miles upstream of NC 581 in Wayne County, is presently 303(d) listed by NCDWQ as an impaired water body due to low dissolved oxygen content. The dam removal and subsequent restoration of the natural lotic flow to the Little River is anticipated to increase dissolved oxygen levels in the water column due to surface agitation and mixing.

In order to monitor dissolved oxygen levels within the former Site Impoundment, baseline data over a 12 year period (dating back to 1994) from the NCDWQ Ambient Monitoring Station (AMS) at the US 301 bridge over the Little River (Station ID# J5690000, Figure 4, Appendix A) has been obtained. Another station, which will be used as a reference, is located approximately 1.0 mile downstream of the former Lowell Mill Dam on the Little River at Bagley Road (SR 2339) (Station ID# J5750000, Figure 4, Appendix A). Surface dissolved oxygen concentrations are measured twice per month at these stations. Dissolved oxygen data will be obtained from NCDWQ throughout the five-year monitoring period and compared with pre-removal/de-watering data to assess improvements in dissolved oxygen concentrations. The post-removal data will also be compared with reference data at the downstream AMS station.

3.2.10 Anadromous Fish Sampling

Anadromous fish sampling will be performed by TCG, and their personnel have provided much of the text in this sub-section with minor modification by ESC for inclusion in the document. Anadromous fish sampling will be conducted within the FBA on the main stems of the Little River, Little Buffalo Creek, Buffalo Creek, and Long Branch. Sampling will be conducted by TCG during the course of the five-year monitoring period. Sampling will be done at least weekly during the anticipated spawning period, lasting approximately four to five weeks. Target species include: American shad, alewife, hickory shad, striped bass, sturgeon, and blueback herring.

For sampling and analysis purposes, each of the streams listed above, with the exception of Long Branch, have been segmented into lower, middle, and upper reaches (Figure 5, Appendix A). A middle segment of Long Branch will not be surveyed due to its relatively short length, and thus it will be divided into upper and lower reaches only. Survey stations in the lower and upper reaches of the Little River will be established immediately upstream of the former Lowell Mill Dam (lower) and at the base of Atkinson Mill Dam (upper), with the middle station approximately halfway between the upper and lower stations. The confluence with the Little River (lower) and the headwaters (upper) will constitute the lower and upper survey stations on Little Buffalo Creek and Long Branch, respectively. This sampling scheme has been developed in order to evaluate how far anadromous fish species migrate into each respective water body. The precise location of sampling stations will be determined based on a number of specific habitat

and sampling factors, and the locations depicted on Figure 5 (Appendix A) are not intended to serve as fixed monitoring stations. Rather, they will serve as general geographic references for potential sampling areas. The specific locations of the survey reaches will be determined in the field and will be based on habitat conditions, accessibility, and results of the ongoing surveys. All of the habitat types present in each survey reach will be sampled at least once. Survey sites may not be necessarily sampled every week, and if success (i.e., presence of spawning adults) for a particular species is demonstrated in a given survey reach, further sampling in that reach will be discontinued.

Anadromous fish sampling methods will be similar to fish sampling methods outlined in Section 3.2.5. In addition to these methods, hook and line fishing and gill netting may be used to sample anadromous fish species depending on site conditions at the time of sampling.

4.0 MAINTENANCE AND CONTINGENCY PLAN

Little River stream banks that were disturbed (and subsequently stabilized and vegetated) at the Site as a result of dam removal activities will be observed throughout the five-year monitoring period for signs of erosion. Any areas of erosion will be re-stabilized with coir fiber matting and re-seeded with appropriate seasonal erosion control grasses to prevent additional erosion.

Changes in the Little River base level as a result of the dam removal within the former Site Impoundment may result in bank erosion along some reaches of the river. In order to monitor potential bank erosion, the former Site Impoundment will be reconnoitered following discharge events equal to or greater than 750 cubic feet per second (cfs) as measured at the Princeton USGS gauge station throughout the five-year monitoring period. Observed areas of erosion will be documented with photography and/or videography.

The results of these erosion evaluations will be made available to regulatory agencies, and if necessary, a management plan of action will be developed through coordination between RS, their sub-consultants, and the commenting agencies. Brief reports summarizing each erosion transit that occur during project monitoring will be provided in an appendix of each Annual Monitoring Report (AMR).

5.0 MITIGATION SUCCESS CRITERIA

Mitigation success criteria for the parameters outlined in the monitoring protocols above (Section 3.0) are summarized in Table 3. Success criteria for each parameter are outlined below.

5.1 Water Quality

5.1.1 Biotic Indices

Biotic indices will be used to support success evaluation for the water quality criterion (Table 1). Macroinvertebrate species are assigned biotic index values based on their tolerance of poor water quality conditions, including low dissolved oxygen concentrations, degree of substrate embeddedness (i.e., channel siltation), and high temperature. Lower biotic index values reflect lower degrees of tolerance, and are associated with higher water quality systems. It is expected that the average biotic indices of macroinvertebrate samples within the former Site Impoundment will decrease (i.e., improve) and begin to approximate the average biotic indices of reference samples, indicating improvements in water quality.

Table 3. Mitigation success criteria.

	Criterion	Parameter	Anticipated Change/Result
Primary success criteria:	Re-introduction of rare and endangered aquatic species	Presence/absence of rare/endangered individuals	Unknown
		Rare/endangered species habitat	Improvement/expansion
	Improved water quality	Benthic biotic indices	Decrease (i.e., improve)
		AMS dissolved oxygen data	Increase within former Site Impoundment (must be ≥ 6.0 mg/L or consistent with reference station data)
	Improved aquatic community	Ephemeroptera, Plecoptera, and Trichoptera taxa, total number of benthic taxa	Increase (i.e., converge with reference station data)
		Fish, Mussel, and Snail community data	Demonstrated shifts in communities from lentic to lotic character
	Anadromous fish passage (under crest pool)	Presence/absence of spawning adults within or above former Site Impoundment	Presence
Reserve success criteria:	Anadromous fish passage (above crest pool)	Presence/absence of spawning adults above former Site Impoundment within FBA	Presence (extent unknown)
	Downstream benefits below dam	Little River bankfull channel within formerly eddied/scoured areas below dam	Narrowing/increased stabilization of channel
	Scientific value	Published research	Successful completion
	Public recreation	Construction of planned on-Site park	Successful completion

In order to evaluate anticipated improvements in water quality within the former Site Impoundment, the average biotic indices of macroinvertebrate samples collected at stations within the former Site Impoundment will be compared with the average biotic indices of samples collected in reference areas. Although ESC does not believe it is possible to establish a specific numeric benchmark at this time (due to lack of sufficient data), success criteria will be achieved by comparing the means of the biotic indices from data collected at stations within the former Site Impoundment with the means of the reference stations. By the end of the five-year monitoring period, it is expected that the biotic index means from the Site Impoundment should reside within no more than one standard deviation greater than the means of those found at reference stations.

5.1.2 Ambient Monitoring Station Data

AMS data will also be used to support success evaluation for the water quality criterion (Table 1). Water quality parameters are currently measured at an AMS station located within the former Site Impoundment on the Little River at US 301 (Station ID# J5690000), approximately 1.5 miles upstream of the former Lowell Mill Dam site. Another AMS station, which will be used as a reference, is located approximately 1.0 miles downstream of the former dam site on the Little River at SR 2339 (Station ID# J5750000). Dissolved oxygen (mg/L) is measured twice per month at these stations by NCDWQ. Dissolved oxygen data dating back to 1994 has been obtained at AMS Station ID# J5690000. The reference station was established in 2004, and thus, data for this station is relatively recent.

A dissolved oxygen concentration of 6.0 mg/L is commonly accepted as the threshold below which aquatic organisms are stressed. Dissolved oxygen concentrations fluctuate seasonally, with higher concentrations characteristic of winter months and lower concentrations of summer months. In order to achieve success, the AMS station on the Little River at US 301 must consistently measure dissolved oxygen concentrations greater than or equal to 6.0 mg/L or demonstrate dissolved oxygen concentrations consistent with or higher than those measured at the reference station.

5.2 Aquatic Communities

5.2.1 Benthic Macroinvertebrates

Benthic macroinvertebrate sampling data will be used to support success evaluation for the improved aquatic community criterion (Table 1). The samples will be compared by their Biotic Index Assigned Values (BIAV) for a quantitative change as outlined in Section 5.1.1 ("Biotic Indices") to assess improvements in water quality. Additionally, data from stations within the former Site Impoundment will be compared with data from reference stations to assess changes in species composition, total number of taxa, EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera), and EPT: Chironomidae (midge) ratio. Benthic data obtained from samples at stations within the former Site Impoundment are expected to demonstrate a shift in community composition characteristic of an impounded, lentic condition to a free-flowing, lotic condition.

As with the biotic indices success criteria outlined in Section 5.1.1, the means of the total number of taxa and EPT taxa of samples collected from stations within the former Site Impoundment will be compared to those of samples collected at reference stations. Although ESC does not believe it is possible to establish a specific numeric benchmark at this time (due to lack of sufficient data), success criteria will be achieved

by comparing the means of these parameters from data collected at stations within the former Site Impoundment with the means of the reference stations. By the end of the five-year monitoring period, it is expected that the various parameter means from the Site Impoundment should reside within one standard deviation of those found at reference stations.

5.2.2 Fishes

Fish sampling data will be used to support success evaluation for the improved aquatic community and rare and endangered aquatic species criteria (Table 1). Data obtained from pre-removal fish surveys at the 14 aquatic species survey stations will be compared by CPUE for a qualitative change. Additionally, the data will be evaluated for a quantitative difference in abundance and diversity between stations located in the former Site Impoundment and reference stations. Success criteria will be achieved by survey data at stations within the former Site Impoundment indicating shifts in fish community composition towards those found at free-flowing, lotic reference survey stations. Achievement of success criteria will be evaluated by TCG personnel to verify fish communities within the former Site Impoundment are making such a transition.

For the rare and endangered aquatic species criterion, the documented presence of rare lotic fish fauna in areas previously characterized as the Site Impoundment will be used to evaluate success (see Section 5.3, "Protected Species," for additional details). If no individuals of rare lotic fish taxa are observed within the post-removal monitoring period, habitat analyses will be used as a surrogate.

5.2.3 Anadromous Fishes

Anadromous fish sampling will be used to support success evaluation for the anadromous fish criterion (Table 1). Annual migration of the six targeted anadromous fish species (i.e., American shad, alewife, hickory shad, striped bass, sturgeon, and blueback herring) will be tracked throughout the five-year project monitoring period using the methodology outlined in Section 3.2.10 ("Anadromous Fish Sampling"). Success criteria will be achieved by the documented presence of at least one spawning adult of the targeted species within or above the former Site Impoundment (i.e., within or above the former crest pool). Monitoring efforts will be invested in demonstrating that anadromous fish have successfully migrated above the Site into each of the streams systems within the FBA.

According to the DRTF guidelines, additional credit at a 5:1 ratio may be awarded to the project if anadromous fish passage is documented in the project FBA above the former crest pool (see Reserve Success Criteria, Table 1). Figure 5 (Appendix A) displays anadromous fish survey locations along the main stems of the Little River, Little Buffalo Creek, Buffalo Creek, and Long Branch. Documented presence of at least one spawning adult of the target species identified above the former Site Impoundment, within streams of the FBA may constitute grounds for rewarding additional credit to the project.

5.2.4 Mussels

Mussel sampling data will be used to support success evaluation for the aquatic community and rare and endangered aquatic species criteria (Table 1). Data obtained from pre-removal mussel surveys at the 14 aquatic species survey stations will be compared by CPUE for a qualitative change. Additionally, the data will be evaluated for a quantitative difference in abundance and diversity between stations located in

the former Site Impoundment and reference stations. Success criteria will be achieved by survey data at stations within the former Site Impoundment indicating shifts in mussel community composition towards those found at free-flowing, lotic reference survey stations. Achievement of success criteria will be evaluated by TCG personnel to verify that mussel communities within the former Site Impoundment are making such a transition.

For the rare and endangered aquatic species criterion, the documented presence of rare lotic mussel fauna in areas previously characterized as the Site Impoundment will be used to evaluate success (see Section 5.3, "Protected Species," for additional details). If no individuals of rare lotic mussel taxa are observed within the post-removal monitoring period, habitat analyses will be used as a surrogate.

5.2.5 Snails

Snail sampling data will be used to support success evaluation for the aquatic criterion (Table 1). Data obtained from pre-removal snail surveys at the 14 aquatic species survey stations will be compared by CPUE for a qualitative change. Additionally, the data will be evaluated for a quantitative difference in abundance and diversity between stations located in the former Site Impoundment and reference stations. Success criteria will be achieved by survey data at stations within the former Site Impoundment indicating shifts in snail community composition towards those found at free-flowing, lotic reference survey stations. Achievement of success criteria will be evaluated by TCG personnel to verify snail communities within the former Site Impoundment are making such a transition

5.2.6 Habitat Assessment

Habitat assessment data (see Section 3.2.8) will be used to support success evaluation for the improved aquatic community and rare and endangered aquatic species criteria. Data will be used to demonstrate improvements in aquatic community and rare and endangered species habitat. As the conditions within the former Site Impoundment transition from lentic, impeded flow to those typical of a free-flowing, lotic system, it is anticipated that the NCDWQ Habitat Assessment Form scores will quantitatively increase. Habitat Assessment Form scores at stations within the former Site Impoundment will be compared with their pre-removal scores as well as reference station scores to assess habitat improvement throughout the five-year monitoring period.

In addition to NCDWQ Habitat Assessment Form scores, channel cross-sectional survey and sediment grain size distribution data (see Sections 3.2.1 and 3.2.2) will be used to assess improvements in lotic habitat for aquatic communities and rare and endangered species. Channel cross-sections (Photo 7) must demonstrate stable bankfull channel properties throughout the five-year monitoring period to achieve success criteria. It is anticipated that the median substrate particle size (D_{50}) will gradually coarsen at cross-sections within the former Site Impoundment. However, the duration of time required for this change to occur may eclipse the five-year project monitoring period. Thus, success criteria will not be based on substrate coarsening alone. Photography and videography (see Section 3.2.3), performed at each channel cross-section station, will also be used to facilitate assessing improvements in aquatic and rare and endangered species habitat.

Photo 7. Channel cross-section on Little Buffalo Creek (summer 2005)

5.3 Protected Species

Several rare aquatic species have been documented in the Little River sub-basin, including the federally endangered dwarf wedgemussel and Tar spinymussel. Table 4, provided by TCG, displays a list of known rare aquatic species in the Little River sub-basin.

As stated in the monitoring success criteria for fish and mussels (Sections 5.2.2 and 5.2.4), the documented presence of any of the above rare species within the former Site Impoundment throughout the five-year monitoring period will constitute success in fulfilling the rare and endangered aquatic species criterion. If no individuals of rare taxa are observed within the post-removal monitoring period, habitat analyses will be used as a surrogate.

5.4 Bonus Factors

5.4.1 Public Recreational Usage

RS has retained a landscape architect to develop a park site plan for the Site and adjacent areas. The park, which will encompass approximately 16 acres, will include at least one canoe and kayak launch area, informational signs regarding the historic character of Lowell Mill Dam and the ecological benefits of its removal, a parking area, and potentially picnic areas. RS plans to present the park concept plan to the Town of Kenly board in the summer of 2006. Additionally, RS is providing a cash endowment to Johnston County to assist with final construction of the park.

Upon finalization and approval by the Town of Kenly and Johnston County, park plans and documentation from Kenly and Johnston Counties will be provided to EEP to demonstrate the Public and Recreational Usage bonus success criterion has been achieved.

Table 4. Rare aquatic species documented from Little River sub-basin.

Scientific Name	Common Name	Taxa Group	Federal Status*	NC Status*
Alasmidonta heterodon	dwarf wedgemussel	mussel	E	E
Alasmidonta undulate	triangle floater	mussel	~	T
Amboplites cavifrons	Roanoke bass	fish	FSC	SR
Elliptio congaraea	Carolina slabshell	mussel	~	W2, W5
Elliptio lanceolata	yellow lance	mussel	FSC	E
Elliptio roanokensis	Roanoke slabshell	mussel	~	T
Elliptio steinstansanna	Tar spinymussel	mussel	E	E
Etheostoma collis	Carolina darter	fish	FSC	SC
Fusconaia masoni	Atlantic pigtoe	mussel	FSC	E
Lampsilis cariosa	yellow lampmussel	mussel	FSC	E
Lampsilis radiata radiata *Lampsilis radiata conspicua*	eastern lampmussel Carolina fatmucket	mussel	~	T
Lasmigona subviridis	green floater	mussel	FSC	E
Lythrurus matutinus	pinewoods shiner	fish	FSC	W2
Necturus lewisi	Neuse River waterdog	amphibian	~	SC
Nocomis raneyi	bull chub	Fish	~	W1
Notropis chalybaeus	ironcolor shiner	Fish	~	W5
Noturus furiosus	Carolina madtom	Fish	FSC	PT
Strophitus undulates	creeper	Mussel	~	T
Villosa constricta	notched rainbow	Mussel	~	SC

**Federal and North Carolina status defined in Appendix D*

5.4.2 Scientific Research

The former Site Impoundment is subject to a study by University of North Carolina Chapel Hill scientist Adam Riggsbee, Ph.D (Riggsbee 2006). Sediment accumulated for many decades within the former Site Impoundment before the dam's removal. Dr. Riggsbee's study investigated the flushing of these sediments and associated nutrients and organic materials as they were routed through the downstream

channel network. Additionally, the study assesses physical and biological controls on nitrogen and phosphorus leaching from wetland sediments exposed by dam removal.

Furthermore, TCG's pre-removal aquatic species surveys and the subsequent post-removal surveys proposed for project monitoring will likely generate data for a potential research paper investigating shifts in aquatic community composition in formerly impounded river reaches following dam removal. Although details regarding this potential research are not available at this time, any progress will be reported to EEP in subsequent Annual Monitoring Reports.

6.0 REFERENCES

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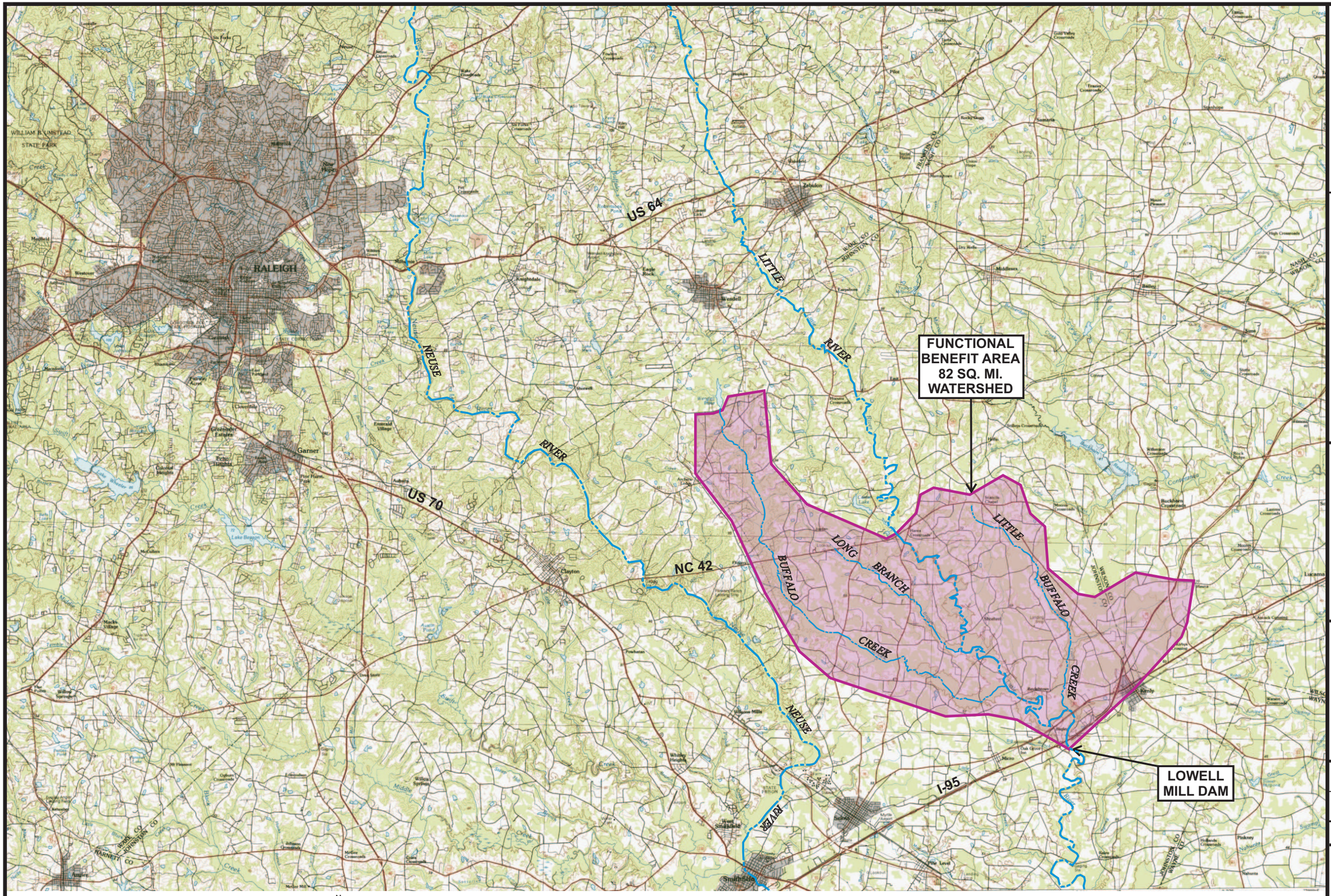
APPENDIX A: Figures



EcoScience Corporation
Raleigh, North Carolina

Client:
RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation
Ecosystem Enhancement PROGRAM

Project:

LOWELL MILL DAM- LITTLE RIVER WATERSHED RESTORATION SITE
Johnston County
North Carolina

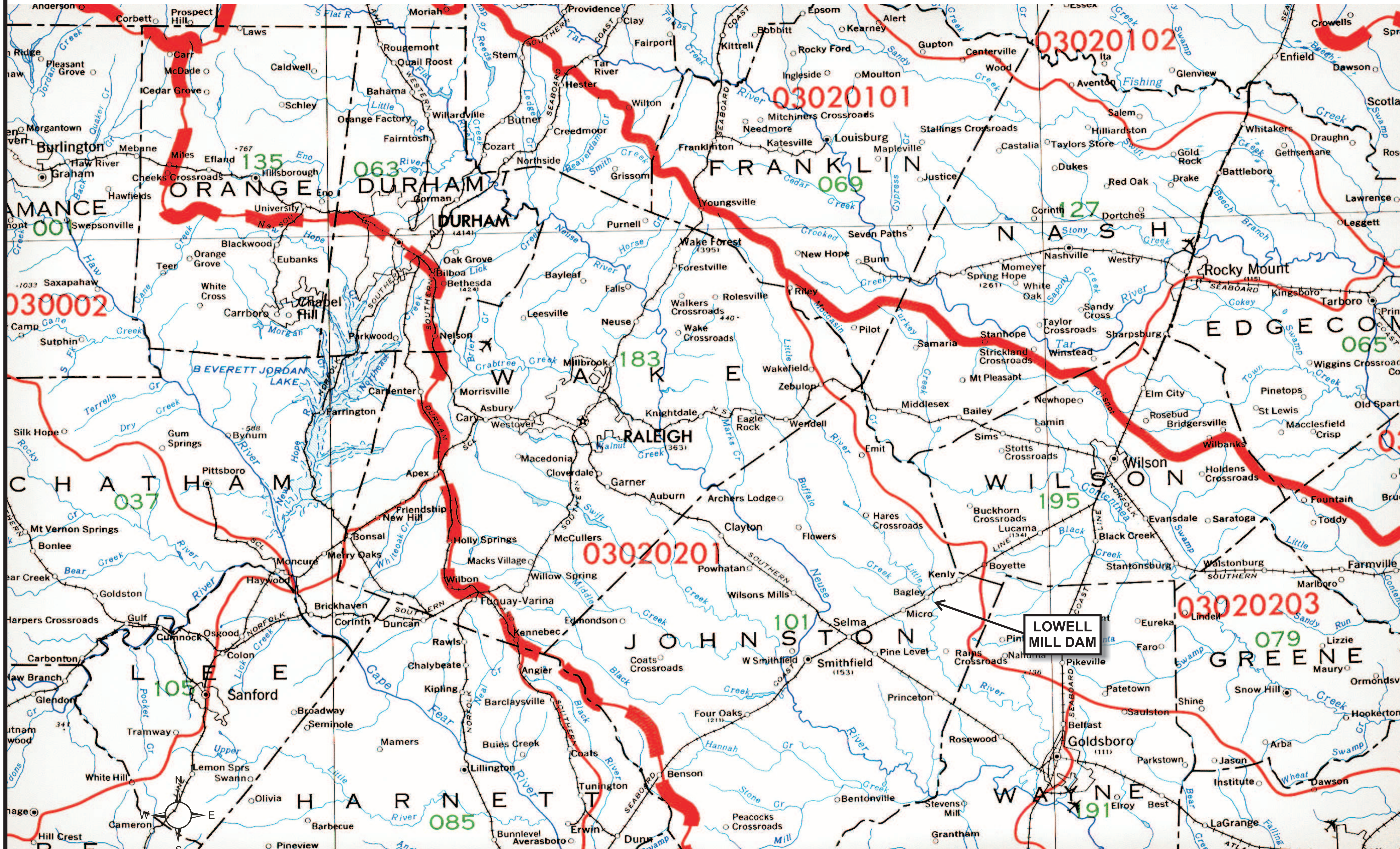
Title:

SITE LOCATION

Dwn By:	Date:
MAF	JUN 2006
Ckd By:	Scale:
JWG	As Shown

ESC Project No.: 06-289

FIGURE
1



0 5 mi. 15 mi.

1:660000

Source: 1974 North Carolina Hydrologic Unit Map

N W E S

EcoScience Corporation

Raleigh, North Carolina

Client:

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

Ecosystem Enhancement PROGRAM

Project:

LOWELL MILL DAM-LITTLE RIVER WATERSHED RESTORATION SITE

Johnston County
North Carolina

Title:

USGS SUB-BASIN AND 8-DIGIT HYDROLOGIC UNIT

Dwn By: MAF	Date: JUN 2006
Ckd By: JWG	Scale: As Shown
ESC Project No.: 06-289	

FIGURE

2

WENDELL LAKE DAM

ATKINSON MILL DAM

FUNCTIONAL BENEFIT AREA 82 SQ. MI. WATERSHED

LITTLE BUFFALO CREEK MAXIMUM EXTENT OF DAM INFLUENCE (STREAM BED ELEV.=131.0)

LITTLE RIVER MAXIMUM EXTENT OF DAM INFLUENCE (STREAM BED ELEV.=131.0)

LOWELL MILL DAM (CREST POOL ELEV.=131.0 FT.)

RESTORED AQUATIC ECOSYSTEMS

Anadromous Fish / Endangered Species Habitat

Little Buffalo Creek	32,580 ln. ft.
Little River	54,810 ln. ft.
Long Branch	30,890 ln. ft.
Buffalo Creek	86,640 ln. ft.
Total Main Stem Length	204,920 ln. ft.

Site Impoundment (131.0 feet above MSL)

Little River Pool	27,680 ln. ft.
Little Buffalo Creek Pool	8,260 ln. ft.
Additional Tributary	935 ln. ft.
Total Channel Under Crest Pool	36,875 ln. ft.

1 mi. 0 1 mi. 2 mi.

1:100000

Source: 2004 Terrain Navigator Pro (Raleigh, NC)

EcoScience Corporation

Raleigh, North Carolina

Client:

Restoration Systems, LLC

Natural Resources Restoration & Conservation

Ecosystem Enhancement Program

Project:

LOWELL MILL DAM- LITTLE RIVER WATERSHED RESTORATION SITE

Johnston County North Carolina

Title:

FUNCTIONAL BENEFIT AREA

Dwn By: MAF	Date: JUN 2006
Ckd By: JDC	Scale: As Shown

ESC Project No.: 06-289

FIGURE

3

AMS STATION ID# 5690000

AMS STATION ID# 5750000

LOWELL MILL DAM

SR 2127

SR 2130

SR 1934

US 301

I-95

SR 2339

SR 1001

SR 2320

SR 1002

MONITORING EFFORT

MCS=MONUMENTED CROSS-SECTION

FMS=FISH, MUSSEL AND SNAIL SURVEY

AD=ANCILLARY DATA

MS=MACROINVERTEBRATE SAMPLING

LEGEND

- MCS/AD + FMS + MS
- FMS
- MCS/AD + MS
- MCS/AD + FMS
- MCS/AD

4000 ft. 0 4000 ft.

SCALE IN FEET

EcoScience Corporation
Raleigh, North Carolina

Ecosystem Enhancement Program

Restoration Systems, LLC
Natural Resources Restoration & Conservation

Project:

MONITORING NETWORK DEPLOYMENT

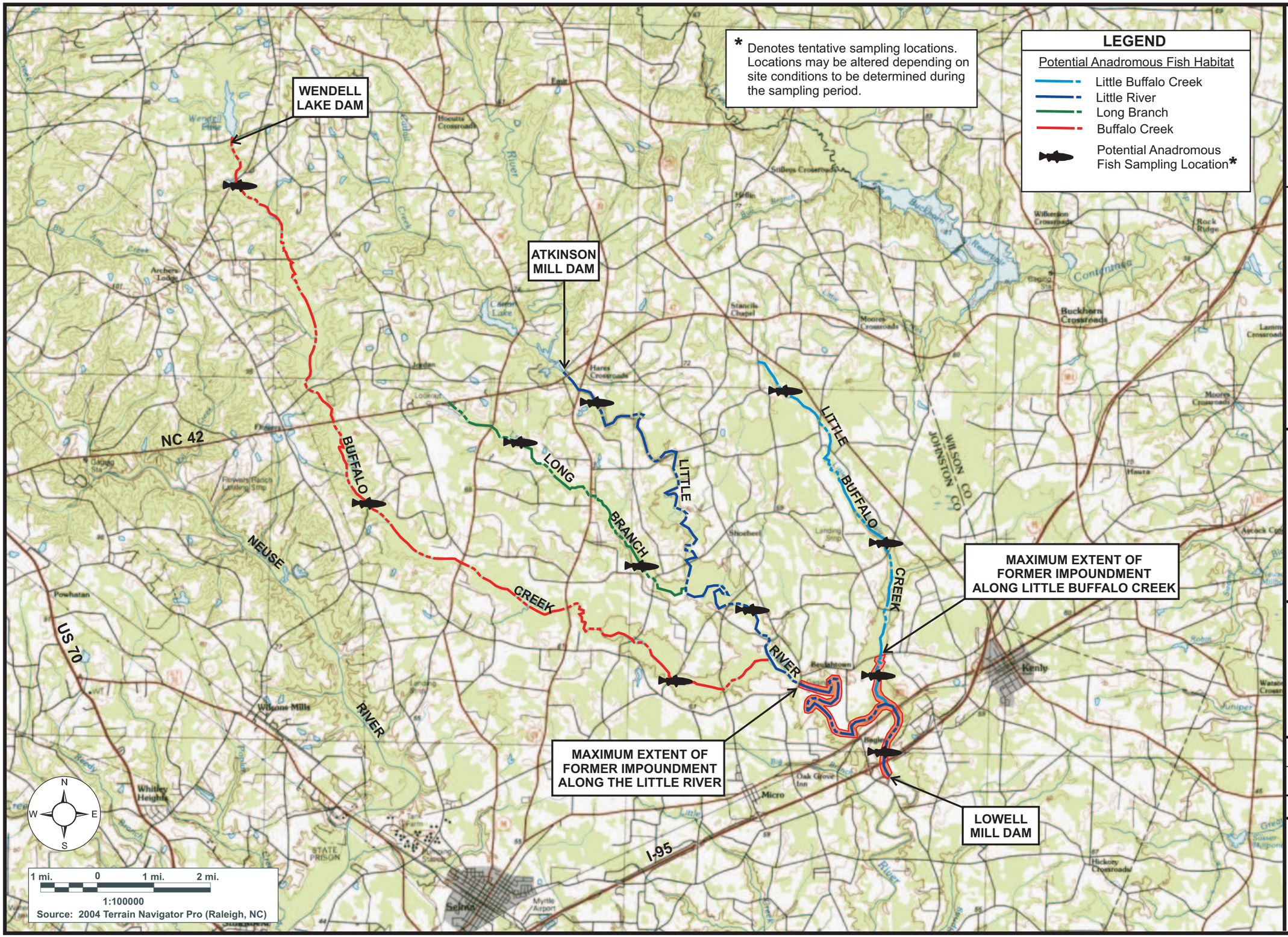
LOWELL MILL DAM - LITTLE RIVER
WATERSHED RESTORATION SITE

Johnston County, North Carolina

Dwn By:	Ckd By:
MAF	JDC
Date:	JUN 2006
Scale:	1"=4000'
ESC Project No.:	06-289

FIGURE

4



EcoScience Corporation
Raleigh, North Carolina

Client:
RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation
Ecosystem Enhancement PROGRAM

Project:

LOWELL MILL DAM-LITTLE RIVER WATERSHED RESTORATION SITE

Johnston County
North Carolina

Title:

ANADROMOUS FISH SURVEY STATION LOCATIONS

Dwn By:	Date:
MAF	JUN 2006
Ckd By:	Scale:
JWG	As Shown

ESC Project No.: 06-289

FIGURE

5

APPENDIX B: Preliminary Evaluation of Sediment Chemistry Data (Tier 2) for The Little River near Lowell Dam (USFWS 2005)

Preliminary Evaluation of Sediment Chemistry Data (Tier 2) for Little River near Lowell Dam

USFWS, Raleigh Field Office

Summary

Five sediment samples from within the impounded reach of Lowell Dam on the Little River (Johnston County, North Carolina) and two samples downstream were collected in April 2004 and analyzed for elemental contaminants and polycyclic aromatic hydrocarbons. Eighty-eight percent of all elemental contaminant results were less than *threshold effects concentrations* (*TECs*, concentrations below which adverse effects to sensitive aquatic organisms should not occur) and are therefore considered toxicologically insignificant. No samples exceeded the *probable effects concentrations* (*PECs*, concentrations above which adverse effects to sediment dwelling organisms may be expected) for any elemental contaminant. About 12 percent of the sample results fell between the TEC and PEC screening values and they were further evaluated by comparing their magnitude to the geometric mean of the screening values. No elemental contaminant concentrations exceeded these median values. Polycyclic aromatic hydrocarbons were not detected in any sample. Review of existing data and an on-site assessment (tier 1) and results of sediment chemistry (tier 2) indicated no significant sediment contamination. From a toxicological perspective, no additional sediment analyses are needed.

Background

One issue to address at dam removal sites is the nature and extent of any contaminated sediments in the impounded reach. In December 2004, the U.S. Fish and Wildlife Service's Raleigh Field Office distributed a draft report, ***Tier 1 Preliminary Evaluation of Sediments within the Lowell Dam Impounded Reach, Johnston County, North Carolina***. That document reviewed existing information on the potential for sediment contamination in the impounded reach of Lowell Dam, located on the Little River in Johnston County, near Kenly, North Carolina. Information reviewed included sources of contamination, pathways of contaminant transport, and the physical nature of the sediments behind the dam. The review indicated no major pollutant sources or contaminant concerns upstream of the dam. Minor concerns noted include highway run-off from I-95, the Kenly wastewater treatment plant, and the disposal of several automobile batteries within the stream near Highway 301.

While no major concerns were noted in the review, it was recommended that new sediment chemistry data be collected to support management decisions. Those data were to focus on heavy metals and hydrocarbons in sediment to address the minor concerns of highway run-off, wastewater treatment plant effluent, and improper battery disposal. The recommendations and a draft sediment sampling and analyses plan were circulated to regulatory agencies for review and comment prior to implementation of the sediment sampling. The following summary presents the sediment sampling methods, results, and implications.

Methods

Tier 2 Sediment collection and analyses

Sample locations:

Based on the small size of this impoundment and the sand and gravel sediment characteristics, five sites within the impounded reach and two sites downstream were sampled (Table 1 and Figure 1). Sampling targeted the few depositional areas where any contamination would be highest (e.g., adjacent to northeast bank behind the dam, and the quiescent area on the north bank near the confluence with Little Buffalo Creek) as worst case scenarios. These quiescent areas are where fine-grained sediments (which have the greatest potential to accumulate contaminants) are most likely to settle. We also sampled downstream of the few potential pollutant source areas (near battery site and downstream of I-95 and the Kenly wastewater treatment plant).

Sediment sample collection:

Samples were collected 04/14/05 and 04/19/05. At Sites 1, 2, 3, 4 and 7, a stainless-steel petit Ponar dredge was used to collect the top 5 to 10 cm of sediment; multiple grabs were collected and composited to form one sample at each site. At sites 5 and 6, a stainless-steel mud auger was used to take the grabs to make the composite for that site. The composite of the grab samples was homogenized by stirring with a stainless-steel spoon in a stainless-steel bucket. Debris (e.g., sticks, leaves, rocks bigger than ~0.1 cm^3) were removed during homogenization. Collection equipment was thoroughly cleaned (ambient water rinse, detergent and water scrub, distilled / demineralized water rinse, 10% nitric acid rinse, distilled / demineralized water rinse, hexanes rinse, and a final rinse with distilled / demineralized water) before sampling each site. Aliquants of the homogenate were put into jars provided by the analytical lab. An aliquant was also put into a 4-L container in the event that additional testing (tier 3) is conducted. Samples were stored in a cooler on ice (~ 4 ^oC) in the field and upon reaching the Service lab in Raleigh until they were delivered to the analytical lab on 04/15/05 (samples 1 to 5) and 04/19/05 (samples 6 and 7). All samples were collected, transported and stored under chain of custody.

Sediment chemical analyses:

TriTest, Inc. of Raleigh, North Carolina performed the analyses. TriTest has the North Carolina Laboratory Certification for the requested analyses. Sediment samples were analyzed for elemental contaminants by inductively coupled plasma mass spectrometry (ICP-MS), inductively coupled plasma atomic emission spectrometry (ICP-AES) and cold vapor atomic absorption (CVAA) and for polycyclic aromatic hydrocarbons by gas chromatography. Sediment particle sizes were determined by sieve series, and percent organic carbon (volatile organic solids) determined by loss on ignition. Particle size and organic carbon help with interpretation of the other chemistry data. Analyses were accompanied by batch-specific quality control / quality assurance samples (blanks, spikes, and duplicates).

Results

Tier 2 Results: Sediment analyses and interpretation

The report from TriTest is reprinted in Appendix A and summarized here. TriTest has their North Carolina Laboratory Certification for the analyses performed; review of quality control samples (laboratory blanks, spiked samples and duplicates) indicate acceptable analytical precision and accuracy for this batch of samples.

Figure 2 (with sub-figures a through h for each element) is a comparison of the elemental contaminant results to freshwater sediment quality guidelines (MacDonald et al. 2000). These consensus-based threshold effects guidelines were established to provide lower bound concentrations below which adverse effects to sensitive aquatic organisms should not occur (Threshold Effects Concentrations, or TECs) and an upper range of concentrations above which adverse effects to sediment dwelling organisms may be expected (Probable Effects Concentrations, or PECs).

Eighty-eight percent of all values evaluated were less than the TECs; these are presumed to be toxicologically insignificant. This category included all the data for arsenic, cadmium, chromium and mercury. No samples exceeded the PECs for any elemental contaminant, meaning there were no samples of obvious toxicological concern.

To evaluate the 12 percent of sample results that fell between the TECs and PECs for copper (n=1), lead (n=2), nickel (n=3) and zinc (n=1), we computed a geometric mean of the TECs and PECs for each element and defined it as a "median effects concentration", or "MEC". From Figure 2, it is apparent that no sediment samples exceeded these MECs.

Over half of the exceedences of the TECs were detected at site 3 (floodplain wetland at Little Buffalo Creek confluence). This site also had the highest percentage organic carbon, and organic and inorganic contaminants have a strong affinity for the organic fraction of sediments (Anderson et al. 1987; Rodgers et al. 1987). Figure 3 shows the correlation between each sample's percentage of organic carbon and corresponding levels of metals. While site 3 has the highest levels of metals from this assessment (Figure 2), it appears to be explained by the high organic carbon at this backswamp site off the main channel (Figure 3). Again, no elemental contaminant concentrations from this or any other site exceeded PECs or MECs.

Analyses included ten polycyclic aromatic hydrocarbons (anthracene, fluorene, naphthalene, phenanthrene, benz[a]anthracene, benzo(a)pyrene, chrysene, dibenz[a,h]anthracene, fluoranthene and pyrene). Polycyclic aromatic hydrocarbons were not detected in any sample; detection limits ranged between 0.5 ug/g dry weight and 1.6 ug/g dry weight (with the varying detection limits a function of the amount of moisture in the samples).

Discussion

There are no federal or North Carolina sediment quality criteria or standards, but the freshwater sediment quality guidelines of MacDonald et al. (2000) are very useful. The State of Florida recommends these for use as guidance in many of their programs, including evaluation of dredged material and risk assessment of contaminated sites (MacDonald et al. 2003). In a review by experts on sediment assessment, sediment quality guidelines like those used here were found to offer good utility in site assessment (Wenning and Ingersoll 2002).

From Figure 2, it is apparent that none of the samples exceeded the probable effects concentrations (PECs, concentrations above which adverse effects to sediment dwelling organisms may be expected) for any elemental contaminant. This means there were no sediment contaminant concentrations of obvious concern. Almost 90 percent of the elemental contaminant results were less than threshold effects concentrations (TECs, concentrations below which adverse effects to sensitive aquatic organisms should not occur). This means those concentrations are considered toxicologically insignificant.

About 12 percent of the elemental contaminant sample results fell between the TEC and PEC, and they were further evaluated by comparing their magnitude to the geometric mean of the TEC and PEC for that element. If the TEC is thought of as a threshold below which no adverse effects are expected to occur, and the PEC is the likely effects concentration, the geometric mean of these two is an estimate of the concentration where adverse effects may begin to be observed. This "median effects concentration" or "MEC", while not a construct of the original guidelines, appears useful as an initial screen of data in the middle category. We note also that this approach is consistent with how the U.S. Environmental Protection Agency summarizes chronic toxicity data in their water quality criteria program (Stephan et al. 1985). In that guidance, the geometric mean of a No Observed Effect Concentration and Lowest Observed Effect Concentration for a compound of interest can be used as a Maximum Allowable Toxicant Concentration, again with the idea that the lowest concentration of interest is somewhere between the no effect and likely effect concentrations. None of the Little River sediment samples exceeded an MEC.

Polycyclic aromatic hydrocarbons were not detected in any sample. Because of the high detection limits encountered as a results of the amount of moisture in the samples), we asked the lab to examine the gas chromatograms to determine if there was any indication that hydrocarbons were present at levels below their reporting limits. The lab indicated that none of the compounds of interest were detected (Appendix A).

Based on the results of the tier 1 review and tier 2 sampling, contamination in sediments impounded behind Lowell Dam are unlikely to be a concern, either in-place or upon mobilization. No additional sediment analyses are warranted at this time. This assessment is limited to the toxicological properties of the sediments evaluated. It does not address the potential physical impacts of sediment mobilization.

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MacDonald, D.D., C.G. Ingersoll and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Arch Environ Contam Toxicol* 39: 20-31.

MacDonald, D.D., C.G. Ingersoll, D.E. Smorong, R.A. Lindskoog, G. Sloane and T. Biernacki. 2003. Development and Evaluation of Numerical Sediment Quality Assessment Guidelines for Florida Inland Waters. Florida Department of Environmental Protection. Tallahassee, FL.

Rodgers, J.H. Jr., K.L. Dickson, F.Y. Saleh, and C.A. Staples. 1987. Bioavailability of sediment-bound chemicals to aquatic organisms - some theory, evidence and research needs. *in* K.L. Dickson, A.W. Maki, and W.A. Brungs, eds. *Fate and Effects of Sediment-Bound Chemicals in Aquatic Systems*. Pergamon Press, Toronto.

Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman and W.A. Brungs. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses. U.S. Environmental Protection Agency, Office of Research and Development Washington, DC.

Wenning, R.J. and C.G. Ingersoll. 2002. Summary of SETAC Pellston Workshop on Use of Sediment Quality Guidelines and Related Tools for the Assessment of Contaminated Sediments; 17-22 August 2002; Fairmont, Montana, USA. Society of Environmental Toxicology and Chemistry (SETAC), Pensacola, FL.

Table 1. Lowell Dam Impounded Reach (Little River) Sediment Sampling Sites (sampled 04/14/05)

Site 1- Upstream confluence with Little Buffalo Creek, and upstream of Hwy 301
N 35.58487˚
W 078.16197˚

Site 2- Downstream of Hwy 301, upstream of 2nd Little Buffalo Creek confluence
N 35.58114˚
W 078.15776˚

Site 3- Floodplain wetland at Little Buffalo Creek confluence
N 35.58085˚
W 078.15753˚

Site 4- Downstream of I-95, upstream of dam, collected along left bank in channel
N 35.56733˚
W 078.16194˚

Site 5- Left bank immediately upstream of dam on "post dam" bank
N 35.56614˚
W 078.16074˚

Lowell Dam Downstream Reach (Little River) Sediment Sampling Sites (sampled 04/19/05)

Site 6- Island immediately downstream of dam
N 35.56623˚
W 078.15991˚

Site 7 – Slight off-channel downstream of dam
N 35.56593˚
W 078.15921˚

Figure 1. Little River Sediment Sampling Points

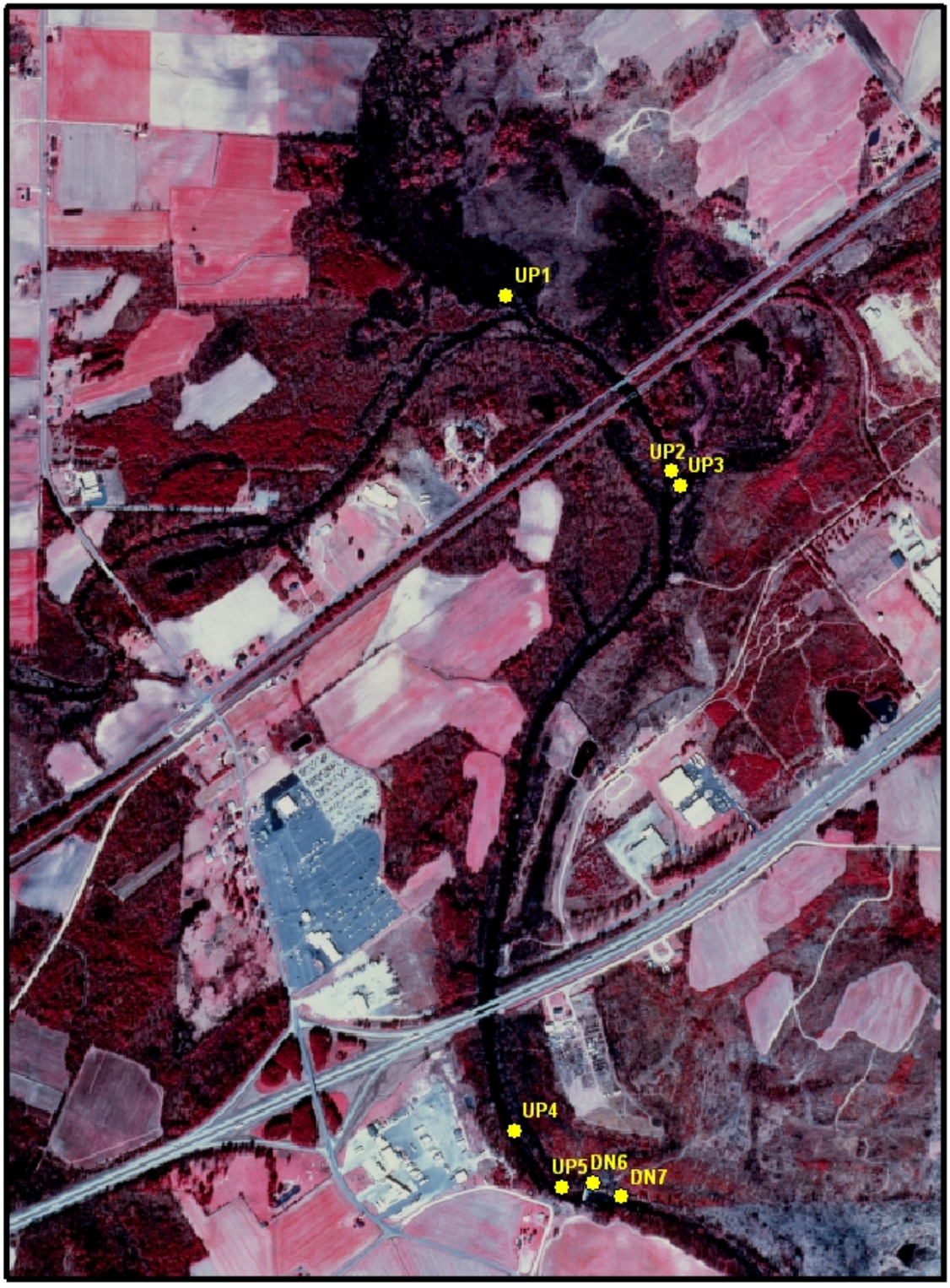
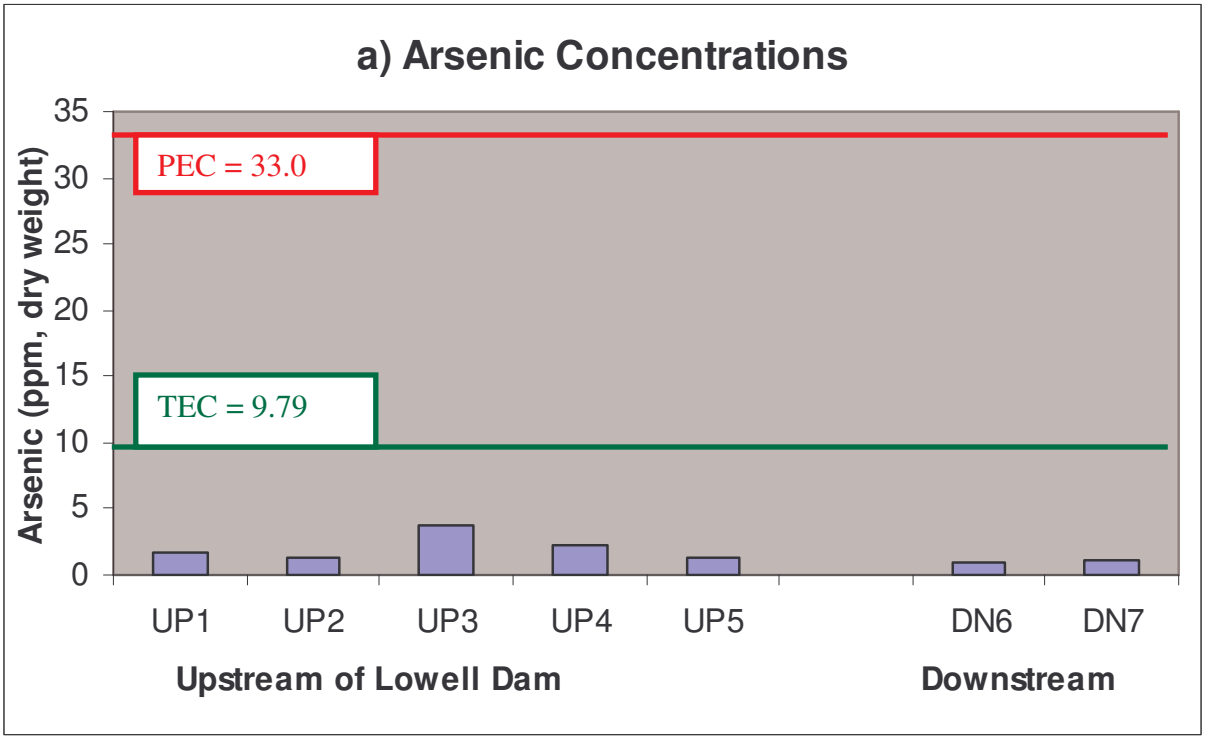
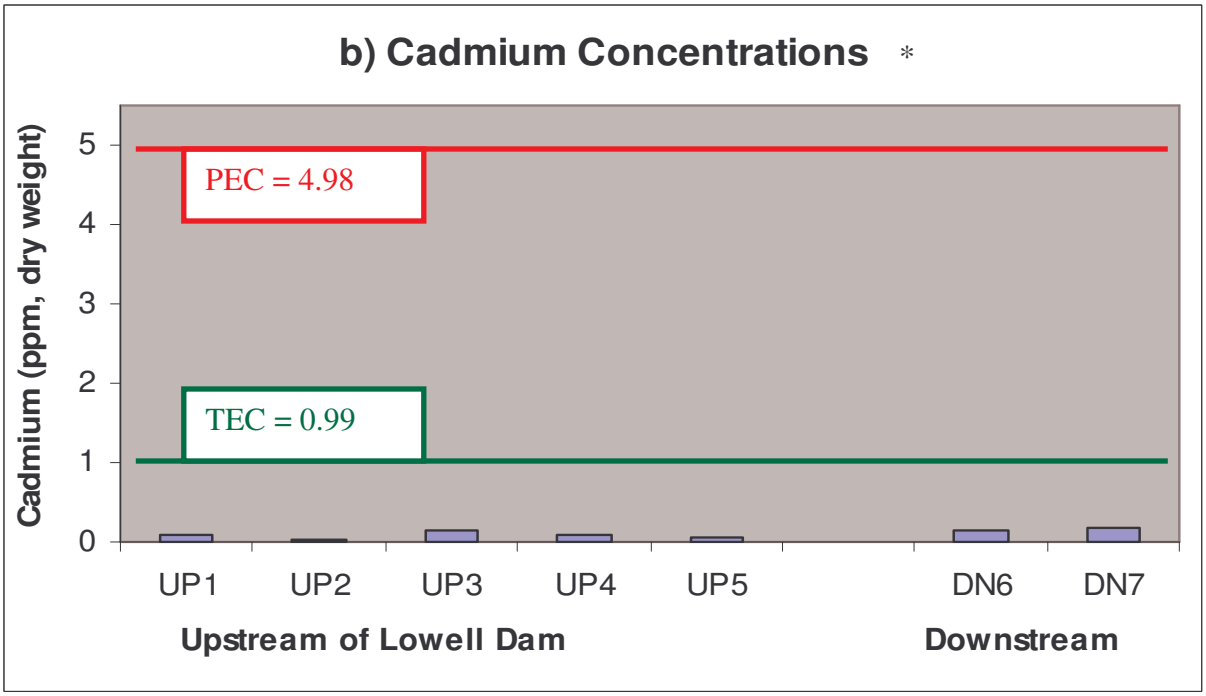


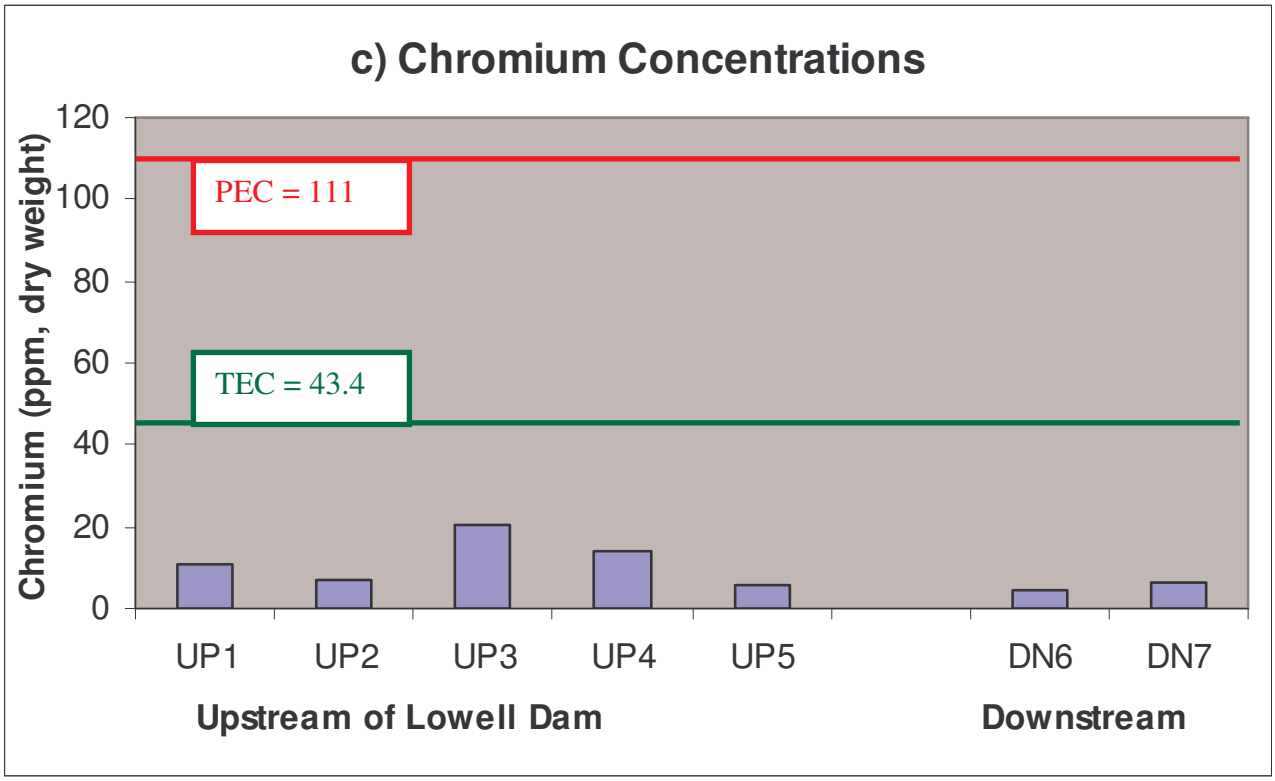
Figure 2 (a-h). Elemental contaminant concentrations of sediments collected within the Lowell Dam impounded reach (UP1, UP2, UP3, UP4 and UP5) and downstream of the dam (DN6 and DN7). For each element, results are compared to threshold-effects concentration (TEC) guidelines of MacDonald et al. (2000) -- values below which adverse effects to sensitive aquatic organisms should not occur, and probable effects concentrations (PECs) -- values above which adverse effects to sediment dwelling organisms may be expected (MacDonald et al. 2000). Some figures also have a "median effects concentration" (MEC), the geometric mean of the TEC and PEC, for reference.





* Cadmium was not detected in any sample, the results provided are the sample-specific detection limits (i.e., cadmium is known to be less than these values)

Figure 2 (cont.)



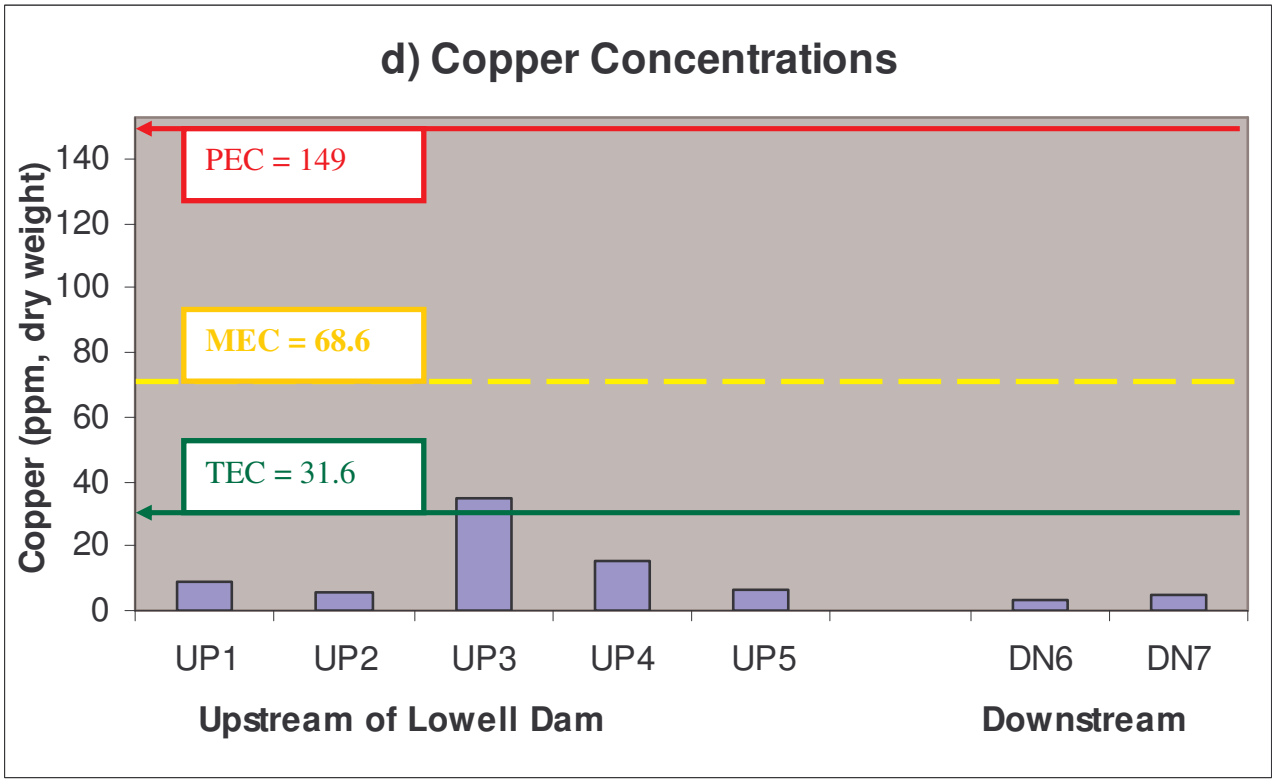
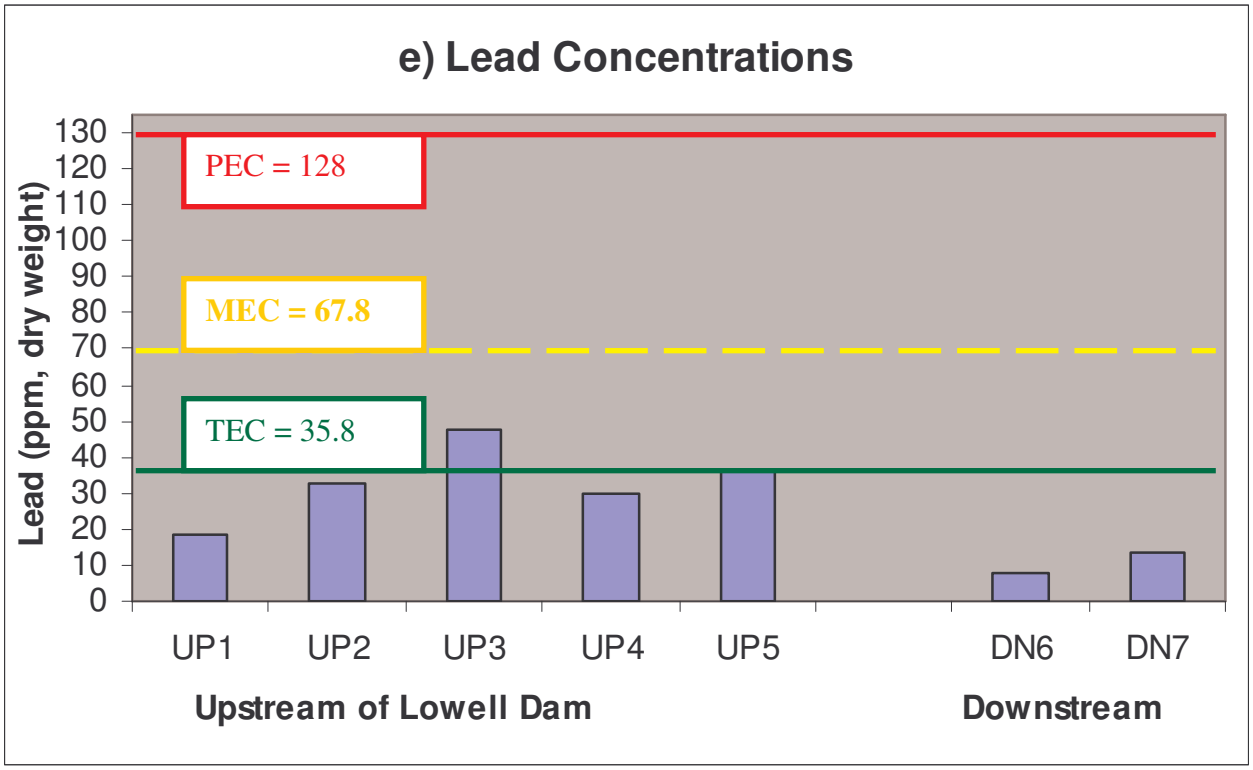


Figure 2 (cont.)



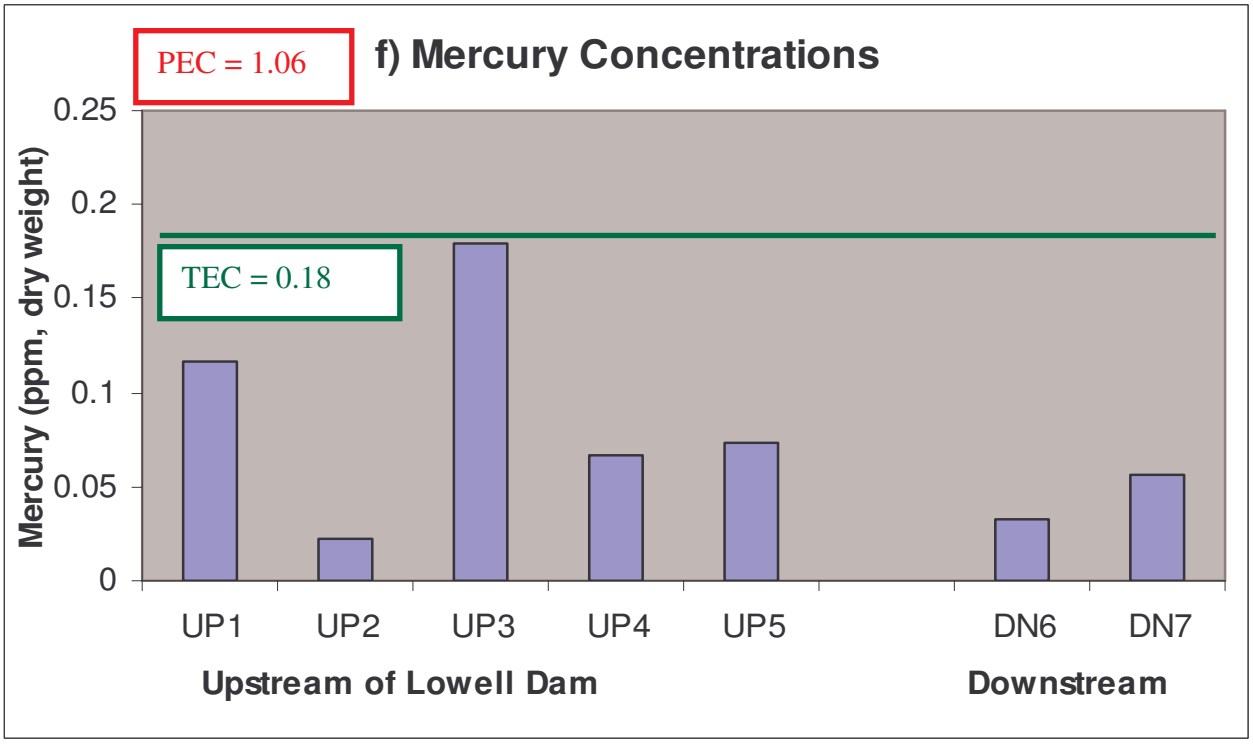
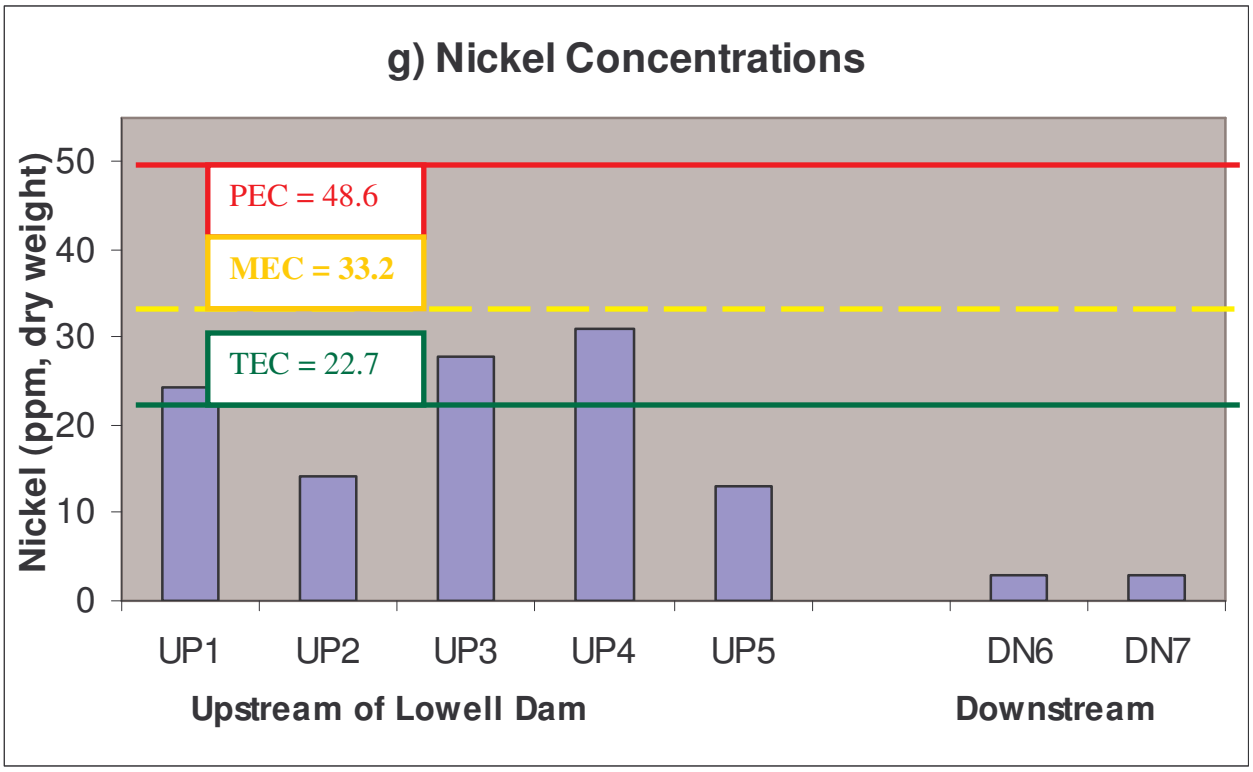


Figure 2 (concluded)



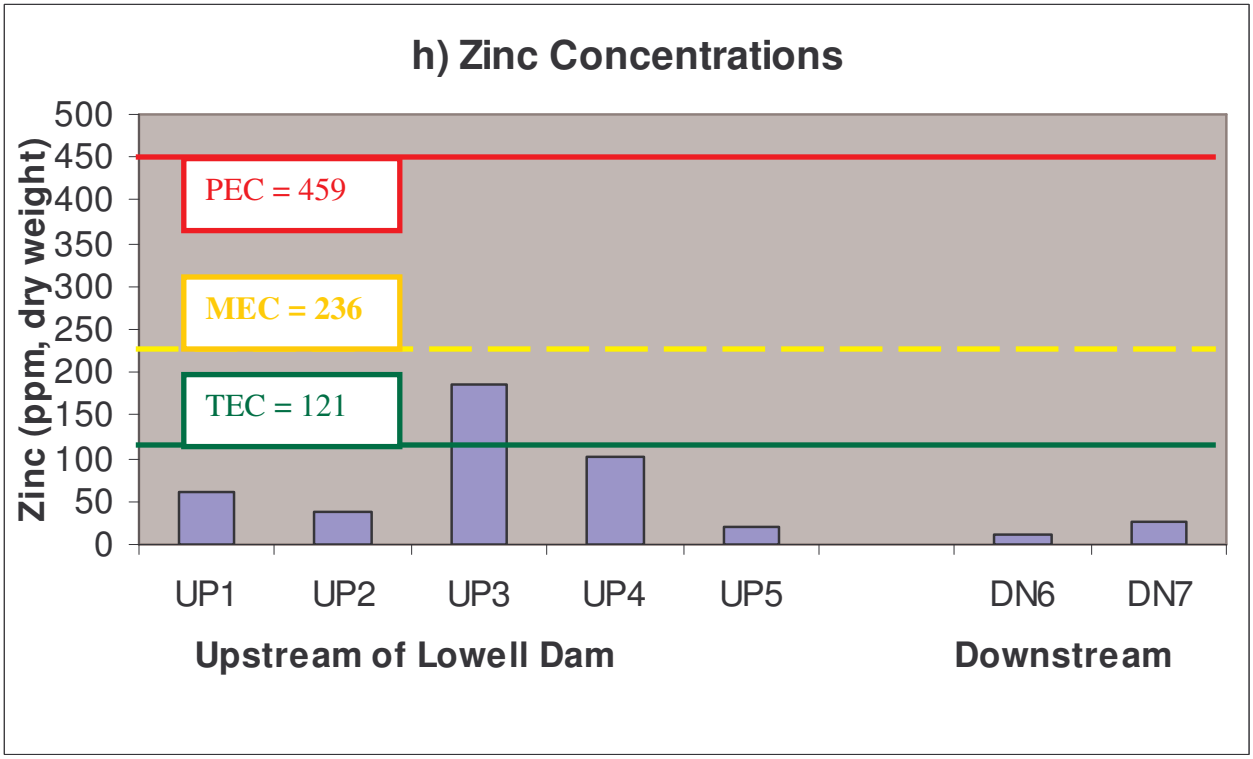
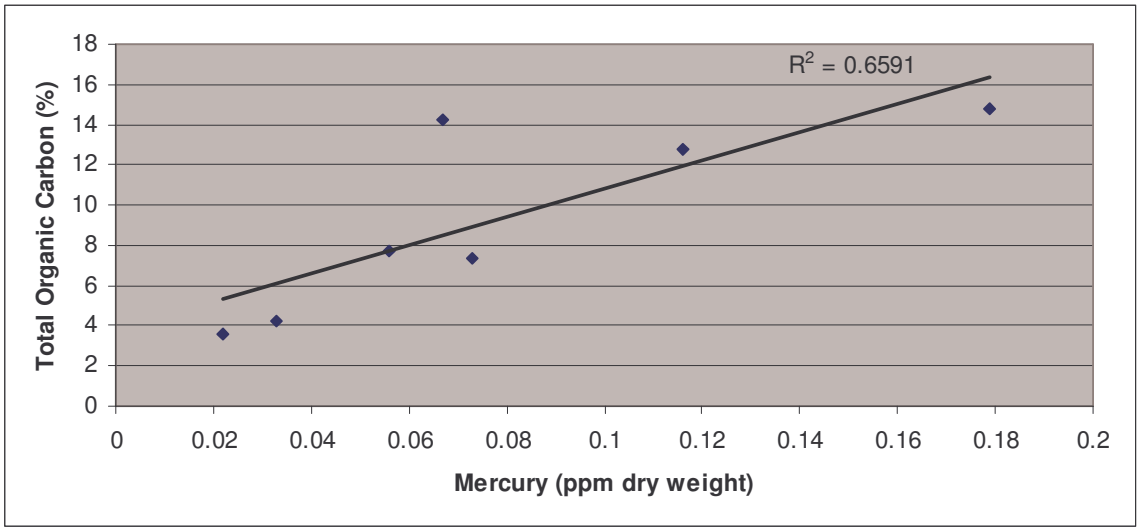
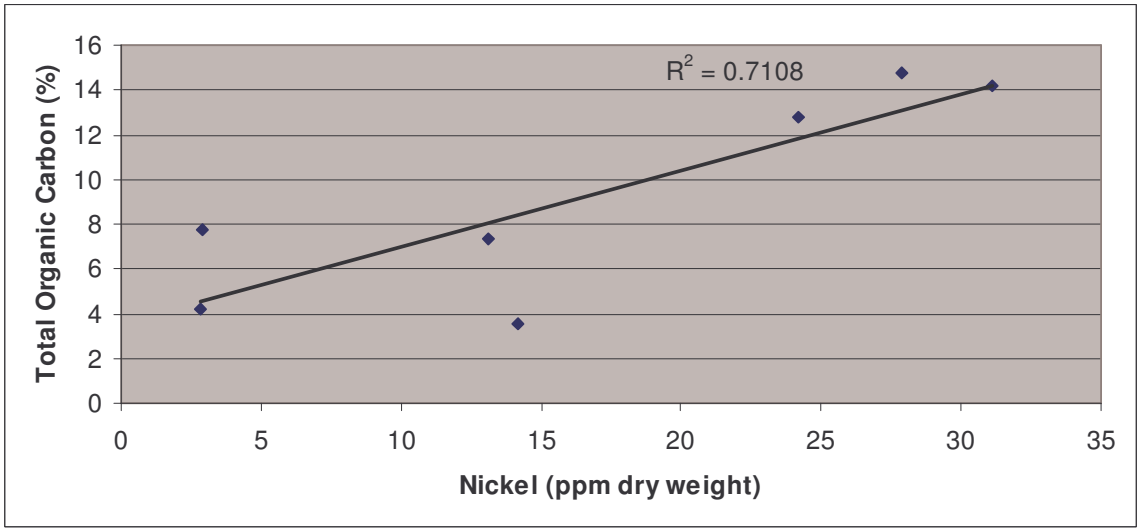
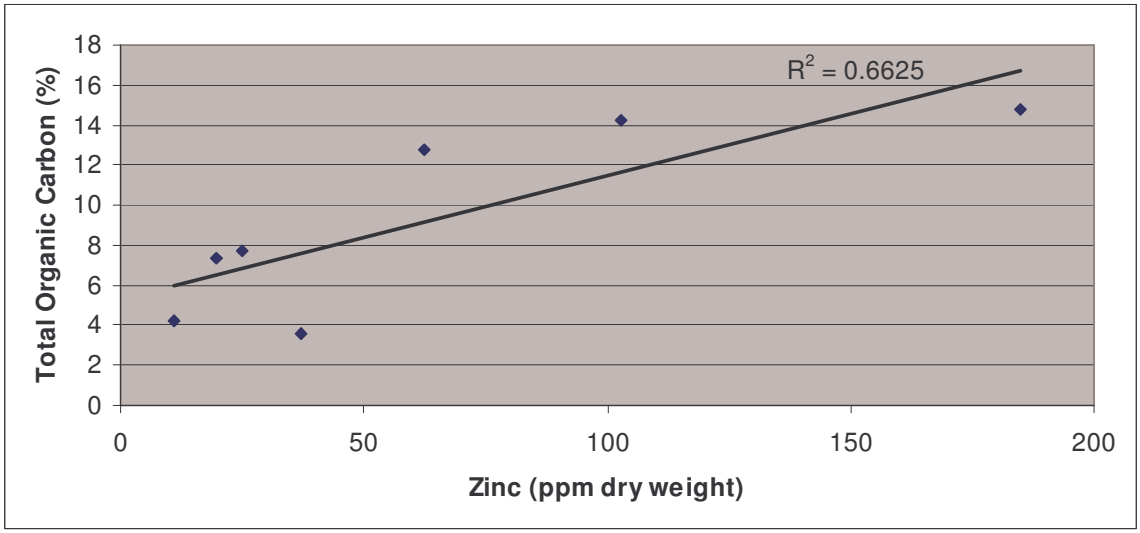


Figure 3. Correlation between total organic carbon and metals in Little River sediments. The sampling site with the greatest amount of organic material (site 3) was generally also the site with the highest concentration of metals.







Appendix A – Analytical Report from TriTest

TRiTEST
6701 Conference Drive
Raleigh, NC 27607

Telephone: (919) 834-4984
Fax: (919) 834-6497

NC/WW Cert. #: 067
NC/DW Cert. #: 37731

Laboratory Report

--- Prepared for ---
Randy Turner
Restoration Systems
1101 Haynes St.
Suite 107 Pilot Mill
Raleigh, NC 27604

Report Date: **7/15/2005**
Date Received: **4/15/2005**
Work Order #: **0504-00788**

Project No.:
Project ID: **River Sediment**
Cust. Code: **RE9490**
Cust. P.O.#:

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
001	SITE 1	4/14/2005	11:20	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	1.65 mg/kg	4/20/05	10:05	
Lead	EPA 6020	18.7 mg/kg	4/20/05	10:05	
Chromium	EPA 6020	10.6 mg/kg	4/20/05	10:05	
Copper	EPA 6020	8.82 mg/kg	4/20/05	10:05	
Mercury	EPA 7471A	116# ug/kg	4/21/05	8:30	
Nickel	EPA 6020	24.2 mg/kg	4/20/05	10:05	
Aluminum	EPA 6020	11800 mg/kg	4/20/05	10:05	
Manganese	EPA 6020	420 mg/kg	4/20/05	10:05	
Zinc	EPA 6020	62.4 mg/kg	4/20/05	10:05	
Iron	EPA 6020	14200 mg/kg	4/20/05	10:05	
8270 (A&B/N)		**	4/18/05	9:30	
Anthracene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Benzo(a)anthracene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Benzo(a)pyrene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Chrysene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Dibenzo(ah)anthracene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Fluoranthene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Fluorene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Naphthalene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Phenanthrene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Pyrene	EPA 8270C	<1190 ug/kg	4/18/05	9:30	
Percent Dry Weight	SM 2540B	27.5 %	4/15/05	15:00	
Particle Size	NCDA	98.29# %	4/28/05	11:45	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	
Volatile Solids, Percent	EPA 160.4	12.8 %	4/15/05	15:00	
Cadmium	EPA 200.8	<0.086 mg/kg	7/14/05	7:55	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
002	SITE 2	4/14/2005	12:14	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	1.30 mg/kg	4/20/05	10:05	

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NC/WW Cert. #: 067
NC/DW Cert. #: 37731

Laboratory Report

Work Order #: **0504-00788**

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
002	SITE 2	4/14/2005	12:14	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Lead	EPA 6020	32.6 mg/kg	4/20/05	10:05	
Cadmium	EPA 6020	<0.042 mg/kg	7/14/05	7:55	
Chromium	EPA 6020	7.08 mg/kg	4/20/05	10:05	
Copper	EPA 6020	6.05 mg/kg	4/20/05	10:05	
Mercury	EPA 7471A	21.6# ug/kg	4/21/05	8:30	
Nickel	EPA 6020	14.2 mg/kg	4/20/05	10:05	
Aluminum	EPA 6020	8620 mg/kg	4/20/05	10:05	
Manganese	EPA 6020	827 mg/kg	4/20/05	10:05	
Zinc	EPA 6020	37.2 mg/kg	4/20/05	10:05	
Iron	EPA 6020	12500 mg/kg	4/20/05	10:05	
8270 (A&B/N)		**	4/18/05	9:30	
Anthracene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Benzo(a)anthracene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Benzo(a)pyrene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Chrysene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Dibenzo(ah)anthracene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Fluoranthene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Fluorene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Naphthalene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Phenanthrene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Pyrene	EPA 8270C	<634 ug/kg	4/18/05	9:30	
Percent Dry Weight	SM 2540B	52.4 %	4/15/05	15:00	
Particle Size	NCDA	74.82# %	4/28/05	11:45	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	
Volatile Solids, Percent	EPA 160.4	3.55 %	4/15/05	15:00	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
003	SITE 3	4/14/2005	13:30	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	3.71 mg/kg	4/20/05	10:05	
Lead	EPA 6020	47.6 mg/kg	4/20/05	10:05	
Cadmium	EPA 6020	<0.14 mg/kg	7/14/05	7:55	
Chromium	EPA 6020	20.5 mg/kg	4/20/05	10:05	
Copper	EPA 6020	34.8 mg/kg	4/20/05	10:05	
Mercury	EPA 7471A	179# ug/kg	4/21/05	8:30	
Nickel	EPA 6020	27.9 mg/kg	4/20/05	10:05	
Aluminum	EPA 6020	18600 mg/kg	4/20/05	10:05	
Manganese	EPA 6020	379 mg/kg	4/20/05	10:05	
Zinc	EPA 6020	185 mg/kg	4/20/05	10:05	
Iron	EPA 6020	23600 mg/kg	4/20/05	10:05	

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No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
003	SITE 3	4/14/2005	13:30	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
8270 (A&B/N)		**	4/18/05	9:30	
Anthracene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Benzo(a)anthracene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Benzo(a)pyrene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Chrysene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Dibenzo(ah)anthracene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Fluoranthene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Fluorene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Naphthalene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Phenanthrene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Pyrene	EPA 8270C	<1570 ug/kg	4/18/05	9:30	
Percent Dry Weight	SM 2540B	21.0 %	4/15/05	15:00	
Particle Size	NCDA	97.79# %	4/28/05	11:45	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	
Volatile Solids, Percent	EPA 160.4	14.8 %	4/15/05	15:00	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
004	SITE 4	4/14/2005	11:20	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	2.20 mg/kg	4/20/05	10:05	
Lead	EPA 6020	29.8 mg/kg	4/20/05	10:05	
Cadmium	EPA 6020	<0.10 mg/kg	7/14/05	7:55	
Chromium	EPA 6020	14.3 mg/kg	4/20/05	10:05	
Copper	EPA 6020	15.4 mg/kg	4/20/05	10:05	
Mercury	EPA 7471A	67.4# ug/kg	4/21/05	8:30	
Nickel	EPA 6020	31.1 mg/kg	4/20/05	10:05	
Aluminum	EPA 6020	15800 mg/kg	4/20/05	10:05	
Manganese	EPA 6020	1220 mg/kg	4/20/05	10:05	
Zinc	EPA 6020	103 mg/kg	4/20/05	10:05	
Iron	EPA 6020	21900 mg/kg	4/20/05	10:05	
8270 (A&B/N)		**	4/18/05	9:30	
Anthracene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Benzo(a)anthracene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Benzo(a)pyrene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Chrysene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Dibenzo(ah)anthracene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Fluoranthene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Fluorene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Naphthalene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	
Phenanthrene	EPA 8270C	<1510 ug/kg	4/18/05	9:30	

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No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
004	**SITE 4**	**4/14/2005**	**11:20**	**Soil**	**Grab**	**4 +/- 2 deg C**

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Pyrene	**EPA 8270C**	**<1510 ug/kg**	**4/18/05**	**9:30**	
Percent Dry Weight	**SM 2540B**	**21.8 %**	**4/15/05**	**15:00**	
Particle Size	**NCDA**	**96.70# %**	**4/28/05**	**11:45**	
Extraction, 8270 Soils	**EPA 3550**	**DONE**	**4/18/05**	**9:30**	
Volatile Solids, Percent	**EPA 160.4**	**14.2 %**	**4/15/05**	**15:00**	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
005	**SITE 5**	**4/14/2005**	**15:40**	**Soil**	**Grab**	**4 +/- 2 deg C**

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	**EPA 6020**	**1.24 mg/kg**	**4/20/05**	**10:05**	
Lead	**EPA 6020**	**36.0 mg/kg**	**4/20/05**	**10:05**	
Cadmium	**EPA 6020**	**<0.064 mg/kg**	**7/14/05**	**7:55**	
Chromium	**EPA 6020**	**5.71 mg/kg**	**4/20/05**	**10:05**	
Copper	**EPA 6020**	**6.12 mg/kg**	**4/20/05**	**10:05**	
Mercury	**EPA 7471A**	**72.7# ug/kg**	**4/21/05**	**8:30**	
Nickel	**EPA 6020**	**13.1 mg/kg**	**4/20/05**	**10:05**	
Aluminum	**EPA 6020**	**7020 mg/kg**	**4/20/05**	**10:05**	
Manganese	**EPA 6020**	**305 mg/kg**	**4/20/05**	**10:05**	
Zinc	**EPA 6020**	**19.8 mg/kg**	**4/20/05**	**10:05**	
Iron	**EPA 6020**	**11400 mg/kg**	**4/20/05**	**10:05**	
8270 (A&B/N)		**	**4/18/05**	**9:30**	
Anthracene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Benzo(a)anthracene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Benzo(a)pyrene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Chrysene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Dibenzo(ah)anthracene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Fluoranthene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Fluorene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Naphthalene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Phenanthrene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Pyrene	**EPA 8270C**	**<457 ug/kg**	**4/18/05**	**9:30**	
Percent Dry Weight	**SM 2540B**	**72.3 %**	**4/15/05**	**15:00**	
Particle Size	**NCDA**	**84.52# %**	**4/28/05**	**11:45**	
Extraction, 8270 Soils	**EPA 3550**	**DONE**	**4/18/05**	**9:30**	
Volatile Solids, Percent	**EPA 160.4**	**7.38 %**	**4/15/05**	**15:00**	

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Laboratory Report

Work Order #: **0504-00788**

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
006	**SITE 1 / MS**	4/14/2005	15:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	100.1 %	4/22/05	11:04	
Lead	EPA 6020	108.0 %	4/22/05	11:04	
Cadmium	EPA 6020	94.6 %	4/22/05	11:04	
Chromium	EPA 6020	61.8* %	4/22/05	11:04	
Copper	EPA 6020	70.3* %	4/22/05	11:04	
Nickel	EPA 6020	66.1* %	4/22/05	11:04	
Aluminum	EPA 6020	* %	4/22/05	11:04	
Manganese	EPA 6020	* %	4/22/05	11:04	
Zinc	EPA 6020	52.0* %	4/22/05	11:04	
Iron	EPA 6020	* %	4/22/05	11:04	
8270 (A&B/N)			4/18/05	9:30	
Pyrene	EPA 8270C	83.6 %	4/18/05	9:30	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
007	**SITE 1 / MSD**	4/14/2005	15:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	0.010 %RPD	4/22/05	11:04	
Lead	EPA 6020	8.45 %RPD	4/22/05	11:04	
Cadmium	EPA 6020	9.74 %RPD	4/22/05	11:04	
Chromium	EPA 6020	0.23 %RPD	4/22/05	11:04	
Copper	EPA 6020	9.84 %RPD	4/22/05	11:04	
Nickel	EPA 6020	11.5 %RPD	4/22/05	11:04	
Aluminum	EPA 6020	* %RPD	4/22/05	11:04	
Manganese	EPA 6020	1.62 %RPD	4/22/05	11:04	
Zinc	EPA 6020	16.3 %RPD	4/22/05	11:04	
Iron	EPA 6020	6.77 %RPD	4/22/05	11:04	
8270 (A&B/N)			4/18/05	9:30	
Pyrene	EPA 8270C	17.3 %RPD	4/18/05	9:30	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
008	**PREP BLANK**	4/14/2005	15:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	<0.001 mg/L	4/22/05	11:04	
Lead	EPA 6020	<0.001 mg/L	4/22/05	11:04	

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NC/WW Cert. #: 067
NC/DW Cert. #: 37731

Laboratory Report

Work Order #: **0504-00788**

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
008	**PREP BLANK**	4/14/2005	15:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Cadmium	EPA 6020	<0.001 mg/L	4/22/05	11:04	
Chromium	EPA 6020	<0.001 mg/L	4/22/05	11:04	
Copper	EPA 6020	<0.001 mg/L	4/22/05	11:04	
Mercury	EPA 7471A	<0.200 ug/L	4/22/05	11:04	
Nickel	EPA 6020	<0.001 mg/L	4/22/05	11:04	
Aluminum	EPA 6020	<.005 mg/L	4/22/05	11:04	
Manganese	EPA 6020	<0.001 mg/L	4/22/05	11:04	
Zinc	EPA 6020	<0.001 mg/L	4/22/05	11:04	
Iron	EPA 6020	<0.010 mg/L	4/22/05	11:04	
8270 (A&B/N)			4/18/05	9:30	
Anthracene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Benzo(a)anthracene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Benzo(a)pyrene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Chrysene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Dibenzo(ah)anthracene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Fluoranthene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Fluorene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Naphthalene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Phenanthrene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Pyrene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
009	**LAB CONTROL SPIKE**	4/14/2005	11:20	WW	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 200.8	102.5 %	4/22/05	9:38	
Lead	EPA 200.8	106.9 %	4/22/05	9:38	
Cadmium	EPA 200.8	105.8 %	4/22/05	9:38	
Chromium	EPA 200.8	107.5 %	4/22/05	9:38	
Copper	EPA 200.8	101.0 %	4/22/05	9:38	
Nickel	EPA 200.8	100.1 %	4/22/05	9:38	
Aluminum	EPA 200.8	111.2 %	4/22/05	9:38	
Manganese	EPA 200.8	105.9 %	4/22/05	9:38	
Zinc	EPA 200.8	102.1 %	4/22/05	9:38	
Iron	EPA 200.8	104.4 %	4/22/05	9:38	
8270 (A&B/N)			7/14/05	11:22	
Pyrene	EPA 8270C	91.8 %	7/14/05	11:22	
Extraction, 8270 Soils	EPA 3550	DONE	7/14/05	11:22	

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Laboratory Report

Work Order #: **0504-00788**

#ANALYZED BY OXFORD LABORATORIES, INC., WILMINGTON, NC (NC/WW CERT. #75; NC/DW CERT. #37721).

*** MATRIX INTERFERENCE**

**** NO COMPOUNDS OF INTEREST DETECTED FOR PAH's IN CHROMATOGRAM**

Reviewed by:

for Tritest, Inc.

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Laboratory Report

— Prepared for —
Randy Turner
Restoration Systems
1101 Haynes St.
Suite 107 Pilot Mill
Raleigh, NC 27604

Report Date: **7/15/2005**
Date Received: **4/19/2005**
Work Order #: **0504-01231**
Cust. Code: **RE9490**
Cust. P.O.#:

Project No.:
Project ID: **River Sediment - SITE 6 & 7**

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
001	SITE 6	4/19/2005	11:15	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	0.900 mg/kg	4/22/05	7:58	
Lead	EPA 6020	7.87 mg/kg	4/22/05	7:58	
Cadmium	EPA 6020	<0.15 mg/kg	4/22/05	7:58	
Chromium	EPA 6020	4.72 mg/kg	4/22/05	7:58	
Copper	EPA 6020	2.92 mg/kg	4/22/05	7:58	
Mercury	EPA 7471A	32.5 ug/kg	4/26/05	8:58	
Nickel	EPA 6020	2.85 mg/kg	4/22/05	7:58	
Aluminum	EPA 6020	11200 mg/kg	4/22/05	7:58	
Manganese	EPA 6020	154 mg/kg	4/22/05	7:58	
Zinc	EPA 6020	10.9 mg/kg	4/22/05	7:58	
Iron	EPA 6020	23200 mg/kg	4/22/05	7:58	
8270 (A&B/N)		**	5/2/05	16:30	
Anthracene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Benzo(a)anthracene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Benzo(a)pyrene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Chrysene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Dibenzo(ah)anthracene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Fluoranthene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Fluorene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Naphthalene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Phenanthrene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Pyrene	EPA 8270C	<489 ug/kg	5/2/05	16:30	
Percent Dry Weight	SM 2540B	67.7 %	4/20/05	11:45	
PARTICLE SIZE	NCDA	90.57# %	4/28/05	10:00	
Extraction, 8270 Soils	EPA 3550	DONE	5/2/05	16:30	
Volatile Solids, Percent	EPA 160.4	4.19 %	4/20/05	11:45	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
002	SITE 7	4/19/2005	10:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	1.06 mg/kg	4/22/05	7:58	

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No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
002	**SITE 7**	**4/19/2005**	**10:40**	**Soil**	**Grab**	**4 +/- 2 deg C**

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Lead	**EPA 6020**	**13.2 mg/kg**	**4/22/05**	**7:58**	
Cadmium	**EPA 6020**	**<0.19 mg/kg**	**4/22/05**	**7:58**	
Chromium	**EPA 6020**	**6.14 mg/kg**	**4/22/05**	**7:58**	
Copper	**EPA 6020**	**4.99 mg/kg**	**4/22/05**	**7:58**	
Mercury	**EPA 7471A**	**55.6 ug/kg**	**4/26/05**	**8:58**	
Nickel	**EPA 6020**	**2.88 mg/kg**	**4/22/05**	**7:58**	
Aluminum	**EPA 6020**	**7200 mg/kg**	**4/22/05**	**7:58**	
Manganese	**EPA 6020**	**182 mg/kg**	**4/22/05**	**7:58**	
Zinc	**EPA 6020**	**25.1 mg/kg**	**4/22/05**	**7:58**	
Iron	**EPA 6020**	**10700 mg/kg**	**4/22/05**	**7:58**	
8270 (A&B/N)		**	**5/2/05**	**16:30**	
Anthracene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Benzo(a)anthracene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Benzo(a)pyrene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Chrysene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Dibenzo(ah)anthracene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Fluoranthene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Fluorene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Naphthalene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Phenanthrene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Pyrene	**EPA 8270C**	**<645 ug/kg**	**5/2/05**	**16:30**	
Percent Dry Weight	**SM 2540B**	**51.6 %**	**4/20/05**	**11:45**	
PARTICLE SIZE	**NCDA**	**94.35# %**	**4/28/05**	**10:00**	
Extraction, 8270 Soils	**EPA 3550**	**DONE**	**5/2/05**	**16:30**	
Volatile Solids, Percent	**EPA 160.4**	**7.72 %**	**4/20/05**	**11:45**	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
003	**SITE 7 / MS**	**4/19/2005**	**10:40**	**Soil**	**Grab**	**4 +/- 2 deg C**

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	**EPA 6020**	**104.9 %**	**4/22/05**	**9:39**	
Lead	**EPA 6020**	**139.4* %**	**4/22/05**	**9:39**	
Cadmium	**EPA 6020**	**98.9 %**	**4/22/05**	**9:39**	
Chromium	**EPA 6020**	**120.2 %**	**4/22/05**	**9:39**	
Copper	**EPA 6020**	**86.6 %**	**4/22/05**	**9:39**	
Nickel	**EPA 6020**	**96.7 %**	**4/22/05**	**9:39**	
Aluminum	**EPA 6020**	*** %**	**4/22/05**	**9:39**	
Manganese	**EPA 6020**	*** %**	**4/22/05**	**9:39**	
Zinc	**EPA 6020**	*** %**	**4/22/05**	**9:39**	
Iron	**EPA 6020**	*** %**	**4/22/05**	**9:39**	
8270 (A&B/N)			**4/18/05**	**9:30**	

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Laboratory Report

Work Order #: **0504-01231**

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
003	SITE 7 / MS	4/19/2005	10:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Pyrene	EPA 8270C	96.0 %	4/18/05	9:30	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	
Mercury	EPA 245.1	92.9 %	4/22/05	9:50	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
004	SITE 7 / MSD	4/19/2005	10:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	4.69 %RPD	4/22/05	9:39	
Lead	EPA 6020	7.98 %RPD	4/22/05	9:39	
Cadmium	EPA 6020	3.59 %RPD	4/22/05	9:39	
Chromium	EPA 6020	9.29 %RPD	4/22/05	9:39	
Copper	EPA 6020	3.75 %RPD	4/22/05	10:40	
Nickel	EPA 6020	8.39 %RPD	4/22/05	10:40	
Aluminum	EPA 6020	* %RPD	4/22/05	10:40	
Manganese	EPA 6020	11.9 %RPD	4/22/05	10:40	
Zinc	EPA 6020	0.6 %RPD	4/22/05	10:40	
Iron	EPA 6020	11.5 %RPD	4/22/05	10:40	
8270 (A&B/N)			4/18/05	9:30	
Pyrene	EPA 8270C	0.03 %RPD	4/18/05	9:30	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	
Mercury	EPA 245.1	0.77 %RPD	4/22/05	9:50	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
005	PREP BLANK	4/19/2005	10:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Lead	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Cadmium	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Chromium	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Copper	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Mercury	EPA 7471A	<0.200 ug/L	4/22/05	10:40	
Nickel	EPA 6020	<0.001 ug/L	4/22/05	10:40	
Aluminum	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Manganese	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Zinc	EPA 6020	<0.001 mg/L	4/22/05	10:40	
Iron	EPA 6020	<0.010 mg/L	4/22/05	10:40	

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No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
005	PREP BLANK	4/19/2005	10:40	Soil	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
8270 (A&B/N)			4/18/05	9:30	
Anthracene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Benzo(a)anthracene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Benzo(a)pyrene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Chrysene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Dibenzo(ah)anthracene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Fluoranthene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Fluorene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Naphthalene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Phenanthrene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Pyrene	EPA 8270C	<330 ug/kg	4/18/05	9:30	
Extraction, 8270 Soils	EPA 3550	DONE	4/18/05	9:30	

No.	Sample ID	Date Sampled	Time Sampled	Matrix	Sample Type	Condition
006	LAB CONTROL SPIKE	4/19/2005	11:15	WW	Grab	4 +/- 2 deg C

Test Performed	Method	Results	Analyzed Date	Analyzed Time	Qualifier
Arsenic	EPA 200.8	92.9 %	4/22/05	9:50	
Lead	EPA 200.8	89.7 %	4/22/05	9:50	
Cadmium	EPA 200.8	88.1 %	4/22/05	9:50	
Chromium	EPA 200.8	88.6 %	4/22/05	9:50	
Copper	EPA 200.8	83.0 %	4/22/05	9:50	
Nickel	EPA 200.8	84.1 %	4/22/05	9:50	
Aluminum	EPA 200.8	94.4 %	4/22/05	9:50	
Manganese	EPA 200.8	86.2 %	4/22/05	9:50	
Zinc	EPA 200.8	90.7 %	4/22/05	9:50	
Iron	EPA 200.8	103.8 %	4/22/05	9:50	
Mercury	EPA 245.1	101.4 %	4/22/05	9:50	
8270 (A&B/N)			7/14/05	11:24	
Pyrene	EPA 8270C	97.4 %	7/14/05	11:24	
Extraction, 8270 Soils	EPA 3550	DONE	7/14/05	11:24	

#ANALYZED BY OXFORD LABORATORIES, INC., WILMINGTON, NC (NC/WW CERT. #75; NC/DW CERT. #37721).

*** MATRIX INTERFERENCE**

**** NO COMPOUNDS OF INTEREST DETECTED FOR PAH's IN CHROMATOGRAM**

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Work Order #: **0504-01231**

Reviewed by:

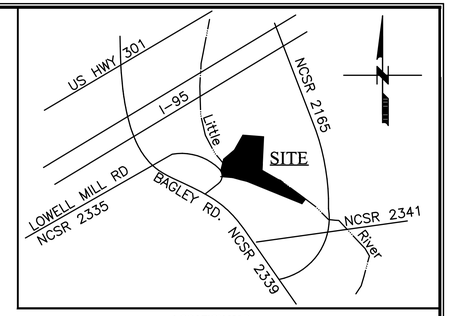
for Tritest, Inc.

APPENDIX C: As-Built Drawings

LITTLE RIVER
LOWELL MILL DAM
RESTORATION SITE

JOHNSTON COUNTY, NORTH CAROLINA

2005



LOCATION MAP
N.T.S.

SHEET INDEX:

RESTORATION SYSTEMS,LLC
Natural Resources Restoration & Conservation

AS BUILT DRAWING

Issued / /

This sheet depicts "record conditions" obtained from the contractor, Backwater Environmental, and the owner's surveyor, K2 Design, Inc., and as observed in the field. Milone & MacBroom, Inc. does not attest to the accuracy of information obtained from others.

Engineering, Landscape Architecture and Environmental Science

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S:\proj\2691 Restoration Systems\2691-02 Lowell Mill dam removal\dwg\title.dwg, 11/18/2005 10:39:04 AM

SOIL EROSION AND SEDIMENT CONTROL NOTES

1. TEMPORARY COFFERDAM(S) ARE INDICATED SCHEMATICALLY ONLY. COFFERDAMS SHALL BE LOCATED AS IS PRACTICAL, ACCORDING TO THE EXISTING RIVER STAGE AND FLOW, AND THE INTENDED WORK AREA. COFFERDAMS MAY BE RELOCATED DURING CONSTRUCTION AS NECESSARY. STRUCTURES MAY BE TEMPORARY CONCRETE ("JERSEY") BARRIERS, FAS-DAM, AQUA-DAM, WATER-FILLED TUBES, OR EQUAL. CONTRACTOR TO SUBMIT SUBMIT INTENDED STRUCTURES AND METHODS TO ENGINEER. POLYETHYLENE BARRIER AND SANDBAGS SHALL BE USED AS NECESSARY TO MINIMIZE WATER SEEPAGE. WATER PUMPED FROM COFFERDAM SHALL BE TREATED USING SPECIAL STILLING BASIN OR EQUAL. COFFERDAMS TO BE REMOVED UPON COMPLETION OF PROJECT.
2. STOCKPILE AREAS SHALL BE ENCLOSED BY SILT FENCE.
3. ALL VEGETATIVE AND STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES WILL BE CONSTRUCTED ACCORDING TO THE STANDARDS AND SPECIFICATIONS MOST RECENT EDITION OF THE NC EROSION CONTROL FIELD MANUAL. THE CONTRACTOR IS RESPONSIBLE FOR THE MAINTENANCE OF ALL SOIL EROSION AND SEDIMENT CONTROL MEASURES.
4. A COPY OF THE APPROVED EROSION AND SEDIMENT CONTROL PLAN SHALL BE MAINTAINED ON THE SITE AT ALL TIMES.
5. THE CONTRACTOR SHALL INSTALL ADDITIONAL EROSION CONTROL MEASURES NECESSARY TO PREVENT EROSION AND SEDIMENTATION AS DETERMINED BY THE ENGINEER AND/OR NCDENR.
6. IF SPOIL MATERIAL IS TO REMAIN ON SITE FOR MORE THAN 48 HOURS, A SILT FENCE SHALL BE PROVIDED ON THE LOW SIDE OF THE SPOIL. TEMPORARY SEEDING AND MULCHING SHALL ALSO BE PERFORMED.
7. WETLAND "A" SHALL BE PROTECTED FROM CONSTRUCTION ACTIVITIES AND ANY DISTURBANCE. WETLAND "B" IS TO BE DISTURBED BY GRADING AS INDICATED
8. DURING ANY DEWATERING PUMPING, WATER SHALL BE ROUTED THROUGH A SPECIAL STILLING BASIN OR EQUAL. SPECIAL STILLING BASINS ARE INDICATED SCHEMATICALLY ONLY,. AND SHALL BE LOCATED AS REQUIRED IN THE FIELD. DEWATERING DIRECTLY INTO FIELD TILES OR STORM WATER STRUCTURES IS PROHIBITED.
9. IF EXISTING DITCH GRADES ARE GREATER THAN 4%, DITCH CHECK DAMS AT 125 FEET ON CENTER SHALL BE INSTALLED. DITCH CHECK DAMS SHALL BE SPACED SO THE BASE OF UPSTREAM DITCH CHECK DAMS SHALL BE EQUAL TO THE TOP OF THE NEXT DOWNSTREAM CHECK DAM.
10. ANY TRENCHED AREAS SHALL BE BACKFILLED BEFORE THE END OF THE DAY EACH WORKING DAY.
11. SEE TEMPORARY SEEDING AND MULCHING SPECIFICATION FOR REQUIREMENTS.
12. ALL DISTURBED AREAS AND ACCESS AREAS ADJACENT TO THE RIVER SHALL BE CONTAINED BY SILT FENCE AT THE END OF EACH DAY AND PRIOR TO RAIN EVENTS.
13. SEDIMENT ACCUMULATED AT SILT FENCES SHALL BE REMOVED WHEN IT REACHES HALF THE HEIGHT OF THE SILT FENCE.

DAM REMOVAL NOTES

1. ACCESS ROADS TO BE BORDERED WITH SEDIMENT AND EROSION CONTROL FENCES.
2. ALL STOCKPILE AREAS TO BE FLAGGED PRIOR TO CONSTRUCTION AND APPROVED BY ENGINEER.
3. ALL DEWATERING PUMPS ARE TO DISCHARGE TO A TEMPORARY DEWATERING SEDIMENT BASIN.
4. EXCAVATED MATERIAL FROM CHANNEL SHALL BE USED AS FILL AND INTERMIXED WITH CONCRETE RUBBLE FOR DISPOSAL. UNDER NO CIRCUMSTANCES SHALL EXCESS DEBRIS, SOIL, ROCK, OR OTHER MATERIALS BE STOCKPILED ON RIVERBED OR BANKS. ANY EXCESS MATERIAL OR DEBRIS SHALL BE REMOVED FROM THESE AREAS AT THE END OF EACH WORK DAY.
5. ONLY NATIVE OR ROUNDED COBBLES SHALL BE ALLOWED FOR RIVER BED ARMORING. TEMPORARY CROSSINGS ON THE RIVERBED MAY BE STABILIZED BY CLASS B SHOT ROCK UNDERLAIN BY FILTER FABRIC. ALL SHOT ROCK AND FILTER FABRIC SHALL BE REMOVED FROM THE RIVERBED UPON COMPLETION OF WORK. NO SHOT OR CRUSHED ANGULAR ROCK WILL BE ALLOWED ON THE RIVERBED SURFACE UPON PROJECT COMPLETION.
6. THE CONCRETE SPILLWAY SHALL BE REMOVED BY BLASTING. CONTRACTOR IS RESPONSIBLE FOR OBTAINING BLASTING PERMIT. (SEE BLASTING PLAN.)
7. ALL REINFORCED CONCRETE SHALL HAVE PROTRUDING STEEL CUT FLUSH BEFORE DISPOSAL.
8. REMOVE TEMP. ACCESS ROAD AND RESTORE TO ORIGINAL CONDITIONS (TO THE EXTENT POSSIBLE) AT END OF WORK.
9. STAGING AREA AND ANY DEWATERING AREAS TO BE REMOVED AND RESTORED TO ORIGINAL CONDITION.
10. ALL DEWATERING INTAKE HOSES SHALL BE PLACED IN A GRAVEL SUMP PIT.

GENERAL NOTES

1. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION'S STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES (2002).
2. THE LOCATION OF ALL EXISTING UTILITIES MUST BE CONFIRMED 24 HRS. PRIOR TO CONSTRUCTION. CALL NORTH CAROLINA ONE-CALL CENTER 1-800-632-4949.
3. ALL LOCATIONS, ELEVATION AND CONTOURS ARE BASED UPON 2005 SURVEYS PROVIDED BY K2 DESIGN GROUP, PA AND ARE ON NATIONAL GEODETIC VERTICAL DATUM (NVGD 1929). THE ENGINEER CAN MAKE NO WARRANTY AS TO THE ACCURACY OF THE BASE SURVEY INFORMATION.
4. A TEMPORARY BENCHMARK (ANCHOR BOLT ATOP THE MILL STRUCTURE) HAS BEEN ESTABLISHED AT ELEVATION 136.93'. CONTRACTOR SHALL COORDINATE WITH K2 DESIGN GROUP, PA AS TO OTHER PERMANENT OR TEMPORARY BENCHMARKS ON THE PROJECT SITE.
5. THE ENGINEER WILL MAKE AVAILABLE A DIGITAL DESIGN FILE FOR THE CONTRACTOR'S USE. DUE TO THE CRITICAL NATURE OF COMPLETING WORK WITHIN THE WATERWAY AS EFFICIENTLY AS POSSIBLE ONCE CONSTRUCTION BEGINS, THE CONTRACTOR SHALL VERIFY DIMENSIONS AND ELEVATIONS IN THE FIELD BEFORE CONSTRUCTION, AND IMMEDIATELY REPORT ANY DISCREPANCIES.
6. THE CONTRACTOR IS RESPONSIBLE FOR WATER CONTROL DURING THE PROJECT. THE CONTRACTOR SHALL COORDINATE THE WATER CONTROL OF THE DAM AREA WITH THE OWNER AND THE ENGINEER.
7. THE CONTRACTOR, JOB SUPERINTENDENT AND SUBCONTRACTORS SHALL BE RESPONSIBLE FOR COMPLYING WITH THE JOB SPECIFICATIONS. THE CONTRACTOR SHALL DESIGNATE A SUPERINTENDENT AT THE START OF CONSTRUCTION AND THE CONTRACTOR'S SUPERINTENDENT SHALL BE ON-SITE AT ALL TIMES DURING CONSTRUCTION.
8. THE CONTRACTOR SHALL PROVIDE FIELD SURVEYING SERVICES AS NEEDED TO ESTABLISH RECORD GRADES, LINES, AND ELEVATIONS AND PROVIDE SAME TO ENGINEER FOR THE PURPOSE OF PREPARING "RECORD PLANS" OF THE PROJECT.
9. NO CONSTRUCTION VEHICLES SHALL BE STORED, SERVICED, WASHED SERVICED OR FLUSHED IN A LOCATION WHERE LEAKS, SPILLAGE, WASTE MATERIALS, CLEANERS, OR WATERS WILL BE INTRODUCED OR FLOW INTO WETLANDS OR WATERCOURSES.
10. THE CONTRACTOR SHALL MAINTAIN ALL STREETS DRIVEWAYS, PARKING AREAS, AND RIGHTS-OF-WAY IN THE AREA FREE OF SOIL, MUD AND CONSTRUCTION DEBRIS.

LEGEND

- GRAVEL PARKING AND TRAIL
- EXISTING ROAD
- 600 EXISTING CONTOUR
- 650 PROPOSED CONTOUR
- PROPERTY LINE
- RIGHT-OF-WAY
- EDGE OF PROPOSED CONST. ACCESS
- STORM DRAINAGE
- E ELECTICAL LINE
- RAILROAD TRACKS
- EDGE OF WATER
- TREELINE
- UTILITY POLE
- SURVEY IRON PIN
- EDGE OF WATER

SAFETY PLAN

THE SAFETY PLAN CONSISTS OF TWO ELEMENTS, THE FIRST INVOLVING THE CONSTRUCTION SITE AND WORKER AND PUBLIC SAFETY. THE SECOND COMPONENT FOCUSES ON DOWNSTREAM AREAS, WHICH IS ADDRESSED UNDER THE EMERGENCY ACTION PLAN.

CONSTRUCTION SITE SAFETY PLAN

1. THE CONTRACTOR IS TO INSTALL PLASTIC SAFETY FENCING AROUND THE PERIMETER OF THE CONSTRUCTION AREA AND EQUIPMENT AT THE END OF EACH WORK DAY.
2. THE CONTRACTOR SHALL PROVIDE EMERGENCY CONTACT PHONE NUMBERS TO LOCAL EMERGENCY DEPARTMENTS (POLICE, FIRE, EMS, ETC.)
3. APPROPRIATE LOCAL EMERGENCY RESPONSE PERSONNEL SHALL BE PROVIDED KEYS TO GATES.
4. THE CONTRACTOR SHALL NOT ALLOW THE GENERAL PUBLIC ONTO THE CONSTRUCTION SITE.
5. ALL PERSONS ON THE SITE, INCLUDING CONSTRUCTION CREWS, RESTORATION SYSTEMS, REPRESENTATIVES OF THE ENGINEER, AUTHORIZED VISITORS, AND OTHERS MUST WEAR ORANGE REFLECTIVE VESTS AND HARD HATS.
6. THE CONTRACTOR SHALL POST EMERGENCY PHONE NUMBERS FOR POLICE, FIRE, AND MEDICAL SERVICES AT THE CONSTRUCTION SITE.
7. THE CONTRACTOR SHALL KEEP A FIRST-AID KIT ON THE SITE.
8. THE CONTRACTOR SHALL POST "KEEP OUT" SIGNS ON THE SAFETY FENCING SITUATED AROUND THE PERIMETER OF THE WORK AREA.

EMERGENCY ACTION PLAN

1. CONTRACTOR SHALL MONITOR LOCAL FORECASTS, PRECIPITATION, AND STREAM FLOW RATE AND STAGE. IN THE EVENT OF MORE THAN ONE INCH OF RAIN IN 24 HOURS, OR THE FORECAST OF A TROPICAL STORM OR HURRICANE, ALL EQUIPMENT, FLOATABLES, FUEL, AND OTHER POSSIBLE CONTAMINANTS WILL BE MOVED OUT OF THE FEMA FLOOD PLAIN.
2. PRIOR TO INITIATING WORK, CONTRACTOR SHALL INSPECT DOWNSTREAM AREAS TO IDENTIFY ZONES THAT COULD POTENTIALLY BE FLOODED WITHIN OR NEAR THE CHANNEL IN EVENT OF A PREMATURE DAM FAILURE OR UNEXPECTED WATER RELEASE. A MAP OF DOWNSTREAM AREAS INDICATING POTENTIAL PROBLEM AREAS SHALL BE KEPT AT THE WORK SITE.
3. ONCE DEMOLITION WORK COMMENCES, CONTRACTOR SHALL MAKE EVERY EFFORT TO PROCEED AS RAPIDLY AS SAFETY ALLOWS IN ORDER TO MINIMIZE FLOOD EXPOSURES WITH A PARTIAL BREACH OF THE DAM IN PLACE. DOWNSTREAM AREAS WILL BE WARNED IF ANY PORTION OF THE DAM IS IN DANGER OF SUDDENLY BREAKING OR WASHING AWAY. IF POTENTIAL SCOUR IS INDICATED, SOUNDING WILL BE EXPANDED TO INCLUDE US HWY 301 AND RAILROAD BRIDGE UPSTREAM OF I-95.
4. CONTRACTOR SHALL MAKE WEEKLY SOUNDINGS AT THE I-95 BRIDGE FOOTINGS TO MONITOR POTENTIAL SCOUR, WITH DAILY READINGS FOR THREE DAYS AFTER ANY POST-BREACH FLOOD.
5. CONTRACTOR SHALL NOTIFY LOCAL EMERGENCY DEPARTMENTS (FIRE, POLICE, EMS, ETC.) AT THE COMMENCEMENT OF WORK AND AT OTHER CRITICAL STAGES (SPILLWAY BREACHING, POWERHOUSE DEMOLITION, ETC.).
6. CONTRACTOR SHALL NOTIFY LOCAL EMERGENCY PERSONNEL IN THE EVENT OF MEDICAL EMERGENCIES OR FLOOD RELATED PROBLEMS.

GENERAL DAM REMOVAL SEQUENCE

THE CONTRACTOR SHALL FOLLOW THE GENERAL SEQUENCE AS OUTLINED BELOW. IF CIRCUMSTANCES ARISE WHEREBY FIELD CONDITIONS REQUIRE A CHANGE IN SCHEDULE, THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY.

PRE-DEMOLITION ACTIVITIES

1. REMOVE SEDIMENT FROM AHEAD OF INLET WORKS.
2. REMOVE MILL HEAD GATES, OPERATORS, AND ANY ANCILLARY EQUIPMENT.
3. REMOVE SEDIMENT AND GRAVEL FROM MILL STRUCTURE.

DAM DEMOLITION ACTIVITIES

4. ESTABLISH EQUIPMENT ACCESS POINTS.
5. INSTALL EROSION AND SEDIMENTATION CONTROLS.
6. INSTALL TEMPORARY RIVER CROSSING BELOW SPILLWAY.
7. DEMOLISH MILL STRUCTURE, RETAINING SOUTH WALL UNTIL READY TO REGRADE BANK.
8. REMOVE RUBBLE OUT OF RIVER CHANNEL FOR SECONDARY SIZING (IF REQUIRED) AND DISPOSAL.
8. DRILL SPILLWAY FOR EXPLOSIVE CHARGES (SEE BLASTING PLAN).
9. IMPLEMENT SUBSTRATE MANAGEMENT PLAN.
10. DEMOLISH OGEE SPILLWAY TO THE LIMITS SHOWN ON THE PLANS.
11. REMOVE RUBBLE OUT OF WATERWAY FOR SECONDARY SIZING (IF REQUIRED) AND DISPOSAL.
12. DISPOSE OF DAM RUBBLE IN DISPOSAL AREAS TO CREATE TOE PROTECTION FOR SLOPES. INTERMIX EXCAVATED SUBSTRATE WITH CONCRETE RUBBLE AND COMPACT AS REQUIRED.
14. COMPLETE FINAL RIVERBANK REGRADING (NORTH BANK) AND STABILAZATION ABOVE SPILLWAY AS SOON AS PROCTICAL TO MINIMIZE EXPOSURE AND EROSION.
15 CUT BACK END FACE OF SPILLWAY THAT IS TO REMAIN IN PLACE.
16. COMPLETE RIVERBANK REGRADING AND STABILIZATION IN DISPOSAL AREAS.

POST-DEMOLITION ACTIVITIES

17. STABILIZE ALL DISTURBED AREAS
18. PLANT ADJACENT RIVER AS INDICATED ON LANDSCAPE PLAN.

GENERAL BLASTING PLAN

1. CONTRACTOR SHALL ENGAGE A BLASTING COMPANY LICENSED IN THE STATE OF NORTH CAROLINA WITH AT LEAST 20 YEARS ACCEPTABLE DEMONSTRATED EXPERIENCE. CONTRACTOR SHALL PROVIDE A BLASTING AND SAFETY PLAN FOR APPROVAL ONE WEEK PRIOR TO WORK.
2. A PRE-BLAST SURVEY SHALL INCLUDE NEAREST RESIDENCES AND SENSITIVE STRUCTURES
3. OGEE SPILLWAY TO BE PNEUMATICALLY DRILLED FOR LOCALIZED, LOW-LEVEL CHARGES, APPROXIMATELY 5' ON CENTER, OR ADJUSTED ACCORDING TO THE BLASTER'S EVALUATION OF CONCRETE STRENGTH DURING DRILLING. CHARGE STRENGTH SHALL BE TO ONLY FRACTURE THE CONCRETE MASS, AND NOT DISPLACE PIECES DURING THE BLAST. ANTICIPATED LOADING IS 0.3 TO 1.0 LBS. PER CUBIC YARD OF CONCRETE, ADJUSTED ACCORDING TO THE BLASTER'S EVALUATION OF CONCRETE DENSITY DURING DRILLING.
4. CHARGES SHALL BE PLACED ACCORDING TO MANUFACTURER'S AND INSTITUTE OF MAKERS OF EXPLOSIVES (IME) RECOMMENDATIONS.
5. NON-ELECTRIC DETONATORS SHALL BE USED, WITH STAGGERED DETONATION TIMES.
6. BLASTING MATS OR EQUIVALENT SHALL BE USED. SHOP DRAWINGS OF INTENDED PROTECTION SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW.
7. VIBRATION BLAST SHALL BE MONITORED AT ONE (1) LOCATION USING SEISMOGRAPHS NEAR HOUSES AT THE SOUTHERN CONSTRUCTION ENTRANCE.
8. CONTRACTOR SHALL NOTIFY ADJACENT PROPERTIES BY WRITTEN NOTICE AT LEAST THREE (3) DAYS BEFORE BLASTING. SUBMIT INTENDED NOTICE TO ENGINEER FOR REVIEW.
9. CONTRACTOR SHALL PROVIDE SUFFICIENT SITE SECURITY, INCLUDING SECURITY PERSONNEL IF NECESSARY, SHALL BE EMPLOYED TO ENSURE PUBLIC SAFETY DURING THE BLAST PERIOD. ALL PUBLIC SHALL BE KEPT AT LEAST 500 FEET FROM THE BLAST AREA.

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REVISIONS

	COMMENTS
10.27.06	

LEGEND AND GENERAL NOTES
LITTLE RIVER
LOWELL MILL DAM RESTORATION SITE
JOHNSTON COUNTY, NORTH CAROLINA

KWK	PFM	JGM
DESIGNED	DRAWN	CHECKED

SCALE NTS
DATE NOV 3, 2005
PROJECT NO. 2691-02
DWG NAME legend & general notes.dwg

1 of 13
SHEET NO.

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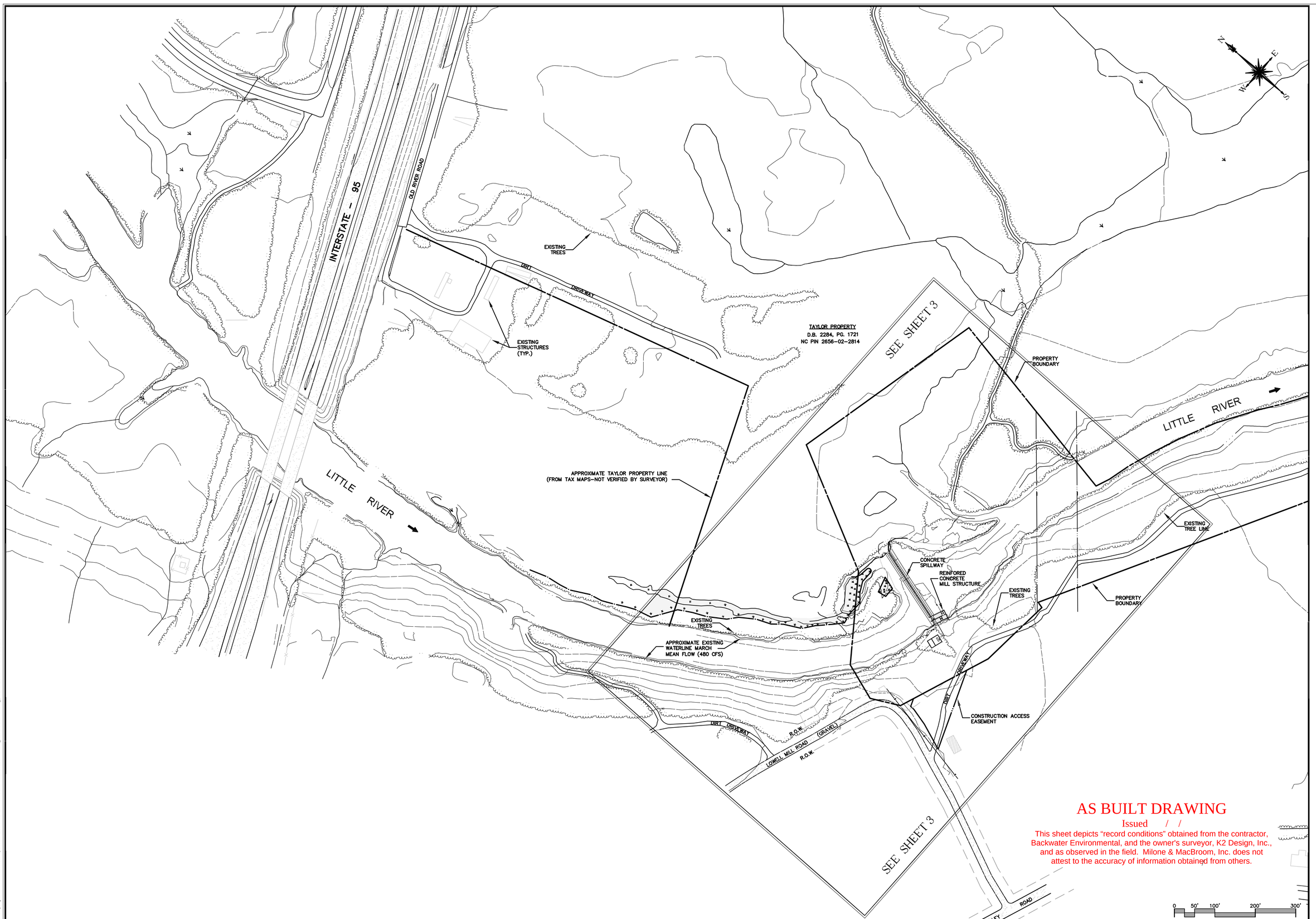

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REVISIONS

EXISTING CONDITIONS

LOWELL MILL DAM REMOVAL
LITTLE RIVEER

JOHNSTON COUNTY, NORTH CAROLINA

KWK	JD	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS NOTED

DATE NOV.3, 2005

PROJECT NO. 2691-02

DWG NAME EXISTING CONDITION

2 of 13

SHEET NO.

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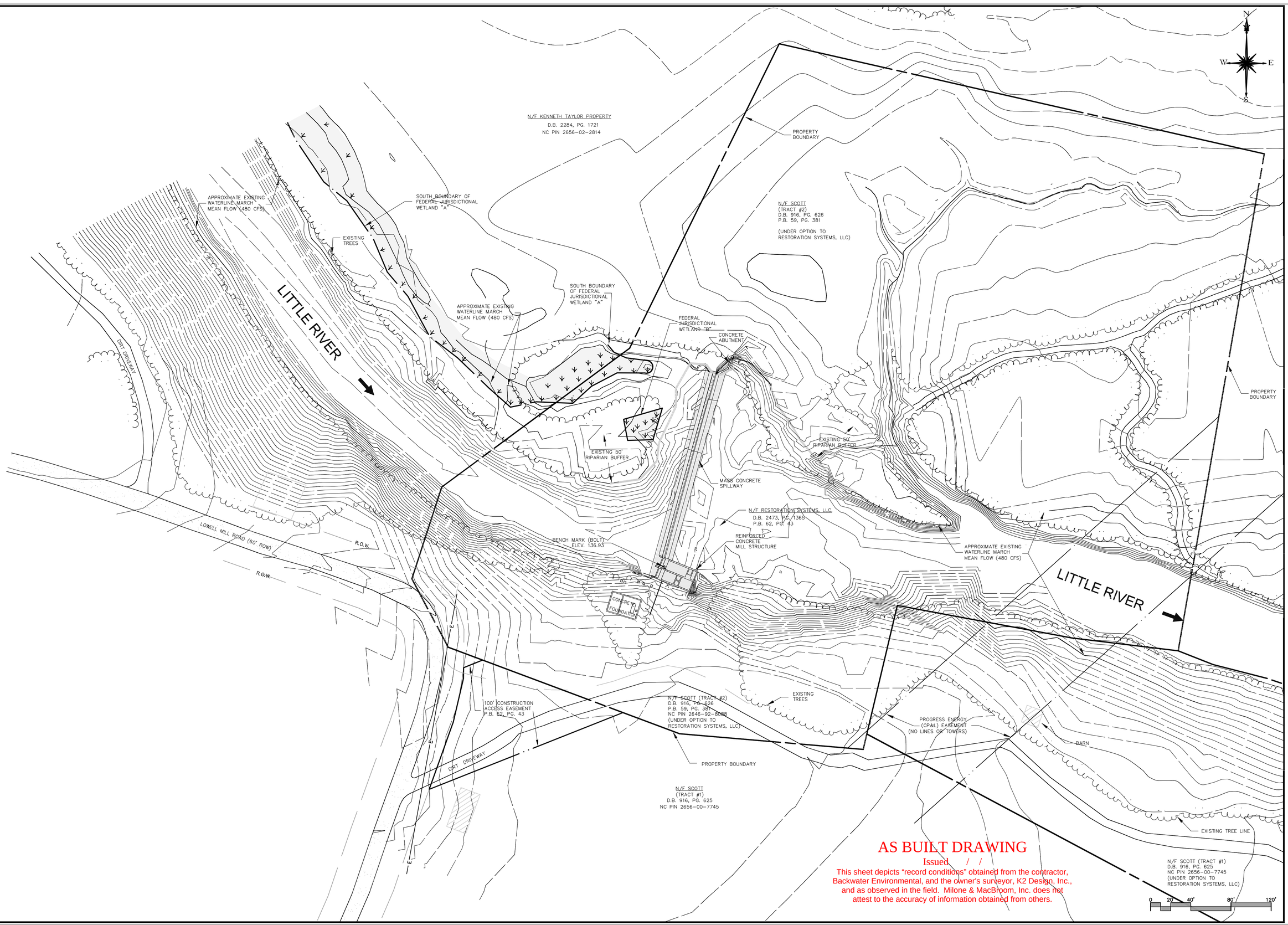

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REVISIONS

EXISTING CONDITIONS

LOWELL MILL DAM REMOVAL
LITTLE RIVER

JOHNSTON COUNTY, NORTH CAROLINA

KWK	JD	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS NOTED

DATE NOV. 11, 2005

PROJECT NO. 2691-02

DWG NAME EXISTING CONDITION

3 of 13

SHEET NO.

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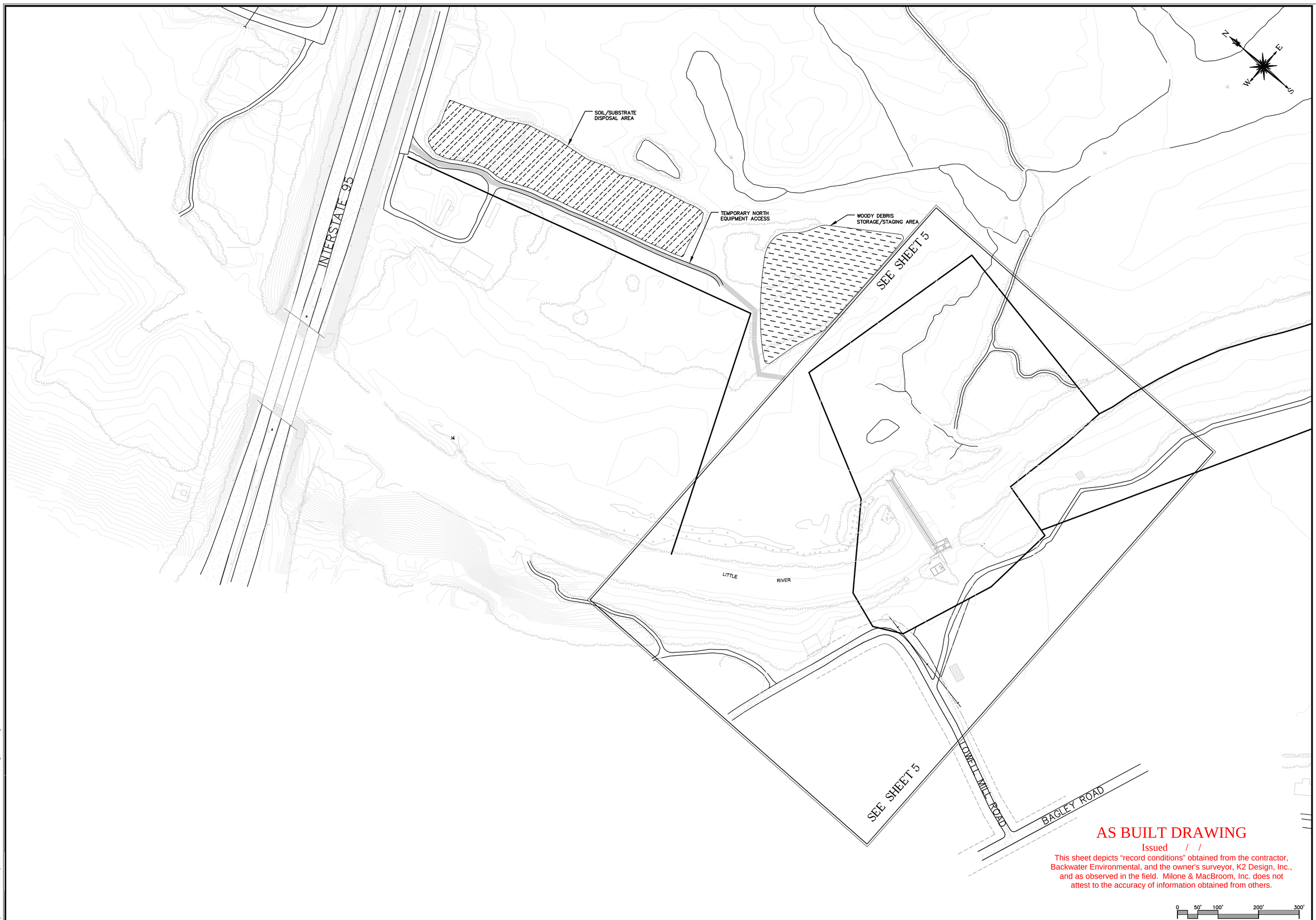

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REVISIONS

EQUIPMENT ACCESS AND WORK ZONES

LITTLE RIVER
LOWELL MILL DAM RESTORATION SITE

JOHNSTON COUNTY, NORTH CAROLINA

KWK	JD	KWK
DESIGNED	DRAWN	CHECKED

SCALE AS NOTED

DATE NOV 11, 2005

PROJECT NO. 2691-02

DWG NAME access.dwg

4 of 13

SHEET NO.

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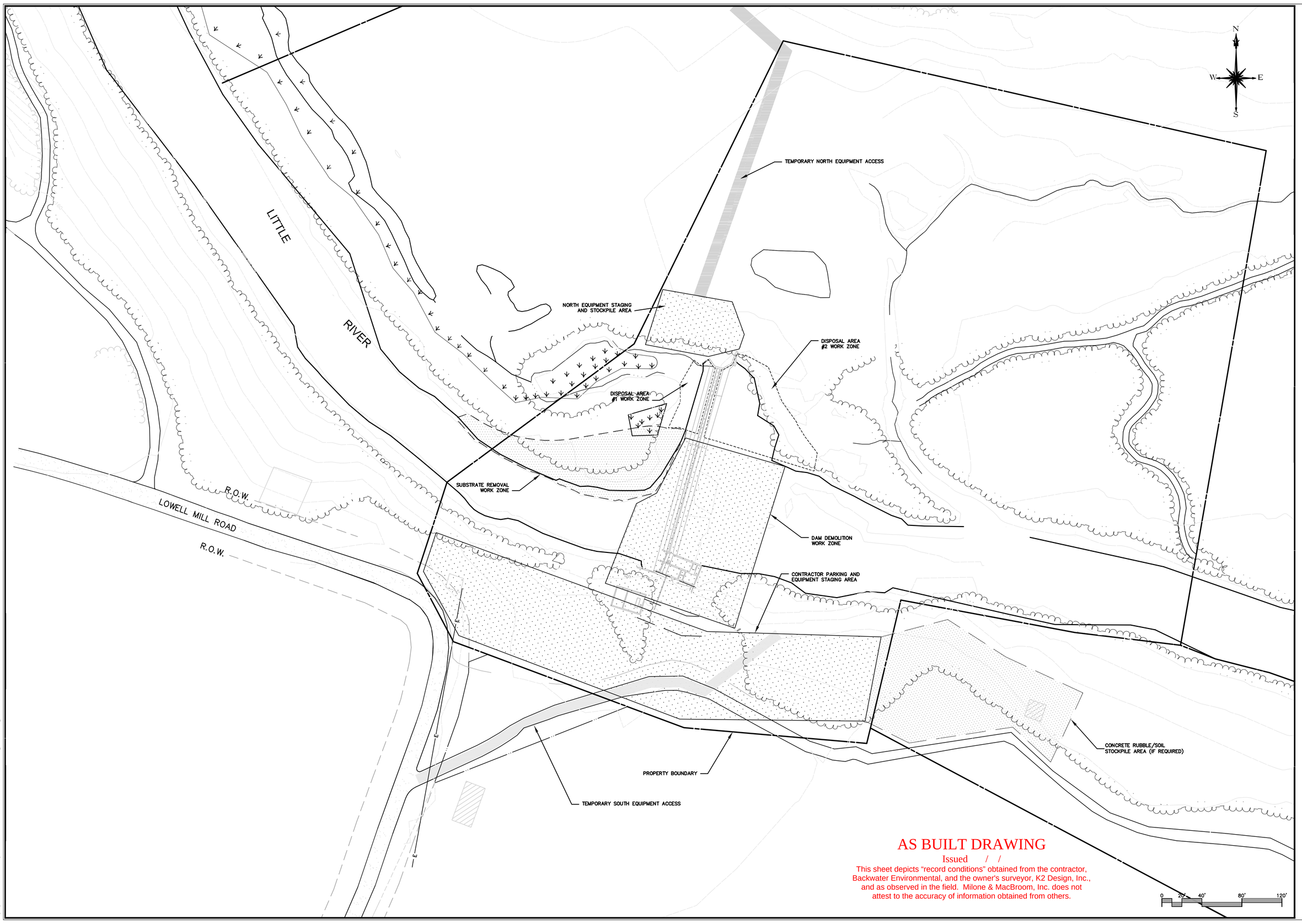

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EQUIPMENT ACCESS AND WORK ZONES

LITTLE RIVER
LOWELL MILL DAM RESTORATION SITE

JOHNSTON COUNTY, NORTH CAROLINA

KWK	JD	KWK
DESIGNED	DRAWN	CHECKED

SCALE AS NOTED

DATE NOV 17, 2005

PROJECT NO. 2691-02

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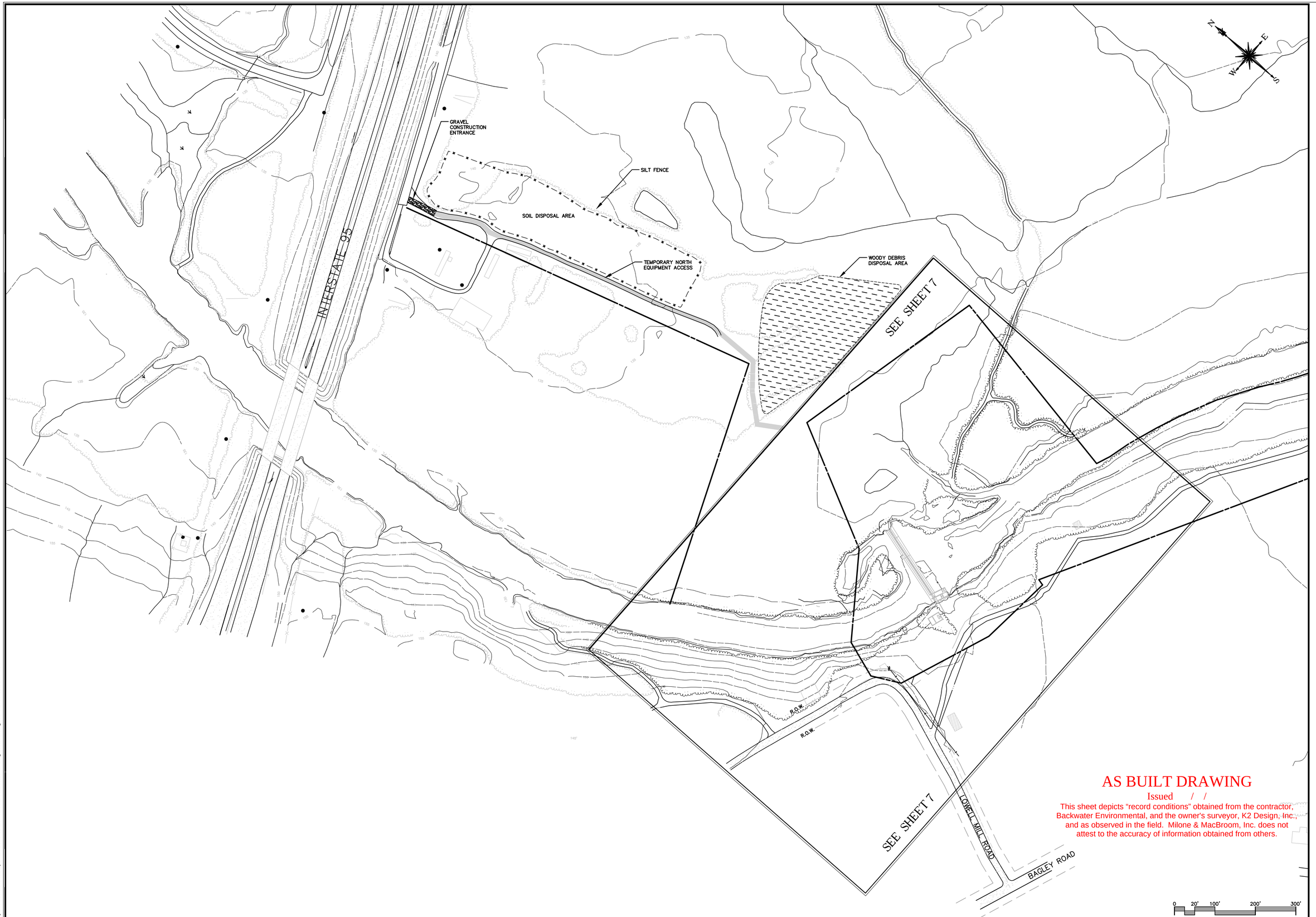

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REVISIONS

EROSION & SEDIMENTATION CONTROL PLAN

LITTLE RIVER
LOWELL MILL DAM RESTORATION SITE

JOHNSTON COUNTY, NORTH CAROLINA

KWK	PFM	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS SHOWN

DATE NOV 11, 2005

PROJECT NO. 2691-02

DWG NAME erosion.dwg

6 of 13

SHEET NO.

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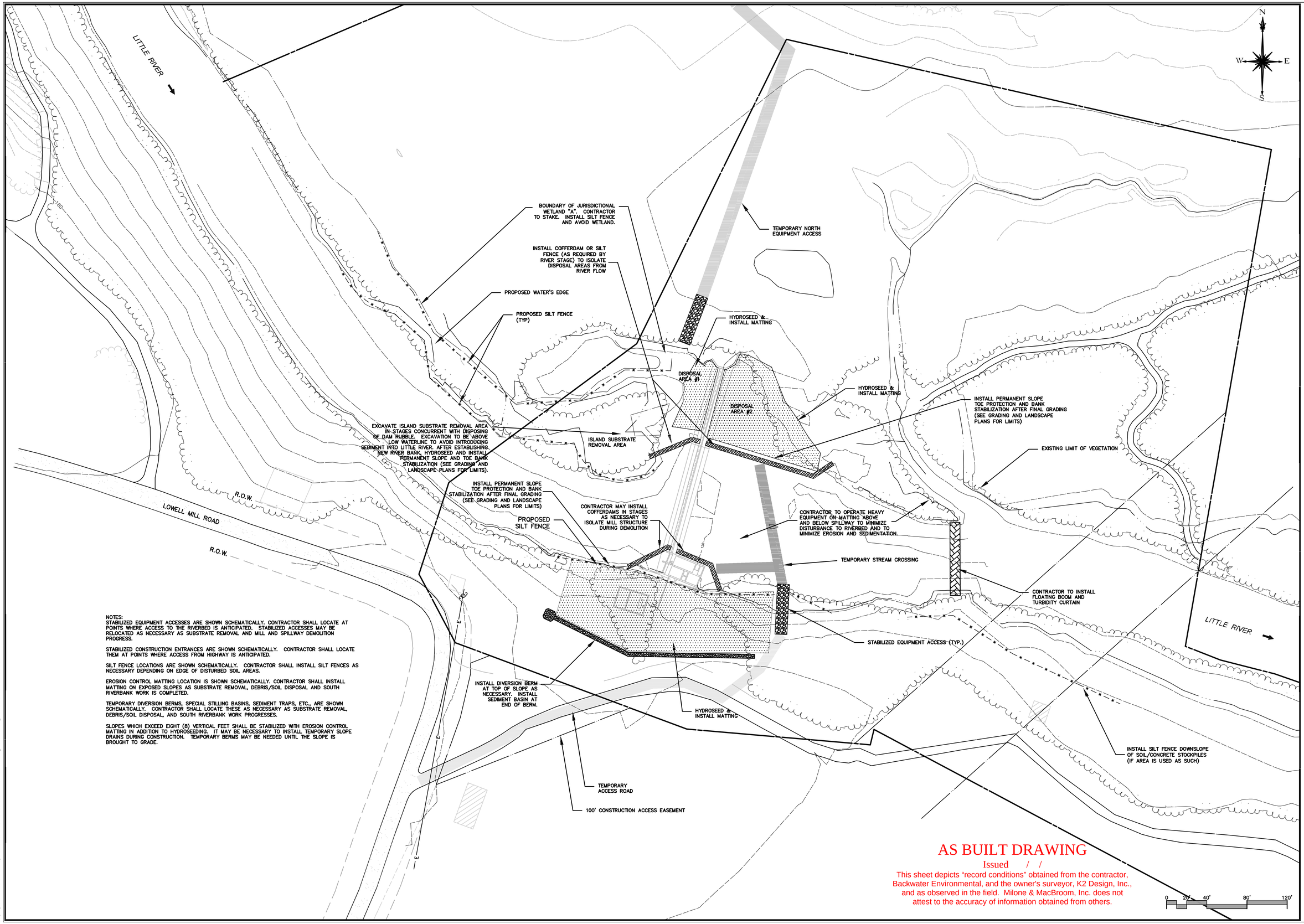

NOTES:
STABILIZED EQUIPMENT ACCESSES ARE SHOWN SCHEMATICALLY. CONTRACTOR SHALL LOCATE AT POINTS WHERE ACCESS TO THE RIVERBED IS ANTICIPATED. STABILIZED ACCESSES MAY BE RELOCATED AS NECESSARY AS SUBSTRATE REMOVAL AND MILL AND SPILLWAY DEMOLITION PROGRESS.

STABILIZED CONSTRUCTION ENTRANCES ARE SHOWN SCHEMATICALLY. CONTRACTOR SHALL LOCATE THEM AT POINTS WHERE ACCESS FROM HIGHWAY IS ANTICIPATED.

SILT FENCE LOCATIONS ARE SHOWN SCHEMATICALLY. CONTRACTOR SHALL INSTALL SILT FENCES AS NECESSARY DEPENDING ON EDGE OF DISTURBED SOIL AREAS.

EROSION CONTROL MATTING LOCATION IS SHOWN SCHEMATICALLY. CONTRACTOR SHALL INSTALL MATTING ON EXPOSED SLOPES AS SUBSTRATE REMOVAL, DEBRIS/SOIL DISPOSAL AND SOUTH RIVERBANK WORK IS COMPLETED.

TEMPORARY DIVERSION BERMS, SPECIAL STILLING BASINS, SEDIMENT TRAPS, ETC., ARE SHOWN SCHEMATICALLY. CONTRACTOR SHALL LOCATE THESE AS NECESSARY AS SUBSTRATE REMOVAL, DEBRIS/SOIL DISPOSAL, AND SOUTH RIVERBANK WORK PROGRESSES.

SLOPES WHICH EXCEED EIGHT (8) VERTICAL FEET SHALL BE STABILIZED WITH EROSION CONTROL MATTING IN ADDITION TO HYDROSEEDING. IT MAY BE NECESSARY TO INSTALL TEMPORARY SLOPE DRAINS DURING CONSTRUCTION. TEMPORARY BERMS MAY BE NEEDED UNTIL THE SLOPE IS BROUGHT TO GRADE.

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REVISIONS

EROSION & SEDIMENTATION CONTROL PLAN

LITTLE RIVER
LOWELL MILL DAM RESTORATION SITE

JOHNSTON COUNTY, NORTH CAROLINA

KWK	PFM	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS SHOWN

DATE NOV 17, 2005

PROJECT NO. 2691-02

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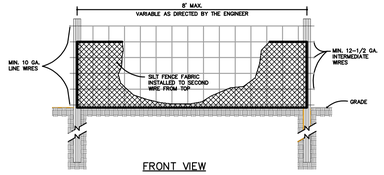
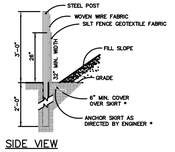


FRONT VIEW



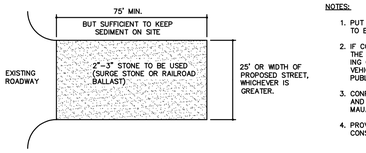
NOTE:
–USE SILT FENCE ONLY WHEN DRAINAGE AREA DOES NOT EXCEED 1/4 ACRE AND NEVER IN AREAS OF CONCENTRATED FLOW
–END OF SILT FENCE NEEDS TO BE TURNED UPHILL.

* FOR REPAIR OF SILT FENCE FAILURES, USE No. 57 WASHED STONE. FOR ANCHOR WHEN SILT FENCE IS PROTECTING CATCH BASIN.

SIDE VIEW

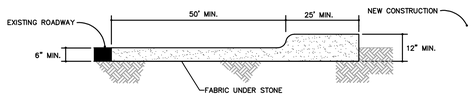
REVISIONS	
DATE	DESCRIPTION

STANDARD TEMPORARY SILT FENCE — 1



PLAN

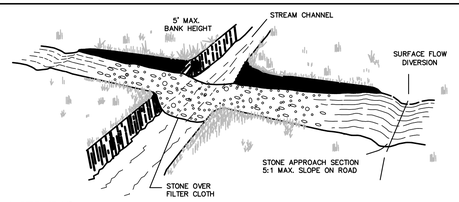
NOTES:
1. PUT SILT FENCE OR TREE PROTECTION FENCE UP TO ENSURE CONSTRUCTION ENTRANCE IS USED.
2. IF CONSTRUCTION ON THE SITES ARE SUCH THAT THE MUD IS NOT REMOVED BY THE VEHICLE TRAVELING OVER THE STONE, THEN THE TIRES OF THE VEHICLES MUST BE WASHED BEFORE ENTERING THE PUBLIC ROAD.
3. CONFORM TO REQUIREMENTS OF THE NCDENR "EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MAUAL", LATEST EDITION.
4. PROVIDE APPROPRIATE TRANSITION BETWEEN CONSTRUCTION ENTRANCE AND EXISTING ROADWAY.



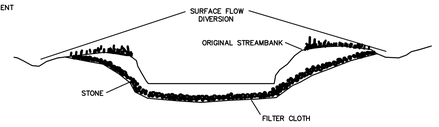
CROSS SECTION

REVISIONS	
DATE	DESCRIPTION

CONSTRUCTION ENTRANCE — 7

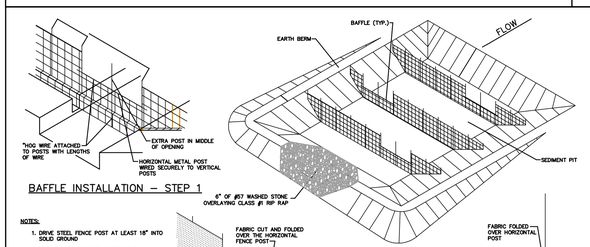


NOTES:
1. CLASS B STONE – MINIMUM DEPTH OF 24"
2. UNDERCUT FOR STONE PLACEMENT



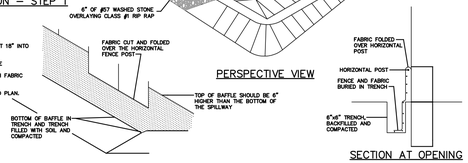
REVISIONS	
DATE	DESCRIPTION

TEMPORARY STREAM CROSSING OPTION — 11B



BAFFLE INSTALLATION – STEP 1

NOTES:
1. DRIVE STEEL FENCE POST AT LEAST 18" INTO SOLID GROUND
2. WOOD POSTS ARE NOT ACCEPTABLE
3. USE STAPLES 1" APART TO ATTACH FABRIC TO "HOG WIRE"
4. BAFFLE SPACED AS PER APPROVED PLAN.



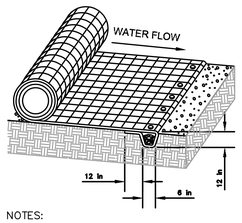
PERSPECTIVE VIEW

SECTION AT OPENING

BAFFLE INSTALLATION – STEP 2

REVISIONS	
DATE	DESCRIPTION

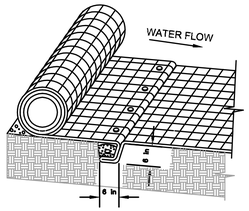
GRAVEL & RIP RAP FILTER BASIN — 3B



NOTES:
1. UTILIZE 700G COIR FIBER MATTING.
2. SECURE AT 1 ft INTERVALS (OR AS RECOMMENDED BY MANUFACTURER BASED ON SLOPE), BACKFILL AND COMPACT SOIL
3. TO BE USED AT TOP OF ALL MATTING AREAS.

INITIAL MATTING ANCHOR TRENCH

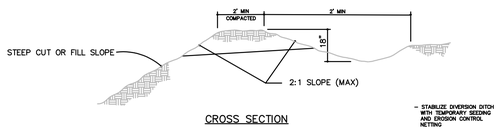
N.T.S.



NOTES:
1. UTILIZE 700G COIR FIBER MATTING.
2. SECURE AT 1 ft INTERVALS (OR AS RECOMMENDED BY MANUFACTURER BASED ON SLOPE), BACKFILL AND COMPACT SOIL
3. ANCHOR, STAPLE AND OVERLAP IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
4. TO BE USED ON ALL MATTING AREAS AT INTERVALS AS RECOMMENDED BY THE MANUFACTURER.

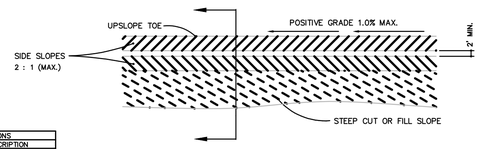
INTERMITTANT MATTING CHECK SLOT

N.T.S.



CROSS SECTION

– STABILIZE DIVERSION DITCH WITH TEMPORARY SEEDING AND EROSION CONTROL NETTING



PLAN VIEW

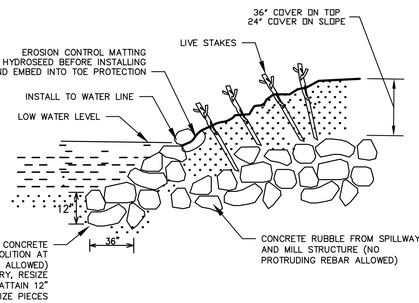
REVISIONS	
DATE	DESCRIPTION

DIVERSION DITCH — 9

CONSTRUCTION SEQUENCE / SEDIMENT & EROSION CONTROL NOTES

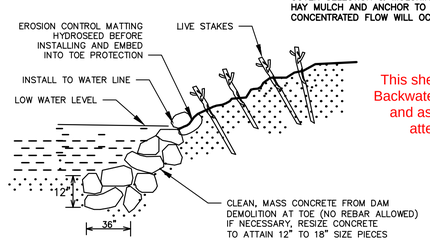
EROSION AND SEDIMENT CONTROL SHALL PROCEED IN THE FOLLOWING MANNER:

1. PRIOR TO COMMENCEMENT OF WORK, A PRECONSTRUCTION MEETING SHALL BE HELD WITH THE ENGINEER AND REPRESENTATIVES OF THE CONTRACTOR, UTILITIES AND OWNER. AT THIS MEETING, THE SEDIMENT AND EROSION CONTROL PLAN WILL BE DISCUSSED.
2. CONTRACTOR TO STAKE OUT LIMIT OF DISTURBANCE, WETLANDS, AND VEGETATION TO BE RETAINED. NO DISTURBANCE IS TO TAKE PLACE BEYOND THE LIMITS STAKED. CONTRACTOR SHALL TAKE SPECIAL PRECAUTIONS TO PROTECT TREES AND AND EXISTING IMPROVEMENTS TO REMAIN.
3. CONTRACTOR TO COORDINATE WORK SCHEDULE WITH IMPACTED PROPERTY OWNERS TO MAINTAIN SAFE VEHICLE AND PEDESTRIAN ACCESS AND PARKING. CONTRACTOR TO MINIMIZE DISRUPTION TO THE GREATEST EXTENT PRACTICABLE.
4. CONTRACTOR TO INSTALL SEDIMENT AND EROSION CONTROLS PRIOR TO CLEARING AND GRUBBING. INSTALL CONSTRUCTION ENTRANCE PADS AS DEPICTED ON THE PLANS.
5. THROUGH FLOW OF WATERCOURSE SHALL BE MAINTAINED DURING CONSTRUCTION SO AS NOT TO SUSPEND SEDIMENT FROM EARTHWORK ACTIVITIES.
6. INITIATE EARTHWORK OPERATIONS AFTER ALL SEDIMENT AND EROSION CONTROLS ARE IN PLACE.
7. AREAS OF ACTIVITY AND EXPOSED AREAS ARE TO BE MINIMIZED. STABILIZE ALL SLOPES IMMEDIATELY AFTER THEIR ESTABLISHMENT.
8. ESTABLISH ALL SLOPES TO GRADE IN AREAS OF DISTURBANCE AS SOON AS POSSIBLE. TEMPORARY SEED AND MULCH IN ACCORDANCE WITH THE LANDSCAPE SPECIFICATIONS.
9. THE SEDIMENT AND EROSION CONTROL PLAN MAY BE MODIFIED BY THE SITE ENGINEER AS NECESSITATED BY CHANGING SITE CONDITIONS. ADDITIONAL CONTROL DEVICES BESIDES WHAT IS SHOWN IN PLANS WILL BE ADDED BY THE ENGINEER IF NEEDED.
10. ALL SEDIMENT CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND AFTER STORMS GREATER THAN 0.5 INCHES OF PRECIPITATION DURING ANY 24–HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY. ALL SEDIMENT CONTROL FEATURES SHALL BE MAINTAINED UNTIL FINAL STABILIZATION HAS BEEN OBTAINED.
11. INSPECTION OF THE SITE FOR EROSION SHALL CONTINUE FOR A PERIOD OF THREE MONTHS AFTER COMPLETION WHEN RAINFALLS OF ONE INCH OR MORE OCCUR.
12. ALL EROSION CONTROL DEVICES SHALL BE PROPERLY MAINTAINED DURING ALL PHASES OF CONSTRUCTION UNTIL THE COMPLETION OF ALL CONSTRUCTION ACTIVITIES AND ALL DISTURBED AREAS HAVE BEEN STABILIZED. ALL TEMPORARY CONTROL DEVICES SHALL BE REMOVED WHEN CONSTRUCTION IS COMPLETE AND THE SITE IS STABILIZED.
13. THE CONTRACTOR MUST TAKE NECESSARY ACTION TO MINIMIZE THE TRACKING OF MUD ONTO THE PAVED ROADWAY FROM CONSTRUCTION AREAS. THE CONTRACTOR SHALL REMOVE MUD/SOIL FROM PAVEMENT DAILY, AS MAY BE REQUIRED.
14. THE SITE SHOULD BE KEPT CLEAN OF LOOSE DEBRIS AND BUILDING MATERIALS SUCH THAT NONE OF THE ABOVE ENTER STORMWATER FACILITIES, ROADWAYS, WATERCOURSES, OR WETLANDS.
15. A COPY OF ALL PLANS AND REVISIONS, AND THE SEDIMENT AND EROSION CONTROL PLAN, SHALL BE MAINTAINED ON–SITE AT ALL TIMES DURING CONSTRUCTION.
16. A COPY OF ALL INSPECTION LOGS SHALL BE RETAINED FOR THE DURATION OF THE PROJECT.
17. ALL SEDIMENT AND EROSION CONTROL MEASURES SHALL BE REMOVED ONLY UPON STABILIZATION OF ALL UPGRADIENT AREAS.



TOE BANK PROTECTION IN DISPOSAL AREAS

NOT TO SCALE



TOE BANK PROTECTION ON SOUTH BANK

NOT TO SCALE

SEDIMENT & EROSION CONTROL SPECIFICATIONS

GENERAL:

THESE GUIDELINES SHALL APPLY TO ALL WORK CONSISTING OF ANY AND ALL TEMPORARY AND/OR PERMANENT MEASURES TO CONTROL WATER POLLUTION AND SOIL EROSION, AS MAY BE REQUIRED, DURING THE CONSTRUCTION OF THE PROJECT.

IN GENERAL, ALL CONSTRUCTION ACTIVITIES SHALL PROCEED IN SUCH A MANNER SO AS NOT TO POLLUTE ANY WETLANDS, WATERCOURSE, WATERBODY, CONDUIT CARRYING WATER, ETC. THE CONTRACTOR SHALL LIMIT, INSOFAR AS POSSIBLE, THE SURFACE AREA OF EARTH MATERIALS EXPOSED BY CONSTRUCTION METHODS AND IMMEDIATELY PROVIDE PERMANENT AND TEMPORARY POLLUTION CONTROL MEASURES TO PREVENT CONTAMINATION OF ADJACENT WETLANDS, WATERCOURSES, WATERBODIES AND TO PREVENT, INSOFAR AS POSSIBLE, EROSION ON THE SITE.

LAND GRADING GENERAL:

1. THE RESHAPING OF THE GROUND SURFACE BY EXCAVATION AND FILLING OR A COMBINATION OF BOTH, TO OBTAIN PLANNED GRADES, SHALL PROCEED IN ACCORDANCE WITH THE FOLLOWING CRITERIA:
   a. THE CUT FACE OF EARTH EXCAVATION SHALL NOT BE STEEPER THAN TWO HORIZONTAL TO ONE VERTICAL (2:1).
   b. THE PERMANENT EXPOSED FACES OF FILLS SHALL NOT BE STEEPER THAN TWO HORIZONTAL TO ONE VERTICAL (2:1).
   c. THE CUT FACE OF ROCK EXCAVATION SHALL NOT BE STEEPER THAN ONE HORIZONTAL TO FOUR VERTICAL (1:4).
   d. PROVISION SHOULD BE MADE TO CONDUCT SURFACE WATER SAFELY TO STORM DRAINS TO PREVENT SURFACE RUNOFF FROM DAMAGING CUT FACES AND FILL SLOPES.

TOPSOILING GENERAL:

1. TOPSOIL SHALL BE SPREAD OVER ALL EXPOSED AREAS IN ORDER TO PROVIDE A SOIL MEDIUM HAVING FAVORABLE CHARACTERISTICS FOR THE ESTABLISHMENT, GROWTH AND MAINTENANCE OF VEGETATION.
2. UPON ATTAINING FINAL SUBGRADES, SCARIFY SURFACE TO PROVIDE A GOOD BOND WITH TOPSOIL.
3. REMOVE ALL LARGE STONES, TREE LIMBS, ROOTS AND CONSTRUCTION DEBRIS.
4. APPLY LIME ACCORDING TO SOIL TEST OR AT THE RATE OF TWO (2) TONS PER ACRE.

MATERIAL:

1. TOPSOIL SHOULD HAVE PHYSICAL, CHEMICAL AND BIOLOGICAL CHARACTERISTICS FAVORABLE TO THE GROWTH OF PLANTS.
2. TOPSOIL SHOULD HAVE A SANDY OR LOAMY TEXTURE.
3. TOPSOIL SHOULD BE RELATIVELY FREE OF SUBSOIL MATERIAL AND MUST BE FREE OF STONES (OVER 1" IN DIAMETER), LUMPS OF SOIL, ROOTS, TREE LIMBS AND TRASH OR CONSTRUCTION DEBRIS. IT SHOULD BE FREE OF ROOTS OR RHIZOMES SUCH AS THISTLE, NUTGRASS AND QUACKGRASS.
4. AN ORGANIC MATTER CONTENT OF SIX PERCENT (6%) IS REQUIRED. AVOID LIGHT COLORED SUBSOIL MATERIAL.
5. SOLUBLE SALT CONTENT OF OVER 500 PARTS PER MILLION (PPM) IS LESS SUITABLE. AVOID TIDAL MARSH SOILS BECAUSE OF HIGH SALT CONTENT AND SULFUR ACIDITY.
6. THE pH SHOULD BE MORE THAN 6.0. IF LESS, ADD LIME TO INCREASE pH TO AN ACCEPTABLE LEVEL.

APPLICATION:

1. AVOID SPREADING WHEN TOPSOIL IS WET OR FROZEN.
2. SPREAD TOPSOIL UNIFORMLY TO A DEPTH OF AT LEAST SIX INCHES (6") OR TO THE DEPTH SHOWN ON THE LANDSCAPING PLANS.

TEMPORARY VEGETATIVE COVER

1. TEMPORARY VEGETATIVE COVER SHALL BE ESTABLISHED ON ALL UNPROTECTED AREAS THAT PRODUCE SEDIMENT, AREAS WHERE FINAL GRADING HAS BEEN COMPLETED AND AREAS WHERE THE ESTIMATED PERIOD OF BARE SOIL EXPOSURE IS LESS THAN 12 MONTHS. TEMPORARY SEED AND MULCH ALL DISTURBED AREAS ACCORDING TO NCDOT STANDARD SPECIFICATIONS.

SITE PREPARATION:

1. INSTALL REQUIRED SURFACE WATER CONTROL MEASURES.
2. REMOVE LOOSE ROCK, STONE AND CONSTRUCTION DEBRIS FROM AREA.
3. APPLY LIME ACCORDING TO SOIL TEST OR AT A RATE OF ONE 45 LBS OF GROUND DOLOMITIC LIMESTONE PER SF.
4. APPLY FERTILIZER ACCORDING TO SOIL TEST OR AT THE RATE OF 1000 LBS. OF 10–10–10 PER ACRE (23 LBS. PER 1,000 SQ. FT.) AND SECOND APPLICATION OF 200 LBS. OF 10–10–10 PER ACRE(5 LBS. PER 1,000 SQ. FT.) WHEN GRASS IS FOUR INCHES (4") TO SIX INCHES (6") HIGH. APPLY ONLY WHEN GRASS IS DRY.
5. UNLESS HYDROSEEDED, WORK IN LIME AND FERTILIZER TO A DEPTH OF FOUR (4") INCHES USING A DISK OR ANY SUITABLE EQUIPMENT.
6. TILLAGE SHOULD ACHIEVE A REASONABLY UNIFORM, LOOSE SEEDBED. WORK ON CONTOUR IF SITE IS SLOPING.

ESTABLISHMENT:

1. SELECT APPROPRIATE SPECIES FOR THE SITUATION. NOTE RATES AND SEEDING DATES (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION).
2. APPLY SEED UNIFORMLY ACCORDING TO THE RATE INDICATED BY BROADCASTING, DRILLING OR HYDRAULIC APPLICATION.
3. UNLESS HYDROSEEDED, COVER RYE GRAIN WITH NOT MORE THAN 1/4 INCH OF SOIL USING SUITABLE EQUIPMENT.
4. MULCH IMMEDIATELY AFTER SEEDING IF REQUIRED (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION BELOW). APPLY STRAW OR HAY MULCH AND ANCHOR TO SLOPES GREATER THAN 3% OR WHERE CONCENTRATED FLOW WILL OCCUR.

VEGETATIVE COVER GENERAL:

1. PERMANENT VEGETATIVE COVER SHALL BE ESTABLISHED AS VARIOUS SECTIONS OF THE PROJECT ARE COMPLETED IN ORDER TO STABILIZE THE SOIL, REDUCE DOWNSTREAM DAMAGE FROM SEDIMENT AND RUNOFF, AND TO ENHANCE THE AESTHETIC NATURE OF THE SITE. IT WILL BE APPLIED TO ALL CONSTRUCTION AREAS SUBJECT TO EROSION WHERE FINAL GRADING HAS BEEN COMPLETED AND A PERMANENT COVER IS NEEDED.

SITE PREPARATION:

1. INSTALL REQUIRED SURFACE WATER CONTROL MEASURES.
2. REMOVE LOOSE ROCK, STONE AND CONSTRUCTION DEBRIS FROM AREA.
3. PERFORM ALL PLANTING OPERATIONS PARALLEL TO THE CONTOURS OF THE SLOPE.
4. APPLY TOPSOIL AS INDICATED ELSEWHERE HEREIN.
5. APPLY FERTILIZER ACCORDING TO SOIL TEST OR:
   - OF 10–10–10 FERTILIZER PER ACRE (23 LBS. PER 1,000 SQ. FT.); THEN SIX TO EIGHT WEEKS LATER, APPLY ON THE SURFACE AN ADDITIONAL 300 LBS. OF 10–10–10 FERTILIZER PER ACRE. AFTER SEPTEMBER 1, TEMPORARY VEGETATIVE COVER SHALL BE APPLIED.

VEGETATIVE COVER SELECTION & MULCHING

TEMPORARY VEGETATIVE COVER:

JANUARY 1 – APRIL 15
RYE GRAIN
120 LBS/AC

APRIL 15 – AUGUST 15
GERMAN MILLET
40 LBS/AC

AUGUST 15 – DECEMBER 30
RYE GRAIN
120 LBS/AC

SOIL AMENDMENTS FOR TEMOPORARY VEGETATION

AGRICULTURAL LIMESTONE 2000LBS/AC
10–10–10 FERTILIZED 1000LBS/AC
MULCH/STRAW 4000 LBS/AC

PERMANENT VEGETATIVE COVER:

REFER TO LANDSCAPE PLANS AND SPECIFICATIONS

TEMPORARY MULCHING:

STRAY OR HAY 70–90 LBS./1,000 SQ.FT.
(TEMPORARY VEGETATIVE AREAS)

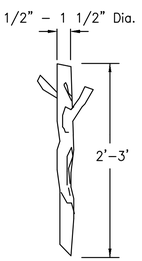
WOOD FIBER IN HYDROMULCH SLURRY 25–50 LBS./1,000 SQ. FT.

ESTABLISHMENT:

1. SMOOTH AND FIRM SEEDBED WITH CULTIPACKER OR OTHER SIMILAR EQUIPMENT PRIOR TO SEEDING (EXCEPT WHEN HYDROSEEDING).
2. SELECT ADAPTED SEED MIXTURE FOR THE SPECIFIC SITUATION. NOTE RATES AND THE SEEDING DATES (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION BELOW).
3. APPLY SEED UNIFORMLY ACCORDING TO RATE INDICATED, BY BROADCASTING, DRILLING OR HYDRAULIC APPLICATION.
4. COVER GRASS AND LEGUME SEED WITH NOT MORE THAN 1/4 INCH OF SOIL WITH SUITABLE EQUIPMENT (EXCEPT WHEN HYDROSEEDING).
5. MULCH IMMEDIATELY AFTER SEEDING, IF REQUIRED, ACCORDING TO TEMPORARY MULCHING SPECIFICATIONS. (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION BELOW).
6. USE PROPER INOCULANT ON ALL LEGUME SEEDINGS, USE FOUR TIMES NORMAL RATES WHEN HYDROSEEDING.
7. USE SOD WHERE THERE IS A HEAVY CONCENTRATION OF WATER AND IN CRITICAL AREAS WHERE IT IS IMPORTANT TO GET A QUICK VEGETATIVE COVER TO PREVENT EROSION.

MAINTENANCE:

1. TEST FOR SOIL ACIDITY EVERY THREE YEARS AND LIME AS REQUIRED.
2. ON SITES WHERE GRASSES PREDOMINATE, BROADCAST ANNUALLY 500 POUNDS OF 10–10–10 FERTILIZER PER ACRE (12 LBS. PER 1,000 SQ. FT.) OR AS NEEDED ACCORDING TO ANNUAL SOIL TESTS.
3. ON SITES WHERE LEGUMES PREDOMINATE, BROADCAST EVERY THREE YEARS OR AS INDICATED BY SOIL TEST 300 POUNDS OF 0–20–20 OR EQUIVALENT PER ACRE (8 LBS PER 1,000 SQ. FT.).



NOTES:
1. LIVE STAKES ARE DORMANT PLANT MATERIAL THAT WILL ROOT WHEN PLACED IN THE GROUND.
2. LIVE STAKES SHALL BE IRONWOOD (CARPINUS CAROLINIANA), BRANCH ALDER (ALNUS SERRULATA) AND SILKY DOGWOOD (CORNUS AMOMUM). MIX SPECIES RANDOMLY IN PLANTING PLAN.
3. PROTECT LIVE STAKES FROM DAMAGE DURING INSTALLATION.
   a) USE PRY BAR TO MAKE OPENING IN ROCK OR
   b) USE TUBING TO PROVIDE OPENING
4. TAMP THE LIVE STAKE INTO THE GROUND AT RIGHT ANGLES TO THE SLOPE. USE A DEAD BLOW HAMMER OT AVOID SPLITTING THE STAKES.
5. INSTALL THE STAKES 2 TO 3 FEET APART USING TRIANGULAR SPACING. THE DENSITY OF THE INSTALLATION SHOULD RANGE FROM 2 TO 4 STAKES PER YARD.
6. FOUR–FIFTHS OF THE STAKE SHOULD BE BURIED IN THE GROUND AND SOIL FIRMLY PACKED AROUND IT AFTER INSTALLATION. THE BUDS SHOULD BE ORIENTED UP.
7. PLANT STAKES WITHIN 5 DAYS AFTER COLLECTION.
8. KEEP STAKES MOIST AND SHADED DURING STORAGE BETWEEN COLLECTION AND PLANTING.

LIVE STAKE DETAIL

NOT TO SCALE

AS BUILT DRAWING

Issued / /

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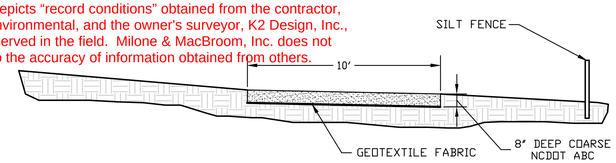

NOTES:
1. TEMPORARY ACCESS ROAD TO BE CONSTRUCTED AS NEEDED.

ACCESS ROUTE

NOT TO SCALE

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REVISIONS

EROSION & SEDIMENTATION CONTROL DETAILS

LOWELL MILL DAM
LITTLE RIVER WATERSHED RESTORATION SITE

KENLY, NORTH CAROLINA

KWK	PFM	JGM
DESIGNED	DRAWN	CHECKED

SCALE N.T.S.

DATE NOV 16, 2005

PROJECT NO. 2691-02

DWG NAME erosion.dwg

8 of 13

SHEET NO.

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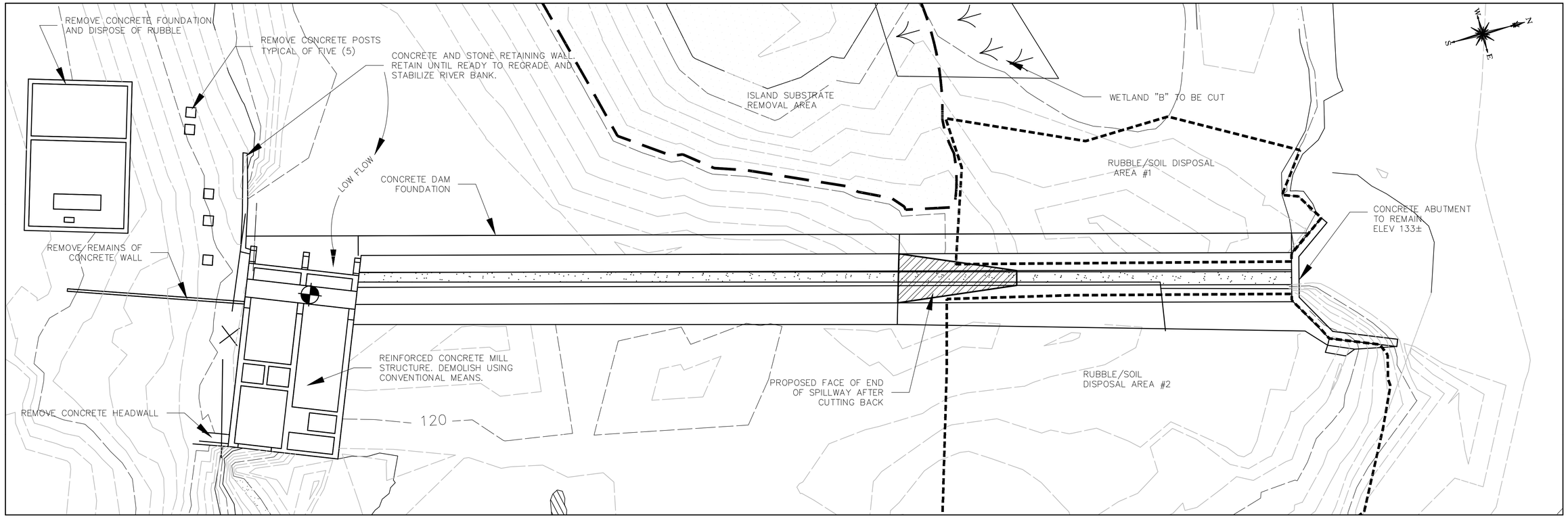
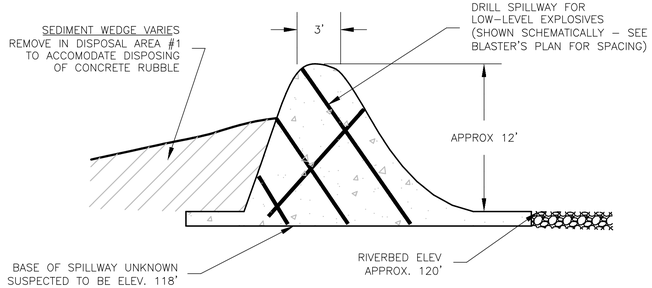
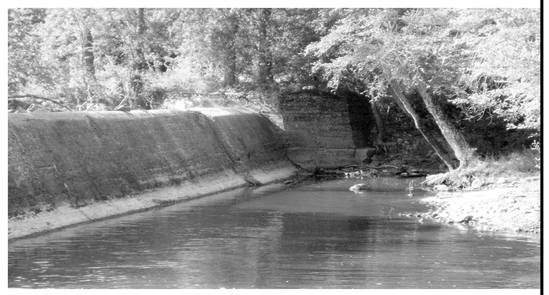
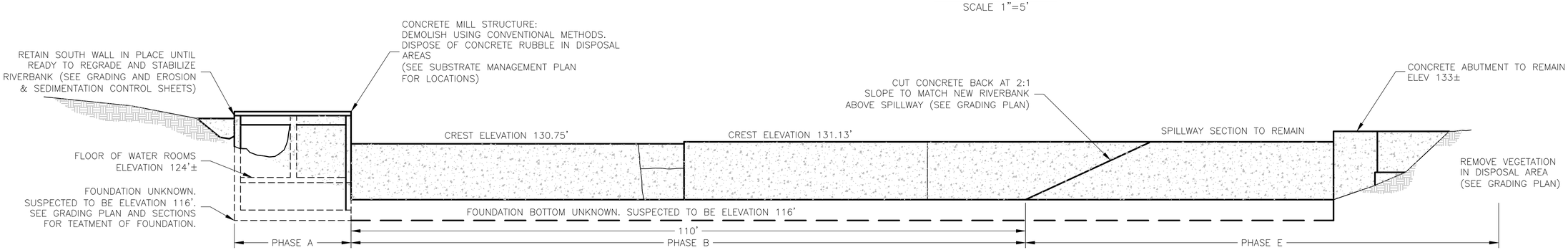




OGEE SPILLWAY SECTION
SCALE 1"=5'



DISPOSAL AREA #2
COMPACT DAM RUBBLE AND RIVERBED SUBSTRATE BELOW SPILLWAY
(SEE GRADING PLAN)



NOTE:
DEMOLISH MILL STRUCTURE BY CONVENTIONAL METHODS AND MOVE RUBBLE OUT OF WATERWAY FOR SECONDARY CRUSHING AS REQUIRED.

DRILL CONCRETE OGEE SPILLWAY FOR EXPLOSIVE CHARGES.

PHASE C:
DEMOLISH CONCRETE SPILLWAY AND MOVE RUBBLE OUT OF WATERWAY FOR SECONDARY CRUSHING AS REQUIRED.

DISPOSE OF RIVERBED SUBSTRATE AND CONCRETE DAM RUBBLE IN DISPOSAL AREAS. COMPACT RUBBLE AND SOIL AND GRADE TO FINAL ELEVATIONS SHOWN ON GRADING PLAN

SPILLWAY PROFILE
SCALE 1"=10'

AS BUILT DRAWING
Issued / /
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REVISIONS

MILL AND SPILLWAY DEMOLITION
LITTLE RIVER
LOWELL MILL DAM RESTORATION SITE
JOHNSTON COUNTY, NORTH CAROLINA

KWK	JD/PM	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS NOTED
DATE NOV 3, 2005
PROJECT NO. 2691-02
DWG NAME demolition.dwg

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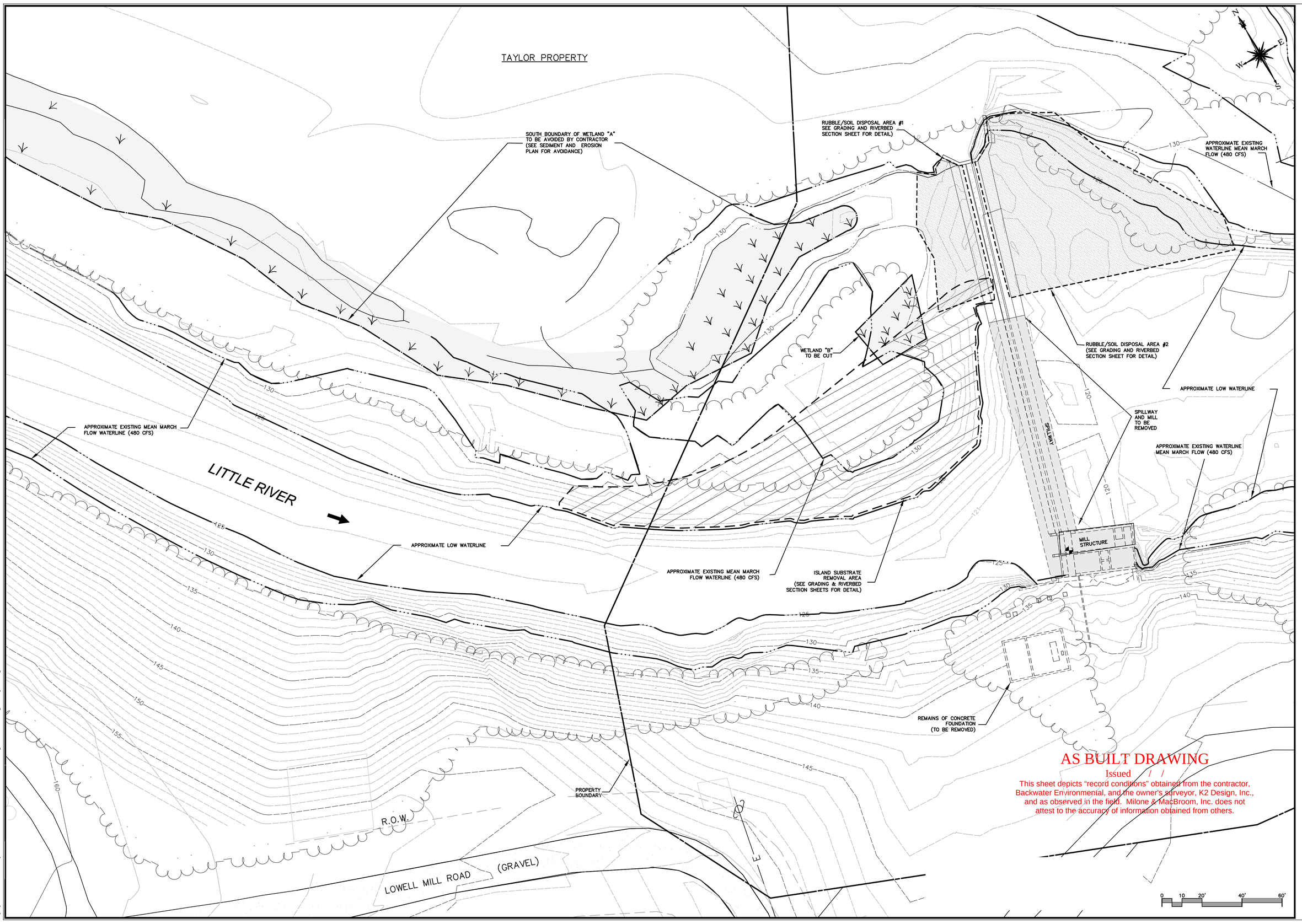

AS BUILT DRAWING

Issued / /

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REVISIONS

GENERAL SUBSTRATE MANAGEMENT PLAN

LOWELL MILL DAM REMOVAL
LITTLE RIVER

JOHNSTON COUNTY, NORTH CAROLINA

KWK	JD	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS SHOWN

DATE NOV. 3, 2005

PROJECT NO. 2691-02

DWG NAME SUBSTRATE MANAGEMENT.DWG

9 of 13

SHEET NO.

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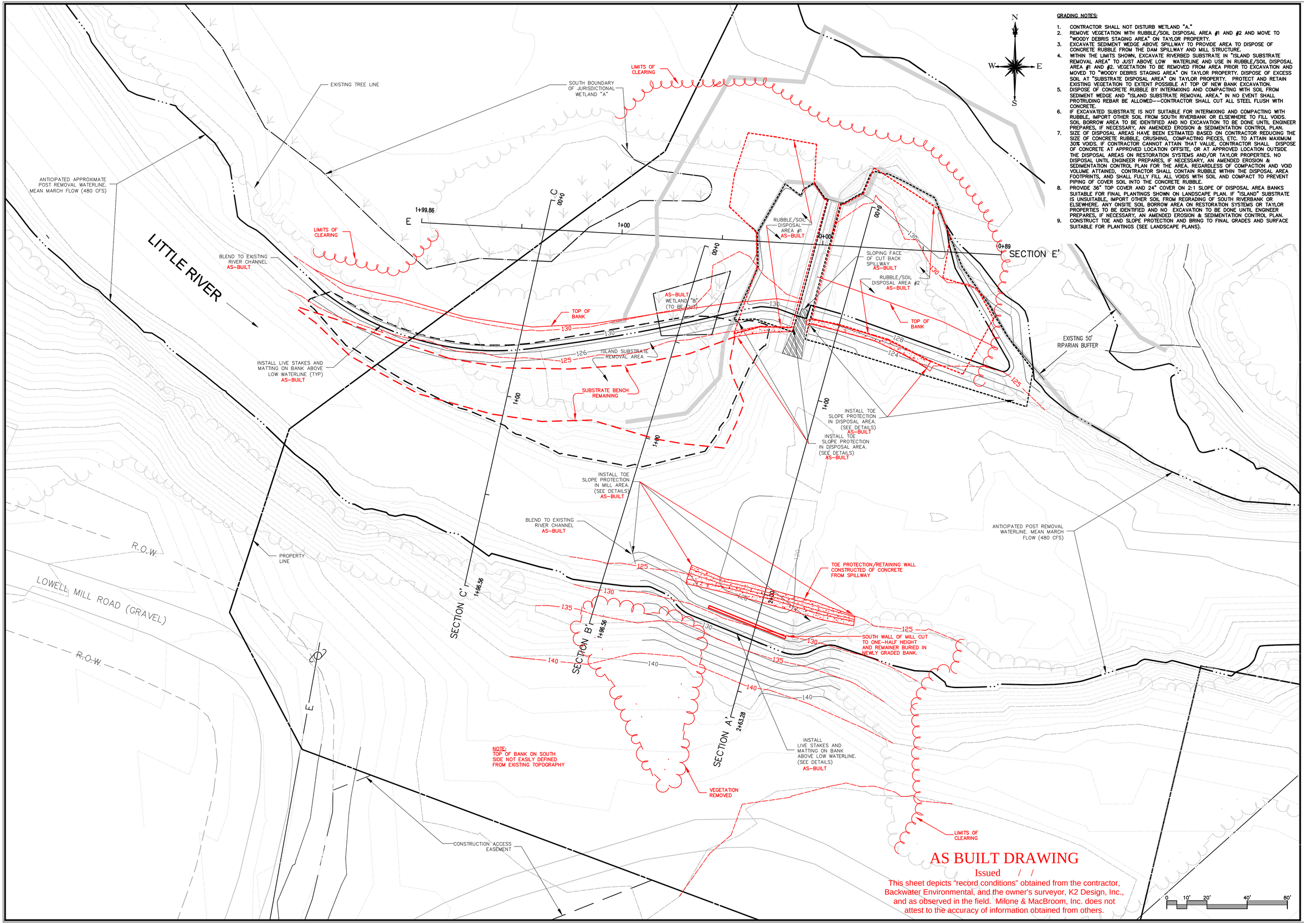

GRADING NOTES:

1. CONTRACTOR SHALL NOT DISTURB WETLAND "A."
2. REMOVE VEGETATION WITH RUBBLE/SOIL DISPOSAL AREA #1 AND #2 AND MOVE TO "WOODY DEBRIS STAGING AREA" ON TAYLOR PROPERTY.
3. EXCAVATE SEDIMENT WEDGE ABOVE SPILLWAY TO PROVIDE AREA TO DISPOSE OF CONCRETE RUBBLE FROM THE DAM SPILLWAY AND MILL STRUCTURE.
4. WITHIN THE LIMITS SHOWN, EXCAVATE RIVERBED SUBSTRATE IN "ISLAND SUBSTRATE REMOVAL AREA" TO JUST ABOVE LOW WATERLINE AND USE IN RUBBLE/SOIL DISPOSAL AREA #1 AND #2. VEGETATION TO BE REMOVED FROM AREA PRIOR TO EXCAVATION AND MOVED TO "WOODY DEBRIS STAGING AREA" ON TAYLOR PROPERTY. DISPOSE OF EXCESS SOIL AT "SUBSTRATE DISPOSAL AREA" ON TAYLOR PROPERTY. PROTECT AND RETAIN EXISTING VEGETATION TO EXTENT POSSIBLE AT TOP OF NEW BANK EXCAVATION.
5. DISPOSE OF CONCRETE RUBBLE BY INTERMIXING AND COMPACTING WITH SOIL FROM SEDIMENT WEDGE AND "ISLAND SUBSTRATE REMOVAL AREA." IN NO EVENT SHALL PROTRUDING REBAR BE ALLOWED--CONTRACTOR SHALL CUT ALL STEEL FLUSH WITH CONCRETE.
6. IF EXCAVATED SUBSTRATE IS NOT SUITABLE FOR INTERMIXING AND COMPACTING WITH RUBBLE, IMPORT OTHER SOIL FROM SOUTH RIVERBANK OR ELSEWHERE TO FILL VOIDS. SOIL BORROW AREA TO BE IDENTIFIED AND NO EXCAVATION TO BE DONE UNTIL ENGINEER PREPARES, IF NECESSARY, AN AMENDED EROSION & SEDIMENTATION CONTROL PLAN.
7. SIZE OF DISPOSAL AREAS HAVE BEEN ESTIMATED BASED ON CONTRACTOR REDUCING THE SIZE OF CONCRETE RUBBLE, CRUSHING, COMPACTING PIECES, ETC. TO ATTAIN MAXIMUM 30% VOIDS. IF CONTRACTOR CANNOT ATTAIN THAT VALUE, CONTRACTOR SHALL DISPOSE OF CONCRETE AT APPROVED LOCATION OFFSITE, OR AT APPROVED LOCATION OUTSIDE THE DISPOSAL AREAS ON RESTORATION SYSTEMS AND/OR TAYLOR PROPERTIES. NO DISPOSAL UNTIL ENGINEER PREPARES, IF NECESSARY, AN AMENDED EROSION & SEDIMENTATION CONTROL PLAN FOR THE AREA. REGARDLESS OF COMPACTION AND VOID VOLUME ATTAINED, CONTRACTOR SHALL CONTAIN RUBBLE WITHIN THE DISPOSAL AREA FOOTPRINTS, AND SHALL FULLY FILL ALL VOIDS WITH SOIL AND COMPACT TO PREVENT PIPING OF COVER SOIL INTO THE CONCRETE RUBBLE.
8. PROVIDE 36" TOP COVER AND 24" COVER ON 2:1 SLOPE OF DISPOSAL AREA BANKS SUITABLE FOR FINAL PLANTINGS SHOWN ON LANDSCAPE PLAN. IF "ISLAND" SUBSTRATE IS UNSUITABLE, IMPORT OTHER SOIL FROM REGRADING OF SOUTH RIVERBANK OR ELSEWHERE. ANY ONSITE SOIL BORROW AREA ON RESTORATION SYSTEMS OR TAYLOR PROPERTIES TO BE IDENTIFIED AND NO EXCAVATION TO BE DONE UNTIL ENGINEER PREPARES, IF NECESSARY, AN AMENDED EROSION & SEDIMENTATION CONTROL PLAN.
9. CONSTRUCT TOE AND SLOPE PROTECTION AND BRING TO FINAL GRADES AND SURFACE SUITABLE FOR PLANTINGS (SEE LANDSCAPE PLANS).

AS BUILT DRAWING

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This sheet depicts "record conditions" obtained from the contractor, Backwater Environmental, and the owner's surveyor, K2 Design, Inc., and as observed in the field. Milone & MacBroom, Inc. does not attest to the accuracy of information obtained from others.

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REVISIONS

1	5/19/06	ADDED AS-BUILT INFORMATION

GRADING PLAN

LITTLE RIVER
LOWELL MILL DAM RESTORATION SITE
JOHNSTON COUNTY, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
PBS	PBS	KWK

SCALE 1"=20'

DATE NOV 3, 2005

PROJECT NO. 2691-02

DWG NAME grading.dwg

11 of 13

SHEET NO.

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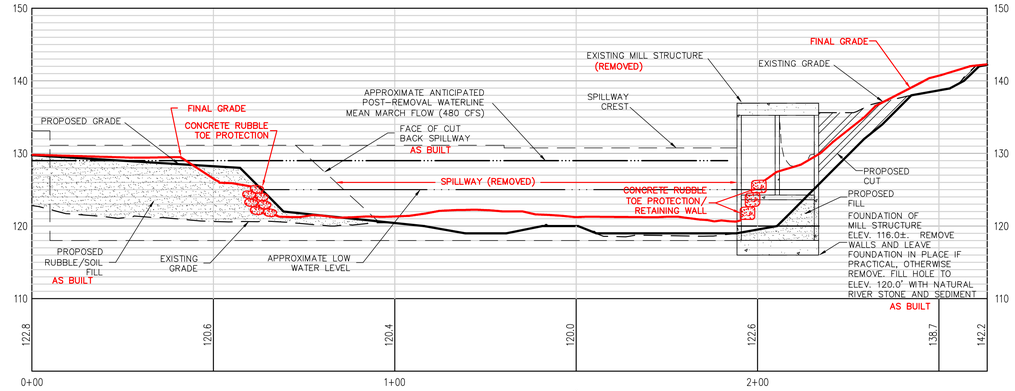

SECTION A–A'

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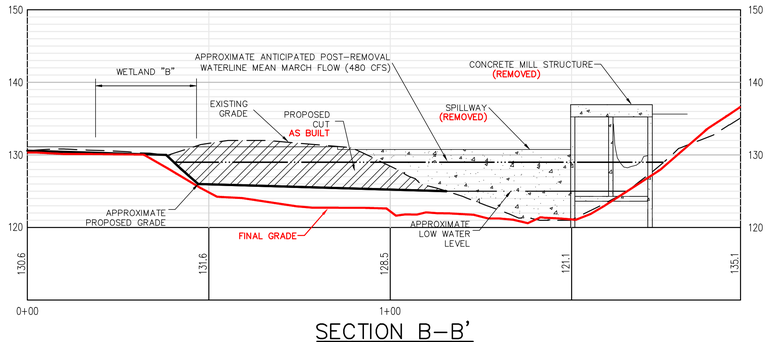
1"=10' VERT.



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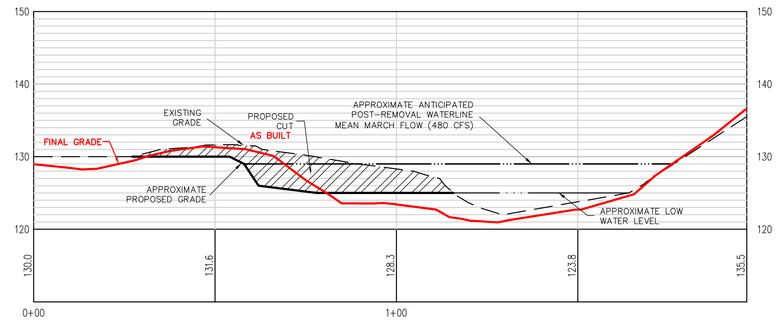

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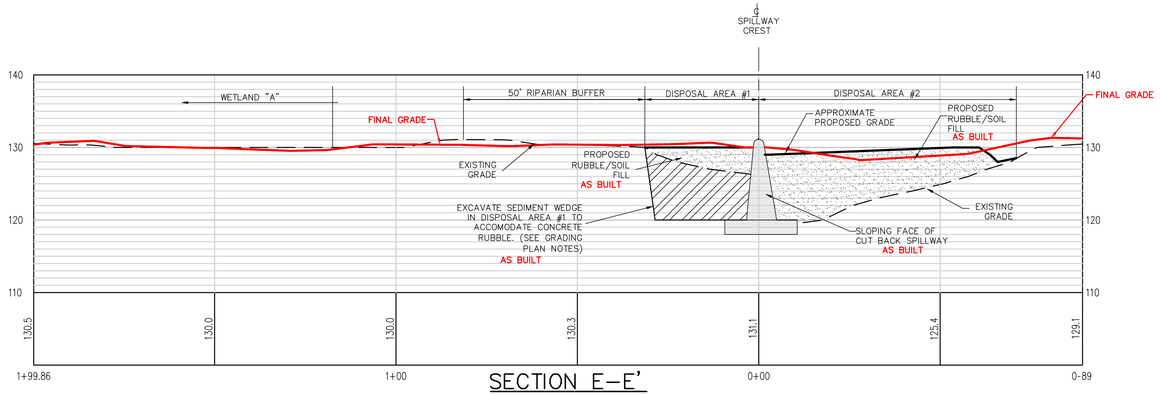

SECTION E–E'

SCALE= 1"=20' HORZ.
1"=10' VERT.

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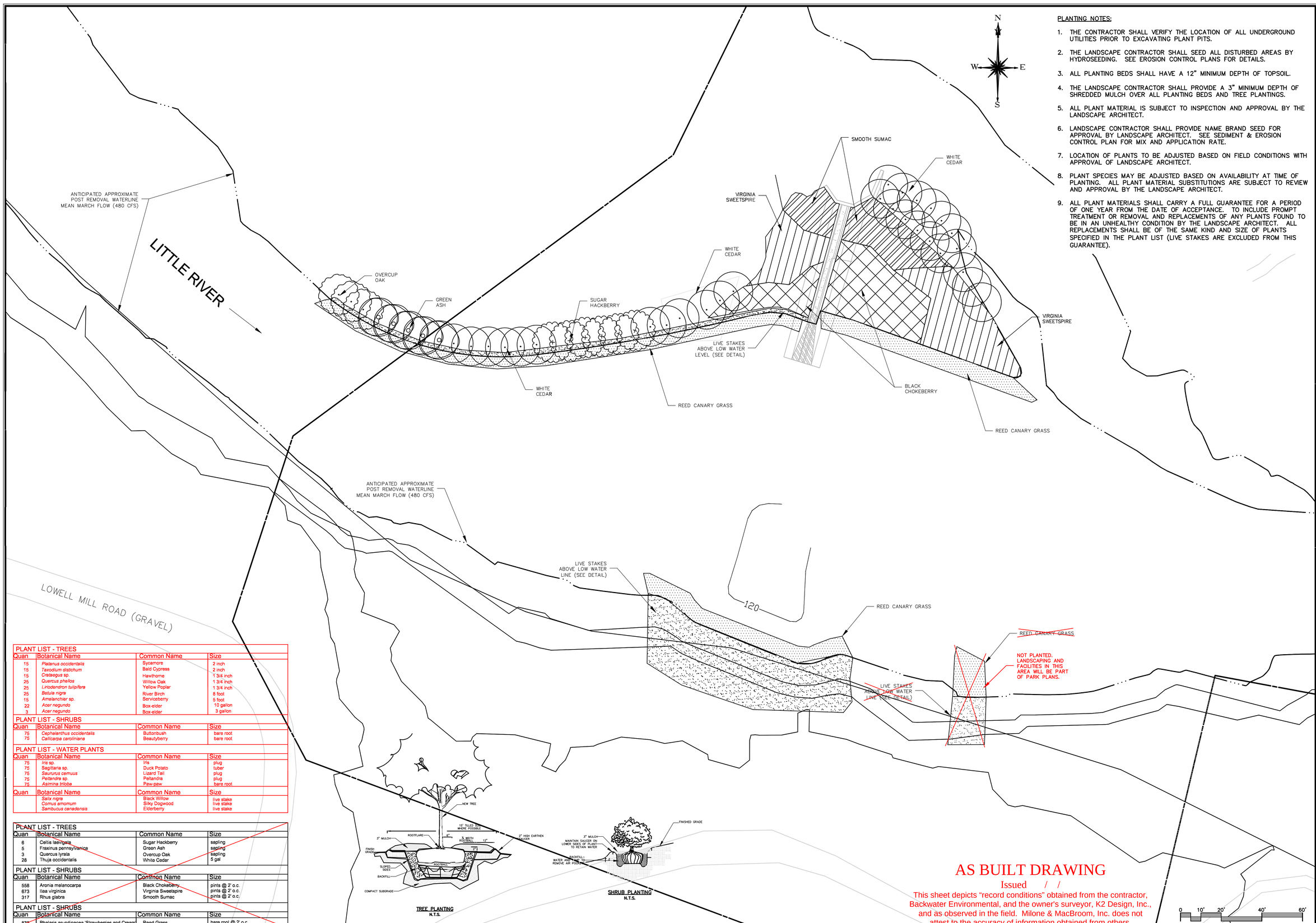
REVISIONS
1 5/10/06 ADDED AS-BUILT INFORMATION

RIVERBED SECTIONS
LOWELL MILL DAM REMOVAL
LITTLE RIVER
JOHNSTON COUNTY, NORTH CAROLINA

KWK	JD	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS NOTED
DATE NOV. 3, 2005
PROJECT NO. 2691-02
DWG NAME substrate manage.dwg



PLANTING NOTES:

1. THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL UNDERGROUND UTILITIES PRIOR TO EXCAVATING PLANT PITS.
2. THE LANDSCAPE CONTRACTOR SHALL SEED ALL DISTURBED AREAS BY HYDROSEEDING. SEE EROSION CONTROL PLANS FOR DETAILS.
3. ALL PLANTING BEDS SHALL HAVE A 12" MINIMUM DEPTH OF TOPSOIL.
4. THE LANDSCAPE CONTRACTOR SHALL PROVIDE A 3" MINIMUM DEPTH OF SHREDDED MULCH OVER ALL PLANTING BEDS AND TREE PLANTINGS.
5. ALL PLANT MATERIAL IS SUBJECT TO INSPECTION AND APPROVAL BY THE LANDSCAPE ARCHITECT.
6. LANDSCAPE CONTRACTOR SHALL PROVIDE NAME BRAND SEED FOR APPROVAL BY LANDSCAPE ARCHITECT. SEE SEDIMENT & EROSION CONTROL PLAN FOR MIX AND APPLICATION RATE.
7. LOCATION OF PLANTS TO BE ADJUSTED BASED ON FIELD CONDITIONS WITH APPROVAL OF LANDSCAPE ARCHITECT.
8. PLANT SPECIES MAY BE ADJUSTED BASED ON AVAILABILITY AT TIME OF PLANTING. ALL PLANT MATERIAL SUBSTITUTIONS ARE SUBJECT TO REVIEW AND APPROVAL BY THE LANDSCAPE ARCHITECT.
9. ALL PLANT MATERIALS SHALL CARRY A FULL GUARANTEE FOR A PERIOD OF ONE YEAR FROM THE DATE OF ACCEPTANCE. TO INCLUDE PROMPT TREATMENT OR REMOVAL AND REPLACEMENTS OF ANY PLANTS FOUND TO BE IN AN UNHEALTHY CONDITION BY THE LANDSCAPE ARCHITECT. ALL REPLACEMENTS SHALL BE OF THE SAME KIND AND SIZE OF PLANTS SPECIFIED IN THE PLANT LIST (LIVE STAKES ARE EXCLUDED FROM THIS GUARANTEE).

PLANT LIST - TREES			
Quan	Botanical Name	Common Name	Size
15	*Platanus occidentalis*	Sycamore	2 inch
15	*Taxodium distichum*	Bald Cypress	2 inch
15	*Crataegus sp.*	Hawthorne	1 3/4 inch
25	*Quercus phellos*	Willow Oak	1 3/4 inch
25	*Liriodendron tulipifera*	Yellow Poplar	1 3/4 inch
25	*Betula nigra*	River Birch	8 foot
15	*Amelanchier sp.*	Serviceberry	5 foot
22	*Acer negundo*	Box-elder	10 gallon
3	*Acer negundo*	Box-elder	3 gallon
PLANT LIST - SHRUBS			
Quan	Botanical Name	Common Name	Size
75	*Cephalanthus occidentalis*	Buttonbush	bare root
75	*Callicarpa caroliniana*	Beautyberry	bare root
PLANT LIST - WATER PLANTS			
Quan	Botanical Name	Common Name	Size
75	*Iris sp.*	Iris	plug
75	*Sagittaria sp.*	Duck Potato	tuber
75	*Saururus cernuus*	Lizard Tail	plug
75	*Peltandra sp.*	Peltandra	plug
75	*Asimina triloba*	Paw-paw	bare root
Quan	Botanical Name	Common Name	Size
	Salix nigra	Black Willow	live stake
	Cornus amomum	Silky Dogwood	live stake
	Sambucus canadensis	Elderberry	live stake

PLANT LIST - TREES			
Quan	Botanical Name	Common Name	Size
6	Celtis laevigata	Sugar Hackberry	sapling
5	Fraxinus pennsylvanica	Green Ash	sapling
3	Quercus lyrata	Overcup Oak	sapling
28	Thuja occidentalis	White Ceder	5 gal
PLANT LIST - SHRUBS			
Quan	Botanical Name	Common Name	Size
558	Aronia melanocarpa	Black Chokeberry	pints @ 2' o.c.
673	Itea virginica	Virginia Sweetspire	pints @ 2' o.c.
317	Rhus glabra	Smooth Sumac	pints @ 2' o.c.
PLANT LIST - SHRUBS			
Quan	Botanical Name	Common Name	Size
572	Phalaris arundinacea 'Strawberries and Cream'	Reed Grass	bare root @ 2' o.c.

TREE PLANTING
N.T.S.

SHRUB PLANTING
N.T.S.

AS BUILT DRAWING

Issued / /

This sheet depicts "record conditions" obtained from the contractor, Backwater Environmental, and the owner's surveyor, K2 Design, Inc., and as observed in the field. Milone & MacBroom, Inc. does not attest to the accuracy of information obtained from others.

0 10' 20' 40' 60'

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REVISIONS

1	5/10/06	ADDED AS BUILT INFORMATION

LANDSCAPE PLAN

LITTLE RIVER
LOWELL MILL DAM RESTORATION

JOHNSTON COUNTY, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
PBS	PBS	KWK

SCALE AS SHOWN

DATE NOV 3, 2005

PROJECT NO. 2691-02

DWG NAME landscape.dwg

13 of 13

SHEET NO.

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APPENDIX D: Definitions of Federal and State Listing Categories
(Provided by TCG from LeGrand et al. 2004)

United States Status. This status is designated by the U.S. Fish and Wildlife Service. Federally listed Endangered and Threatened species are protected under the provisions of the Endangered Species Act of 1973, as amended through the 100th Congress. Unless otherwise noted, definitions are taken from the Federal Register, Vol. 56, No. 225, November 21, 1991 (50 CFR Part 17).

STATUS CODE	STATUS	STATUS DEFINITION
E	Endangered	A taxon "which is in danger of extinction throughout all or a significant portion of its range" (Endangered Species Act, Section 3).
T	Threatened	A taxon "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (Endangered Species Act, Section 3).
FSC	(Federal) Species of Concern [also known as Species at Risk]	"... the Service is discontinuing the designation of Category 2 species as candidates in this notice. The Service remains concerned about these species, but further biological research and field study are needed to resolve the conservation status of these taxa. Many species of concern will be found not to warrant listing, either because they are not threatened or endangered or because they do not qualify as species under the definition in the [Endangered Species] Act. Others may be found to be in greater danger of extinction than some present candidate taxa. The Service is working with the States and other private and public interests to assess their need for protection under the Act. Such species are the pool from which future candidates for listing will be drawn." (Federal Register, February 28, 1996). The Service suggests that such taxa be considered as "Species of Concern" or "Species at Risk", neither of which has official status. The N.C. Natural Heritage Program uses "(Federal) Species of Concern" in this document for those taxa formerly considered as Category 2.
P	Proposed	pecies proposed in the Federal Register as a status different from its current Federal status.
T (S/A)	Threatened due to Similarity of Appearance	"Section 4 (e) of the [Endangered Species] Act authorizes the treatment of a species (subspecies or population segment) as endangered or threatened even though it is not otherwise listed as endangered or threatened if -- (a) the species so closely resembles in appearance an endangered or threatened species that enforcement personnel would have substantial difficulty in differentiating between the listed and unlisted species; (b) the effect of this substantial difficulty is an additional threat to an endangered or threatened species; and (c) such treatment of an unlisted species will substantially facilitate the enforcement and further the policy of the Act." (Federal Register, November 4, 1997). [The American Alligator is listed as T (S/A) due to Similarity of Appearance with other rare crocodilians, and the southern population of the Bog Turtle is listed as T (S/A) due to Similarity of Appearance with the northern population of the Bog Turtle (which is federally listed as Threatened and which does not occur in North Carolina).]

XN	Nonessential Experimental Population	"Section 10 (j) of the Endangered Species Act of 1973, as amended, provides for the designation of introduced populations of federally listed species as nonessential experimental. This designation allows for greater flexibility in the management of these populations by local, state, and Federal agencies. Specifically, the requirement for Federal agencies to avoid jeopardizing these populations by their actions is eliminated and allowances for taking the species are broadened." (U.S. Fish and Wildlife Service, 1995).
D	De-listed	Species has been proposed by the U.S. Fish and Wildlife Service for de-listing from the List of Endangered and Threatened Wildlife. However, at the present time, the species is still on the List of Endangered and Threatened Wildlife and is thus protected under the Endangered Species Act. Because such species still have legal Federal protection, the NHP will maintain existing records on the species, though new records might not necessarily be added. If the status becomes law prior to the next publication of the NHP Rare Animal List, the Program will remove the Federal designation from its database (and thus the species will no longer appear on printouts of Federally listed species). NHP may or may not continue to track the species, depending on its legal State status and other factors such as overall abundance and range in the state.

North Carolina Status. Endangered, Threatened, and Special Concern species of mammals, birds, reptiles, amphibians, freshwater fishes, freshwater and terrestrial mollusks, and crustaceans have legal protection status in North Carolina (Wildlife Resources Commission). In addition to the above categories, the Natural Heritage Program maintains computer and map files on Significantly Rare species, as well as species considered Extirpated. Paper files only are maintained for a few of the above species; these species are indicated by the phrase "not tracking."

STATUS CODE	STATUS	STATUS DEFINITION
E	Endangered	"Any native or once-native species of wild animal whose continued existence as a viable component of the State's fauna is determined by the Wildlife Resources Commission to be in jeopardy or any species of wild animal determined to be an 'endangered species' pursuant to the Endangered Species Act." (Article 25 of Chapter 113 of the General Statutes; 1987).
T	Threatened	"Any native or once-native species of wild animal which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, or one that is designated as a threatened species pursuant to the Endangered Species Act." (Article 25 of Chapter 113 of the General Statutes; 1987).
SC	Special Concern	"Any species of wild animal native or once-native to North Carolina which is determined by the Wildlife Resources Commission to require monitoring but which may be taken under regulations adopted under the provisions of this Article." (Article 25 of Chapter 113 of the General Statutes; 1987).
P	Proposed	Species has been proposed by a Scientific Council as a status (Endangered, Threatened, Special Concern, Watch List, or for Delisting) that is different from the current status, but the status has not yet been adopted by the General Assembly as law. In the lists of rare species in this book, these proposed statuses are listed in parentheses below the current status. Only those proposed statuses that are different from the current statuses are listed.
SR	Significantly Rare	Any species which has not been listed by the N.C. Wildlife Resources Commission as an Endangered, Threatened, or Special Concern species, but which exists in the state in small numbers and has been determined by the N.C. Natural Heritage Program to need monitoring. (This is a N.C. Natural Heritage Program designation.) Significantly Rare species include "peripheral" species, whereby North Carolina lies at the periphery of the species' range (such as Hermit Thrush).

EX	Extirpated	A species which is no longer believed to occur in the state. (This is a N.C. Natural Heritage Program designation, though WRC also uses this status; the NHP list includes those on the WRC list.)
W	Watch List	Any other species believed to be of conservation concern in the state because of scarcity, declining populations, threats to populations, or inadequacy of information to assess its rarity (see page 59 for a more complete discussion). (This is a N.C. Natural Heritage Program designation.)
G		Species is a game animal, and therefore (by law) cannot be listed for State protection as E, T, or SC.

MITIGATION PLAN - ADDENDUM

FULL DELIVERY PROJECT TO PROVIDE STREAM RESTORATION
NEUSE RIVER BASIN CATALOGING UNIT 03020201

LOWELL MILL DAM-LITTLE RIVER WATERSHED
RESTORATION SITE
Johnston County, North Carolina

PREPARED FOR:

Ecosystem Enhancement PROGRAM

NCDENR - ECOSYSTEM ENHANCEMENT PROGRAM
1652 Mail Service Center
Raleigh, North Carolina 27699-16152

AUGUST 2006

MITIGATION REPORT – ADDENDUM

LOWELL MILL DAM-LITTLE RIVER WATERSHED RESTORATION SITE

The following are responses to the North Carolina Ecosystem Enhancement Program's (EEP) comments (dated July 28, 2006, see attached) concerning the Lowell Mill Dam-Little River Watershed Restoration Site Mitigation Plan (dated June 2006) prepared by Restoration Systems, LLC (RS) and EcoScience Corporation (ESC). EEP comments are in bold.

The EEP requests the following information be submitted as addenda to the mitigation plan:

1. A table of biotic reference data and pre-dam removal data within the impoundment
As discussed in Section 5.1.1, benthic macroinvertebrate biotic index values will be used in conjunction with North Carolina Division of Water Quality (NCDWQ) Ambient Monitoring Station (AMS) data to support success evaluation for the improved water quality success criterion. The mean of the biotic index values of benthic macroinvertebrate samples collected at stations within the former Site Impoundment will be compared to the mean of the biotic index values from reference stations. In order to achieve success, the mean of the biotic index values from stations within the former Site Impoundment must reside within no more than one standard deviation of the mean of biotic index values from reference station samples by the end of the five-year monitoring period.

Table A displays baseline (Year 2005) biotic index data from formerly impounded and reference benthic macroinvertebrate sampling stations. The mean biotic index value of samples from reference stations is 5.38 with a standard deviation of 0.20. Therefore, in order to achieve success, the mean of the biotic index values from stations within the former Site Impoundment must be equal to or less than **5.58** by the end of the five-year monitoring period.

Similarly, the means of the total number of benthic macroinvertebrate taxa and EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa will be compared between sampling stations within the former Site Impoundment and reference stations. In order to achieve success criteria, the means of these two parameters from stations within the former Site Impoundment must reside within no less than one standard deviation of the means of the parameters from reference stations.

Table B displays baseline (Year 2005) benthic macroinvertebrate summary data from formerly impounded and reference stations. The mean number of total taxa from reference samples was 56.50 with a standard deviation of 0.71. The mean number of EPT taxa from reference samples was 20.00, with a standard deviation of 1.41. Thus, in order to achieve success for the benthic macroinvertebrate component of the improved aquatic community success criterion, the mean of the total number of taxa from samples within the former Site Impoundment must be greater than or equal to **55.79**, and the mean of the EPT taxa must be greater than or equal to **18.59**.

2. A table of habitat assessment results (Section 3.2.8) from pre-dam removal
As discussed in Sections 3.2.8 and 5.2.6, NCDWQ Habitat Assessment Form (most recent version) scores will be used to facilitate evaluation of the improved aquatic community success criterion. It is expected that Habitat Assessment Form scores will quantitatively increase over the five-year project monitoring period. Habitat Assessment Form scores at stations within the former Site Impoundment will be compared with their baseline (i.e., pre-dam removal) Year 2005 scores as well as reference station scores to assess habitat improvement throughout the monitoring period.

Table C displays baseline (Year 2005) NCDWQ Habitat Assessment Form scores for all monitoring stations. The mean score for stations within the former Site Impoundment is 48.26, and the mean score for reference stations is 74.75. In order to achieve success, Habitat Assessment Form scores from stations within the former Site Impoundment must quantitatively increase by the end of the five-year monitoring period.

3. A table of fish, snail, and mussel results from pre-dam removal
Fish, mussel, and snail sampling was performed by The Catena Group during the baseline (pre-dam removal) Year 2005 sampling period. Sampling will be performed throughout the monitoring period to support success evaluation for the improved aquatic community. The Catena Group has provided the attached report that includes tables of baseline sampling results for fish, mussels, and snails. Fish, snail, and mussel sampling stations are displayed on the attached **Figure 4** (submitted in the original Mitigation Plan).

4. A map of locations for all of the above sample sites (pre-dam removal)
Monitoring activities described in the Mitigation Plan for baseline (pre-dam removal) sampling stations are displayed on **Figure 4** of the Mitigation Plan (attached). Monitoring activities will be performed throughout the monitoring period at the same station locations shown on **Figure 4**. A monumented cross-section/ancillary data collection monitoring station has been added directly downstream of the former Lowell Mill Dam site to evaluate achievement of the downstream benefits below the dam reserve success criterion (see **Table 1** in the Mitigation Plan). Since this station was installed following dam removal, no baseline data is available. The field effort for all 24 monitoring stations consists of one of the five following combinations as displayed on **Figure 4**:

- Monumented cross-section/ancillary data collection, fish, mussel, and snail survey, and macroinvertebrate sampling
- Fish, mussel, and snail survey
- Monumented cross-section/ancillary data collection and macroinvertebrate sampling
- Monumented cross-section/ancillary data collection and fish, mussel, and snail survey
- Monumented cross-section/ancillary data collection

Table A. Baseline (Year 2005) Benthic Macroinvertebrate Biotic Index Values

	IMPOUNDED STATIONS	**REFERENCE STATIONS**
	Biotic Index	Biotic Index
High	7.36	5.52
Low	6.72	5.24
Mean	**7.02**	**5.38**
Median	6.98	5.38
Standard Deviation	0.32	0.20
Standard Deviation of Reference mean **(Success Criterion)**	**5.58**	

Table B. Baseline (Year 2005) Benthic Macroinvertebrate Summary Data

	IMPOUNDED				**REFERENCE**			
	Total Organisms	Total Taxa	EPT Richness	Biotic Index	Total Organisms	Total Taxa	EPT Richness	Biotic Index
HIGH	265.00	45.00	6.00	7.36	494.00	57.00	21.00	5.52
LOW	53.00	25.00	0.00	6.72	312.00	56.00	19.00	5.24
MEAN	152.33	**37.33**	**4.00**	**7.02**	403.00	**56.50**	**20.00**	**5.38**
MEDIAN	139.00	42.00	6.00	6.98	403.00	56.50	20.00	5.38
STANDARD DEVIATION	106.63	10.79	3.46	0.32	128.69	0.71	1.41	0.20
Success Criteria	---------	**55.79**	**18.59**	**5.58**				

Table 3. Baseline (Year 2005) NCDWQ Habitat Assessment Form Scores

Impounded Stations		Reference Stations	
Station	NCDWQ Habitat Assessment Form Score	Station	NCDWQ Habitat Assessment Form Score
XS-1	60	REF-1	75
XS-2	49	REF-2	64
XS-3	57	REF-3	80
XS-4	57	REF-4	80
XS-5	65	**MEAN SCORE**	**74.75**
XS-6	55		
XS-7	56		
XS-8	54		
XS-9	53		
XS-10	46		
XS-11	45		
XS-12	40		
XS-13	37		
XS-14	39		
XS-15	36		
XS-16	42		
XS-17	49		
XS-18	47		
XS-19	30		
MEAN SCORE	**48.26**		

AMS STATION ID# 5690000

AMS STATION ID# 5750000

LOWELL MILL DAM

SR 2127

SR 2130

SR 1934

US 301

I-95

SR 2339

SR 1001

SR 2320

SR 1002

MONITORING EFFORT

MCS=MONUMENTED CROSS-SECTION

FMS=FISH, MUSSEL AND SNAIL SURVEY

AD=ANCILLARY DATA

MS=MACROINVERTEBRATE SAMPLING

LEGEND

- MCS/AD + FMS + MS
- FMS
- MCS/AD + MS
- MCS/AD + FMS
- MCS/AD

4000 ft. 0 4000 ft.

SCALE IN FEET

EcoScience Corporation
Raleigh, North Carolina

Ecosystem Enhancement Program

Restoration Systems, LLC
Natural Resources Restoration & Conservation

Project:

MONITORING NETWORK DEPLOYMENT

LOWELL MILL DAM - LITTLE RIVER
WATERSHED RESTORATION SITE

Johnston County, North Carolina

Dwn By:	Ckd By:
MAF	JDC
Date:	JUN 2006
Scale:	1"=4000'
ESC Project No.:	06-289

FIGURE

4

The Catena Group

410-B Millstone Drive
Hillsborough, NC 27278
(919) 732-1300

LOWELL DAM REMOVAL YEAR-1 MONITORING REPORT

Little River Watershed Restoration Site Neuse River Basin Catologing Unit 03020201

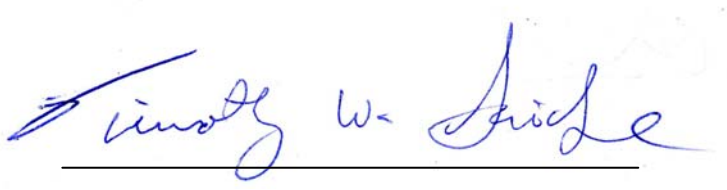
Prepared For:

Restoration Systems LLC
1101 Haynes Street, Suite 107
Raleigh, NC 27604

Prepared By:

The Catena Group
Hillsborough, North Carolina

September 10, 2006



Timothy W. Savidge

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LIST OF APPENDICES

1.0 INTRODUCTION

The removal of Lowell Dam on the Little River within the Neuse River Basin by Restoration Systems LLC (RS) is projected to result in the restoration of more than 34,990 linear feet of river and tributaries under the former reservoir pool. The project is expected to restore significant riverine habitat for mussels, fish (including anadromous fish), and other lotic aquatic species documented within the Little River, as well as providing a mitigation bank for future activities within the Neuse River Basin.

Based on the restoration success criteria established by U.S. Fish and Wildlife Service (USFWS) and the goals of RS, documenting the effectiveness of the restoration initiative requires that the aquatic fauna that occurred within the reservoir pool be identified and then monitored for changes in composition after the dam is removed. The Catena Group Inc. (TCG) was retained by RS in 2005 to conduct pre-removal aquatic species surveys at selected locations within the former reservoir pool, as well as at a number of upstream and downstream locations. The aquatic fauna sampled include freshwater mussels and clams, aquatic snails, aquatic salamanders, and freshwater fish. The results of the pre-removal surveys were presented in a report submitted to RS on April 04, 2006 (Lowell Pre-removal Survey Report).

A five-year monitoring plan of aquatic species communities (freshwater mussels, aquatic snails, aquatic salamanders and freshwater fist) and anadromous fish has been initiated to evaluate the success of the dam removal. TCG was retained by RS in 2006 to conduct post-removal monitoring surveys for both the aquatic species communities and anadromous species.

The aquatic community survey plan involves conducting aquatic species surveys at the same six stations within the former reservoir pool that were sampled during the pre-removal surveys (Table 1). Fish surveys were not conducted at sites 6 (CX-12) and 7 (CX 16) during the pre-removal surveys due to water depth.

Table 1. Post Dam Removal Permanent Monitoring Survey Locations

Site #	Corresponding TCG Pre-removal Site #	GPS Location
1	4- Impoundment 1 (CX-1)	35.58878ºN, -78.18713ºW
2	5-Impoundment 2 (CX-3)	35.59071ºN, -78.17819ºW
3	6-Impoundment 3 (CX-4)	35.58519ºN, -78.17772ºW
4	7-Impoundment 4 (CX-7)	35.57771ºN, -78.17752ºW
5	8-Impoundment 5 (CX-10)	35.58051ºN, -78.16672ºW
6	9-Impoundment 6 (CX-12)	35.58329ºN, -78.15951ºW
7	10-Impoundment 7 (CX-16)	35.56751ºN, -78.16239ºW

CX denotes corresponding Cross Sections being evaluated by RS

Changes in freshwater mussel fauna resulting from dam removal will likely not be evident for at least four years post removal because of their life histories. Thus, these

sites will be not be monitored for mussels until four years post removal when recruitment of freshwater mussels into the restored habitats will be visible. Aquatic snails and freshwater clams will also not be sampled until this time, as similar survey methodologies are used. The results of the Year-4 monitoring will determine if future monitoring is warranted. It was determined that fish community and anadromous species surveys would be conducted during the first year following removal. Additionally, a quantitative study of freshwater mussels was conducted below the former dam to monitor potential adverse sedimentation effects resulting from dam removal.

The anadromous species survey plan involves conducting multiple surveys at multiple locations during peak spawning runs of a number of anadromous species (February-May) to document the effects of barrier removal and the utilization of newly accessible habitats.

The results of the Year-1 fish community monitoring (Year-1 monitoring), the post-removal anadromous species surveys (anadromous surveys) and the quantitative mussel survey (quantitative surveys) are presented in this report. The results of these studies will factor into the decision for future monitoring.

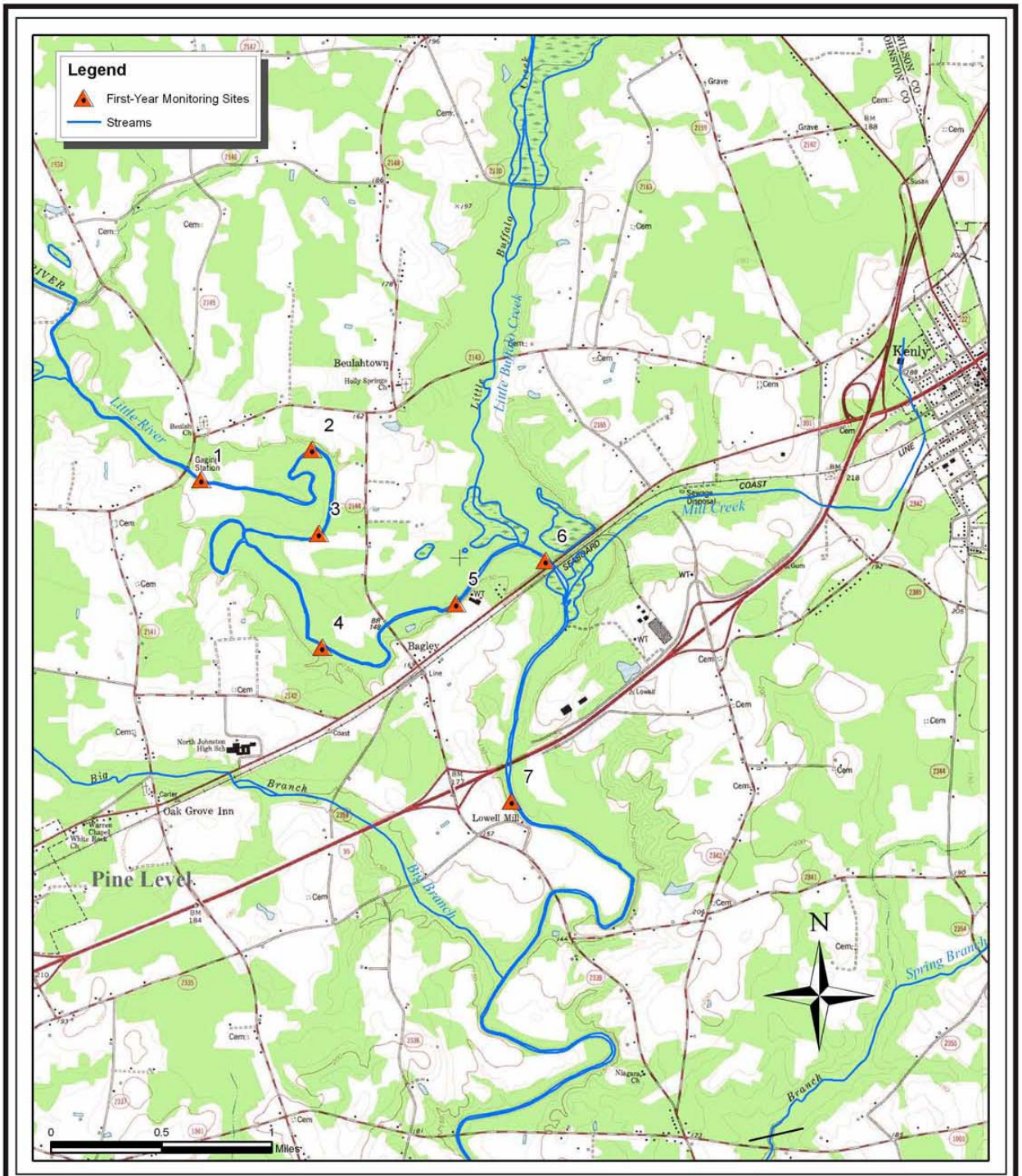
2.0 FISH COMMUNITY SURVEY EFFORTS

Fish surveys were conducted in August 2006, for the Year-1 monitoring at all of the sites listed in Table 1 and depicted in Figure 1, with the exception of TCG Site 9 (Impoundment 6), which was omitted due to the water level being too deep to follow the sampling protocol:

Tom Dickinson – August- 8, 9, 17
Shay Garriock – August- 8, 17
Kate Montieth – August- 8, 9, 17
Fred C. Rhode Ph.D* – August-8, 9
Tyler Rhode* – August-8, 9
Tim Savidge – August 17
Chris Sheats - August 8, 17
*** Contracted by TCG to assist field crew**

2.1 Fish Community Survey Methodology

A fish sampling protocol patterned after the North Carolina Division of Water Quality (NCDWQ) Standard Operating Procedure Biological Monitoring Stream Fish Community Assessment (NCDENR 2001) was developed specifically for this project, to document changes in fish communities in the Little River over time following dam removal. The NCDWQ has developed a method of assessing water quality based on an evaluation of the fish community. This evaluation results in a numerical score called the North Carolina Index of Biotic Integrity (NCIBI) being assigned to the water body. The NCIBI evaluates 12 metrics (parameters) pertaining to species richness and composition,



The Catena Group

Site Map
Lowell Dam Removal
First-Year Fish Monitoring
Johnston County, North Carolina

Date:	August 2006
Scale:	As Shown
Job No.:	3177

Figure 1

trophic composition, and fish abundance and condition. Each metric value is converted into a score of 1, 3 or 5, with 5 representing conditions expected for a relatively undisturbed reference stream in the specific river basin, or ecoregion (NCDENR 2001). NCIBI reference indices for the Outer Piedmont of the Neuse River Basin have been developed. The sampling protocol states that the NCIBI is applicable only in streams within ecoregions that have established reference indices, and only if collection methodology and data analysis is strictly followed.

The purpose of applying the NCIBI methodology to the post-removal monitoring is not necessarily to compare scores generated at each of the monitoring sites with other streams in the reference ecoregion, but rather to compare scores generated at the monitoring sites overtime to monitor changes at each site in response to the dam removal. Thus, the scores generated during the Year-1 monitoring surveys will be compared to scores generated using the same methodologies under similar conditions (time of year, water levels, etc) in future years.

A standard 600 linear feet of stream at each of the survey sites listed in Table 1 (except Site 6:CX 12) and depicted in Figure 1 was sampled for fish community parameters using a 4-person survey team, with two backpack electroshocker units, and dipnets. Survey methodology, data analysis, and interpretation (scoring) essentially follow procedures outlined in Standard Operating Procedures Biological Monitoring Stream Fish Community Assessment (NCDENR 2001).

3.0 FISH COMMUNITY SURVEY RESULTS

It was apparent from field observations and fish surveys that the habitats within the former reservoir pool created by the Lowell Dam are in the process of reverting to lotic conditions, as a total of 36 fish species were captured within the former reservoir pool (Tables 2-7).

3.1 Species Composition and Site Descriptions

Brief descriptions of current habitat conditions and the results of the fish surveys for each site are provided below.

3.2 Site 1 (CX-1)

The habitat is characterized by runs and pools with a sand, and occasionally pea gravel, substrate. A large vegetative sand bar is present along the left descending bank. Woody debris is common through the reach. Accumulations of silt and detritus occur in the pools and slack-water areas along the river banks.

Table 2. Site 1 (CX 1): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	4	3
Amia calva	Bowfin	2	2
Anguilla rostrata	American eel	1	1
Aphredoderus sayanus	pirate perch	3	2
Centrarchus macropterus	flier	1	1
Cyprinella analostanus	satinfin shiner	4	3
Etheostoma nigrum	johnny darter	4	3
Etheostoma olmstedi	tessellated darter	49	5
Etheostoma vitreum	glassy darter	13	4
Gambusia holbrookii	eastern mosquitofish	3	3
Lepomis auritus	redbreast sunfish	32	7
Lepomis cyanellus	green sunfish	1	1
Lepomis macrochirus	bluegill	13	6
Lepomis microlophus	redear sunfish	4	4
Luxilus albeolus	white shiner	1	1
Micropterus salmoides	largemouth bass	3	2
Moxostoma colapsum	notchlip redhorse	4	3
Notropis amoenus	comely shiner	2	2
Notropis procne	swallowtail shiner	54	5
Noturus gyrinus	margined madtom	2	2
Percina nevisense	chainback darter	10	3
Percina roanoka	Roanoke darter	9	4
Pomoxis nigromaculatus	black crappie	1	1

3.3 Site 2 (CX-3)

This site occurs in a fairly sharp bend in the river. Habitat consists of a long shallow riffle run area with a consolidated sand and gravel substrate with scattered cobble. Prior to dam removal, this site was considered to provide the "best" aquatic species habitat within the reservoir pool. High quality habitat conditions remain at this site following removal, and it was the most species rich (27 species) site sampled during the Year-1 monitoring surveys.

Table 3. Site 2 (CX- 3): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	2	2
Anguilla rostrata	American eel	14	4
Aphredoderus sayanus	pirate perch	1	1
Cyprinella analostanus	satinfin shiner	1	1
Erimyzon oblongus	creek chubsucker	1	1

Esox americanus	redfin pickerel	1	1
Etheostoma olmstedi	tessellated darter	48	3
Etheostoma vitreum	glassy darter	5	3
Gambusia holbrookii	eastern mosquitofish	5	3
Ictalurus punctatus	channel catfish	1	1
Lepisosteus osseusi	longnose gar	2	1
Lepomis auritus	redbreast sunfish	50	7
Lepomis macrochirus	bluegill	7	4
Lepomis microlophus	redear sunfish	3	3
Luxilus albeolus	white shiner	11	4
Lythrurus matutinus	pinewoods shiner	2	1
Micropterus salmoides	largemouth bass	3	2
Moxostoma pappillosum	V-lip redhorse	1	1
Nocomis leptocephalus	bluehead chub	3	3
Nocomis raneyi	bull chub	3	3
Notropis amoenus	comely shiner	1	1
Notropis cummingsae	dusky shiner	3	2
Notropis procne	swallowtail shiner	32	3
Noturus gyrinus	margined madtom	11	4
Percina nevisense	Chainback darter	5	3
Percina roanoka	Roanoke darter	42	4
Scartomyzon cervinus	black jumprock	2	2

3.4 Site 3 (CX-4)

Site 3 is located below a wide bend of the river with clay banks and bedrock outcrops. The habitat is characterized as a series of riffles and runs separated by shallow pools. The substrate is dominated by rocky cobble and sand, with large accumulations of woody debris and a fair amount of fine sediments (silt and mud) in the pools. Stream banks are actively eroding, which was also noted during the pre-removal surveys in 2005 (Lowell Pre-removal survey report).

Table 4. Site 3 (CX-4): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	12	3
Anguilla rostrata	American eel	15	4
Aphredoderus sayanus	pirate perch	4	2
Etheostoma olmstedi	tessellated darter	49	4
Gambusia holbrookii	eastern mosquitofish	17	3
Lepomis auritus	redbreast sunfish	57	6
Lepomis macrochirus	bluegill	11	4
Lepomis microlophus	redear sunfish	3	3
Micropterus salmoides	largemouth bass	3	3

Notropis procne	swallowtail shiner	3	2
Noturus gyrinus	margined madtom	5	3
Percina nevisense	chainback darter	7	3
Percina roanoka	Roanoke darter	18	3

3.5 Site 4 (CX-7)

This site occurs in a long straight run of the river. Small riffles formed by woody debris occur throughout. The substrate is sand with silt deposits in slack-water areas below bars and along the river banks. Shallow sand bars and woody debris are common.

Table 5. Site 4 (CX 7): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	2	2
Anguilla rostrata	American eel	5	3
Aphredoderus sayanus	pirate perch	1	1
Cyprinella analostanus	satinfin shiner	8	3
Etheostoma olmstedi	tessellated darter	27	4
Etheostoma vitreum	glassy darter	7	3
Lepomis auritus	redbreast sunfish	33	6
Lepomis macrochirus	Bluegill	3	3
Lepomis microlophus	redear sunfish	2	2
Luxilus albeolus	white shiner	10	4
Lythrurus matutinus	pinewoods shiner	1	1
Micropterus salmoides	largemouth bass	3	3
Moxostoma colapsum	notchlip redhorse	1	1
Nocomis leptocephalus	bluehead chub	1	1
Notropis procne	swallowtail shiner	33	4
Noturus gyrinus	margined madtom	1	1
Percina nevisense	chainback darter	4	1
Percina roanoka	Roanoke darter	16	3

3.6 Site 5 (CX-10)

This site occurs in the vicinity of the WRC boat landing located off of SR 2144 (Weaver Road) and is characterized by a series of small riffles formed by woody debris. The substrate is sand with silt deposits in slack-water areas below bars and along the river banks. Shallow sand bars and accumulations of woody debris are common in this reach.

Table 6. Site 5 (CX 10): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Anguilla rostrata	American eel	5	3
Aphredoderus sayanus	pirate perch	1	1

Cyprinella analostanus	satinfin shiner	3	3
Etheostoma nigrum	johnny darter	4	2
Etheostoma olmstedi	tessellated darter	63	4
Etheostoma vitreum	glassy darter	3	2
Gambusia holbrookii	eastern mosquitofish	13	3
Ictalurus punctatus	channel catfish	1	1
Lepomis auritus	redbreast sunfish	40	5
Lepomis macrochirus	Bluegill	35	6
Lepomis microlophus	redear sunfish	2	2
Lythrurus matutinus	pinewoods shiner	4	1
Micropterus salmoides	largemouth bass	4	3
Notropis amoenus	comely shiner	4	3
Notropis hudsonius	spottail shiner	1	1
Notropis procne	swallowtail shiner	16	3
Noturus gyrinus	margined madtom	5	5
Percina nevisense	chainback darter	9	3
Percina roanoka	Roanoke darter	21	3

3.7 Site 6 (CX-12)

Site 6 is in the vicinity of the US 301 crossing of the river. During the pre-removal survey, the habitat was characterized as a deep (max. depth 10 feet) slack-water run of the river, with substrate composed of sand and occasional rock. Large amounts of woody debris and fallen trees were evident. Habitat conditions have changed little following dam removal. Although it is new shallower, the site remains a 2 to 5 foot deep slack-water pool/run, with large amounts of woody debris. This site was not sampled because there was not a 600 foot wadeable stretch that could be sampled using the NCIBI methodology.

3.8 Site 7 (CX-16)

This site is the location of the former Lowell Dam, extending upstream 600 feet through a fairly long, straight, and narrow section of the river. Multiple riffles with comparatively fast current have formed. The substrate is gravel and shifting sand with scattered rock, particularly along the banks. Moderate accumulations of woody debris are scattered throughout.

Table 7. Site 7 (CX- 16): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Anguilla rostrata	American eel	7	5
Cyprinella analostanus	satinfin shiner	11	4
Enneacanthus gloriosus	bluespotted sunfish	1	1
Etheostoma olmstedi	tessellated darter	17	4
Etheostoma vitreum	glassy darter	3	3

Gambusia holbrookii	eastern mosquitofish	7	2
Hypentelium nigricans	northern hogsucker	1	1
Ictalurus punctatus	channel catfish	2	1
Lepomis auritus	redbreast sunfish	39	5
Lepomis macrochirus	bluegill	46	6
Lepomis microlophus	redear sunfish	12	6
Lythrurus matutinus	pinewoods shiner	4	2
Micropterus salmoides	largemouth bass	2	2
Nocomis raneyi	bull chub	1	1
Notropis amoenus	comely shiner	1	1
Notropis procne	swallowtail shiner	55	3
Noturus gyrinus	margined madtom	2	2
Percina nevisense	chainback darter	7	2
Percina roanoka	Roanoke darter	33	3
Pylodictis olivaris	flathead catish	1	1
Pomoxis nigromaculatus	black crappie	1	1

3.9 NCIBI Scores

The NCIBI scores of the Year-1 monitoring surveys range from 38 (Fair) at Site 3 to 54 (Excellent) at Site 2 (Table 8). Score sheets for each site are included in Appendix A.

Table 8. NCIBI Scores Post Dam Removal Permanent Monitoring Survey Locations

Site #	# of Species	NCIBI Score
1 (CX-1)	23	46 (Good)
2 (CX-3)	27	54 (Excellent)
3 (CX-4)	13	38 (Fair)
4 (CX-7)	18	46 (Good)
5 (CX-10)	19	44 (Good-Fair)
6 (CX-12)	Not Sampled	Not Sampled
7 (CX-16)	21	48 (Good)

CX denotes corresponding Cross Sections being evaluated by RS

4.0 FISH COMMUNITY SURVEY DISCUSSION/CONCLUSIONS

The results of the Year-1 fish community monitoring indicate that the Little River is transitioning towards lotic conditions within the former reservoir pool as a result of dam removal. Some areas within the former impoundment appear to have retained some of the pre-removal lentic habitat characteristics such as slack flow, large deposits of fine sediments and accumulations of woody debris. The lack of major flow events in the Little River watershed since the removal of the dam in late 2005 have likely contributed to the slow pace of habitat change. Fish surveys employing NCIBI methodologies were conducted at six previously defined locations in the former reservoir pool to document

establishment of lotic habitats and improving habitat conditions in this reach overtime following dam removal.

4.1 Fish Surveys

Lotic fish communities are developing within the former reservoir pool in response to dam removal. The most upstream sites, Sites 1 and 2, contained the highest species diversity, 23 and 27 species, respectively. Based on habitat observations and aquatic species survey results during the 2005 pre-removal surveys, it was concluded that these upstream sites may have already been reverting to lotic conditions as a result of the water level lowering efforts that began in November of 2004 (Lowell Pre-removal Survey Report).

As discussed earlier, the implementation of the NCIBI methodologies for the post-removal monitoring surveys will allow for quantitative comparison of the fish community overtime in response to dam removal. The purpose of the pre-removal survey was to establish a baseline inventory of aquatic species in the Little River and thus, determine targeted faunal community composition. Multiple collection/observation methods were employed (electro-fishing, seine netting, dip net sweeps of banks, visual observations, and hook and line) to maximize the number of species that were documented. NCIBI methods could not be applied during pre-removal conditions due to insufficient lengths of wadeable habitat.

Although different fish survey methodologies were used during the pre-removal surveys in 2005 (Lowell Pre-removal Survey Report) and the Year-1 fish community monitoring surveys, general comparisons between the two results can be made. With the exceptions of Site 6, which was not sampled, and Site 3, which produced only 13 species, a greater number of fish species were documented at each site during the Year-1 fish community monitoring surveys than previously during the 2005 pre-removal surveys (Table 9).

Table 9. Comparison of Pre-removal and Year-1 Monitoring Surveys

Site #	# Species Pre-removal	# Species Year-1 monitoring
1 (CX-1)	21	23
2 (CX-3)	26	27
3 (CX-4)	16	13
4 (CX-7)	15	18
5 (CX-10)	11	19
6 (CX-12)	5*	Not Sampled
7 (CX-16)	3*	21

*visual observations only

Although differences in sampling methodologies may account for some of the differences in species richness, it can be concluded that habitat restoration in response to dam

removal is a major reason for these changes. Because the combined methodologies used during the pre-removal surveys were likely to detect more species than the NCIBI survey methodology, which only utilizes back-pack electro-fishing, the increases in species richness are more likely attributable to other factors, such as improved habitat conditions. The reasons for the relatively low species diversity and corresponding low NCIBI score from Site 3 are not clear, though moderate amounts of stream-bank erosion and scour were noted at this site as well as a fair amount of accumulated fine sediments and woody debris.

4.2 Future Fish Survey Monitoring

Habitat within the former impoundment is expected to continue to transition from lentic to lotic conditions in response to dam removal. As discussed earlier, this further transition pertains primarily to the middle and lower portions of the former reservoir pool, as the upper segments appear to be more advanced in this habitat transition. This transition is expected to be reflected in changes of the aquatic communities. One of the fish community components of the success criteria is to demonstrate an increase in species diversity and population vitality. Therefore, future monitoring surveys using the same NCIBI methodology employed during the Year-1 surveys will allow for this analysis to be made.

It is recommended that fish survey monitoring take place in at least three of the remaining four years of the monitoring plan. However, each site, particularly the upper sites, does not necessarily have to be sampled every year. Additionally, reference sites in the Little River outside of the former dam effects should be sampled in a similar manner near the end (year 4-5) of the monitoring program for comparison.

5.0 ANADROMOUS SPECIES SURVEY EFFORTS

Eight species of anadromous fish are known to occur in North Carolina (Table 10). The Lowell Dam was recognized as an impediment to anadromous species spawning runs, and its removal was designated by the North Carolina Dam Removal Task Force (NCDRTF) as the highest priority for dam removal in North Carolina (NCDRTF 2001).

Table 10. Anadromous Fish Species of North Carolina

Scientific Name	Common Name
Acipenser brevirostrum	shortnose sturgeon[1]
Acipenser oxyrhynchus oxyryinchus	Atlantic sturgeon
Alosa aestivalis	blueback herring
Alosa mediocris	hickory shad
Alosa pseudoharengus	Alewife
Alosa sapidissima	American shad
Morone saxatilis	striped bass
Petromyzon marinus	sea lamprey[2]

1-The shortnose sturgeon is Federally and State Endangered.
2- The sea lamprey is on the NCWRC freshwater list prioritized for conservation.

Based on habitat conditions, watershed size, biology, and distribution, the species most likely to benefit from the dam removal are American shad and hickory shad, followed by striped bass, blueback herring, and alewife. Although it is conceivable that shortnose sturgeon, Atlantic sturgeon, and sea lamprey could benefit from the dam removal, it is unlikely due to low population numbers in the Neuse River Basin and lack of typical habitat for these species in the Little River.

Surveys targeting anadromous fish species were conducted February-May, 2006, by the following personnel from TCG on the listed dates:

Alex Adams – March 2
Tom Dickinson – February 23, 24; March 9, 10, 23, 24, 31; April 4, 6, 10; May 9, 11
Shay Garriock – March 2, 31; April 10
Kate Montieth - February 24; April 6; May 9, 11
Fred C. Rhode Ph.D * - March 23, 24, 31; April 6, 10; May 9
Bryant Savidge - April 14
Daniel Savidge - April 14
Tim Savidge - February 23, 24; March 2, 9, 10; April 14; May 11
Chris Sheats – March 23, 24, 31; April 6, 10; May 9, May 11
*** Contracted by TCG to assist field crew**

5.1 Anadromous Species Surveys Methodology

A combination of survey methodologies were employed in an effort to document spawning runs of anadromous species upstream of the former Lowell Dam following its removal in January 2006.

5.1.1 Fish Capture

A number of active and passive fish collection methods were used during this effort, often in conjunction with one another.

Passive/ Semi-passive Capture (Gill netting)
Gill netting was used as a passive and semi-passive capture technique during anadromous fish sampling. During likely peak spawning periods, a gill net was set (tied across an appropriate section of river) at the beginning of a sampling day and checked at the end of the day. Semi-passive gill netting techniques consisted of two people slowly dragging a gill net through a pool or slow run areas and were sometimes used in conjunction with electro-fishing to herd fish into the gill net.

Active Capture (Electro-fishing/Seine/Hook and Line) Methods
After the gill net was set, the survey team would move to the next site and use a combination of electro-fishing and seine netting to capture anadromous fish. The survey team began at the downstream point of the survey site and proceeded upstream. Two

back-pack electroshocking units were used in most reaches. One person with a dip net accompanied each shocker and a straight haul seine net was positioned downstream of the shockers where appropriate. The two shockers often worked in concert to herd fish towards the seine net, or gill net, a technique termed "block-shocking." All appropriate habitat types in the survey reach were sampled using these methods, moving upstream until the entire length of the habitat type (riffle/run, pool) was sampled. This process was performed in the middle of the channel and close to each bank, in order to survey the entire habitat. This method was effective in riffle and run habitats of shallow to moderate depths, but was fairly ineffective in deep runs and wide deep pools.

All fish captured were placed into a water bucket until they could be identified, counted, and released. The length of time necessary to identify, count, and release the fish depended on the number of fish in the bucket and their condition. Any fish that did not recover from the electroshocking were preserved in 95% ethanol. Habitat notes were recorded at each collection site. A relative abundance was assigned to each species captured or observed at each site. Relative abundance for fish species were estimated using the following criteria:

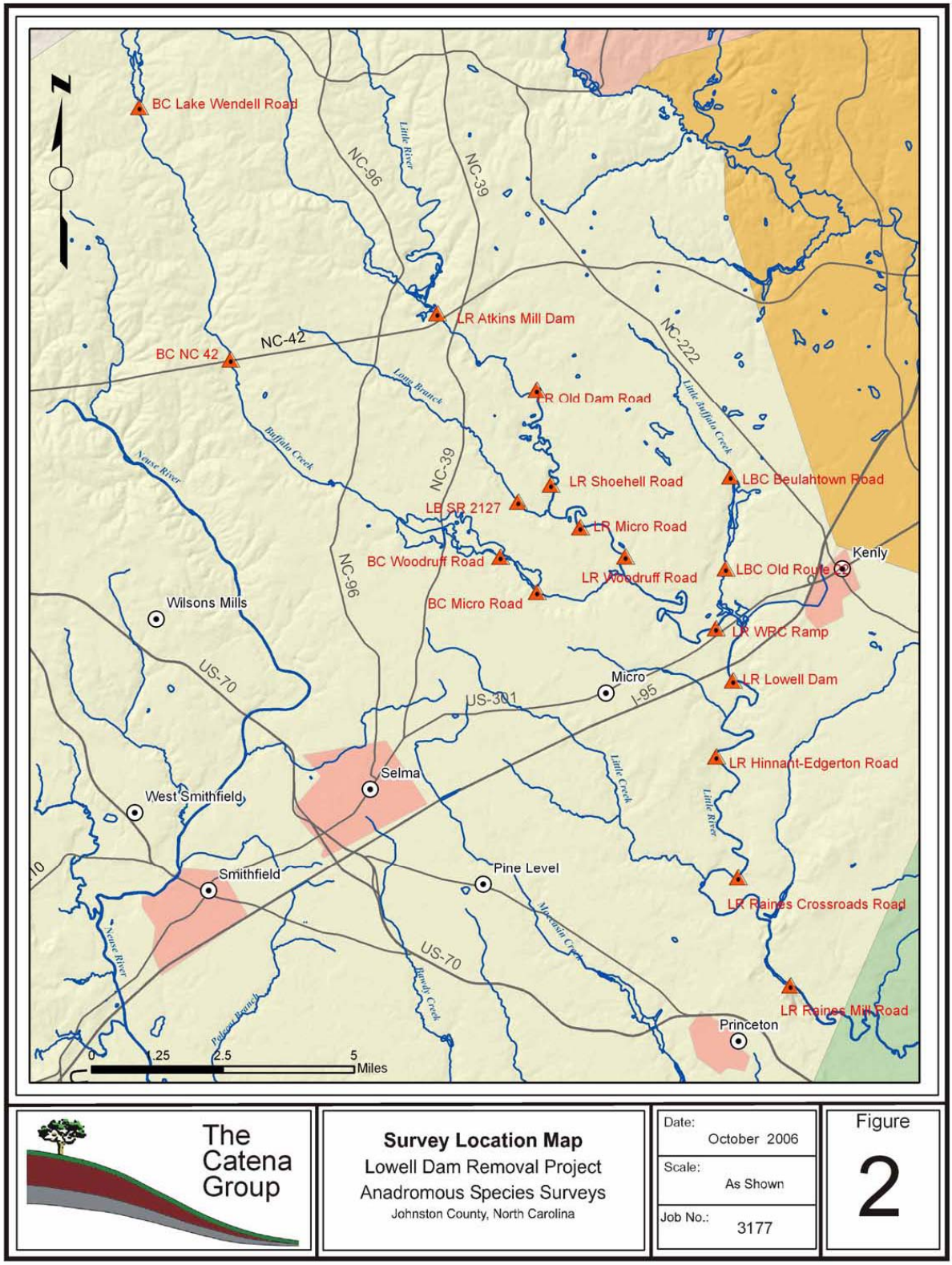
- Very abundant > 30 collected at survey station
- Abundant 15-30 collected at survey station
- Common 6-15 collected at survey station
- Uncommon 3-5 collected at survey station
- Rare 1-2 collected at survey station

Hook and line fishing with shad darts and spoons was also employed at a few locations. This was not a primary method of sampling and mainly used during the time between other capture methods. It did not produce any species that were not detected using other sampling methods.

The anadromous fish surveys were conducted at a number of general sampling locations in Little River, Buffalo Creek, Little Buffalo Creek, and Long Branch on various dates during. Potential anadromous fish habitat was noted during the 2005 pre-removal sampling and during habitat reconnaissance on February 23 and 24, 2006. Habitat types, substrate composition, and water levels were all considered in deciding what areas would be best to sample and what survey methodologies would be most effective. Additionally, potential fish barriers upstream of the impoundment area (Atkins Mill on Little River, Wendell Lake on Buffalo Creek) were targeted as sampling areas. General site location, survey dates, and GPS location of the midpoint of the survey site are included in Table 11. The approximate midpoints of each survey locations listed in Table 11 are depicted in Figure 2.

Table 11. Anadromous Survey Locations in Little River (downstream to upstream)

Site #/Location	Survey Dates 2006	GPS Location
LR Raines Mill Road	4/10	35.48168ºN, -78.14261ºW
LR Raines Crossroads Road	4/10	35.51162ºN, -78.16001ºW
LR Hinnant-Edgerton Road	4/10	35.54519ºN, -78.16701ºW


N
BC Lake Wendell Road
NC-96
Little River
NC-39
LR Atkins Mill Dam
NC-42
BC NC 42
NC-222
Little Buffalo Creek
Long Branch
LR Old Dam Road
Buffalo Creek
Neuse River
NC-39
LR Shoehell Road
LBC Beulahtown Road
LB SR 2127
LR Micro Road
Kenly
BC Woodruff Road
LR Woodruff Road
LBC Old Route
NC-96
Wilsons Mills
BC Micro Road
LR WRC Ramp
US-70
Micro
LR Lowell Dam
US-301
I-95
LR Hinnant-Edgerton Road
Selma
Little Creek
Little River
West Smithfield
Smithfield
Pine Level
LR Raines Crossroads Road
Neuse River
US-70
Marrenia Creek
Buffalo Creek
LR Raines Mill Road
Princeton
0
1.25
2.5
5
Miles
The Catena Group
Survey Location Map
Lowell Dam Removal Project
Anadromous Species Surveys
Johnston County, North Carolina
Date:
October 2006
Scale:
As Shown
Job No.:
3177
Figure
2

LR Lowell Dam	2/23, 3/31	35.56609°N, 78.16112°W
LR WRC Ramp	2/23, 2/24, 3/2, 3/23, 4/6, 4/10, 4/16	35.58051ºN, -78.16672ºW
LR Woodruff Road	3/23, 3/24, 3/31	35.60047ºN, -78.19724ºW
LR Micro Road	3/23, 4/6, 4/14	35.60858ºN, -78.21242ºW
LR Shoehell Road	4/6	35.62049ºN, -78.22219ºW
LR Old Dam Road	4/6	35.64702ºN, -78.22681ºW
LR Atkins Mill Dam	2/23, 3/24, 3/31, 4/6, 5/9, 5/11	35.66832ºN, -78.26021ºW
LB SR 2127	2/24,3/24, 5/11	35.61582°N, 78.23340°W
BC Micro Road	2/24	35.59091°N, 78.22722°W
BC Woodruff Road	3/24, 5/9	35.60070°N, 78.23949°W
BC NC 42	5/11	35.65602°N, 78.33038°W
BC Lake Wendell Road	3/24, 5/11	35.72581°N, 78.36069°W
LBC Old Route 22	5/9	35.59691ºN, -78.16331ºW
LBC Beulahtown Road	2/24, 3/2	35.62232ºN, -78.16138ºW

LR,LB,BC and LBC denote Little River, Long Branch, Buffalo Creek and Little Buffalo Creek respectively

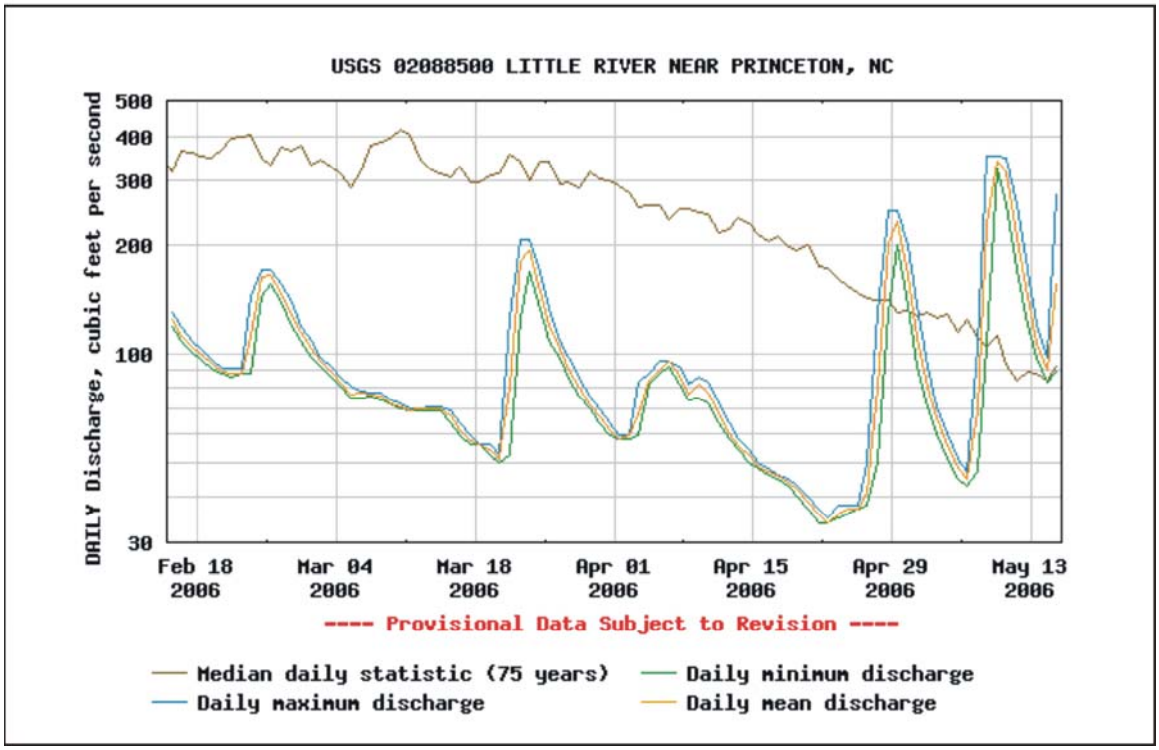
5.1.2 Creel Surveys

Valuable information pertaining to specific fisheries can be gathered through interviews with anglers (creel surveys). A questionnaire was developed (Appendix B) and posted at various businesses (country stores/bait shops, restaurants, gas stations) within the Little River watershed. Anyone interested in participating in the survey was asked to fill out the questionnaire and mail it to the TCG office in Raleigh. The participants had the option of being identified in the survey reports for this project. A self addressed stamped envelope was attached to the questionnaires that were distributed. Efforts were also made to interview local fisherman encountered in the watershed while conducting fish surveys at the survey stations listed in Table 11. Fisherman were asked questions pertaining to their fishing activities in the Little River (catch and methods) and prior fishing experience in the Little River, particularly with regards to the targeted anadromous species (shad, herring etc.).

6.0 ANADROMOUS SPECIES SURVEY RESULTS

Attempts were made to document anadromous fish species above the former Lowell Dam beginning in late February and extending through early May 2006. Efforts were to begin on a bi-weekly schedule, and increase to weekly during the expected “peak” spawning period; however, extreme low flow conditions persisted in the Little River during this time (Figure 3), and sampling efforts were scaled back in April. Efforts were resumed following moderate rain events in late April and early May that resulted in above mean discharge rates.

Figure 3. Lowell Dam Removal Anadromous Species Surveys: Flow Data for Little River February - May, 2006



6.1 Results: Anadromous Fish Sampling Efforts

The results of the anadromous fish sampling efforts are presented by date and the corresponding survey locations:

6.1.1 February 23

The majority of time on this date was spent conducting habitat reconnaissance in the Little River, Buffalo Creek, Little Buffalo Creek and Long Branch. Habitat conditions (stream width, depth, accessibility, flow rate etc.) were recorded. The information gathered was used to determine future survey sites and appropriate survey methodologies. Creel survey questionnaires were also distributed at various businesses in the area and interviews with local fisherman were conducted at the site of the former Lowell Dam and at the WRC boat ramp off of Weaver Road (SR 2144). A brief fish survey was conducted using seine and dip nets in Long Branch at Shoeheel Road (SR 2127), and hook and line methods were conducted in the Little River at the site of the former Lowell dam, WRC ramp, and tailrace of Atkins Mill Dam.

Site 1 Little River Former Lowell Dam Site:

Approximately 0.5 hours (0.25 hrs x 2) of time was spent casting shad darts and rooster tails in the Little River in the general area immediately above the site of the former

Lowell Dam and no fish were captured. A gentleman (name not provided) who claimed the Little River as "his river" was interviewed. He reported that during the previous ten years he made annual trips in early March to the base of the former Lowell Dam to fish for American and hickory shad, and now with the dam being removed, he would focus his future fishing efforts at the base of Atkins Mill Dam. The gentleman also stated that originally he was not in favor of the dam removal project; however, he was impressed with "how good the river looks" in the former reservoir.

Site 2 Little River (WRC ramp @ Weaver Road/SR 2144):

Approximately 0.5 hours (0.25 hrs x 2) of time was spent casting shad darts and rooster tails in the vicinity of the WRC boat ramp located off of Weaver Road. One largemouth bass and one bluegill were captured. An interviewed gentleman (name not provided) stated that he often fished for shad in the Little River below the former Lowell Dam; however he spent more time shad fishing further downstream in the Neuse River. He reported that "white shad" (American shad) were being captured in the Neuse River near Goldsboro and it was "3-4 weeks early" for shad in the Little River.

Site 3 Long Branch (Shoeheel Road/SR 2127):

Active sampling was conducted in Long Branch using seine and dip nets. Seine hauls were performed by a two person team beginning at the Shoeheel Road bridge and proceeded upstream for a distance of approximately 50 meters (164 feet). Dip net sweeps were conducted in submerged rootmats along the banks.

Table 12. February 23 Site 3 Long Branch at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish*	~	~
Aphredoderus sayanus	pirate perch	Uncommon
Esox americanus	redfin pickerel	Uncommon
Etheostoma olmstedi	tessellated darter	Common
Gambusia holbrookii	Eastern mosquitofish	Abundant
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Common
Luxilus albeolus	white shiner	Uncommon
Notropis procne	swallowtail shiner	Common

Site 4 Little River Tailrace of Atkins Mill Dam (above NC 42):

Approximately 1 hour (0.5 hrs x 2) of time spent casting shad darts and rooster tails in the spillway of the Atkins Mill Dam yielded three largemouth bass. An interview was conducted with an employee of the Atkins Mill (name not provided) regarding fishing efforts at this site. The employee reported that the base of the dam was a popular fishing spot that people accessed off of NC 42 on the southwest side of the dam. He stated that largemouth bass, various sunfish and "shad" were commonly captured at the base of the

dam, and bass and blackfish (bowfin) occur in the mill pond above the dam. Based on a description provided, it was concluded that the "shad" he was referring to were gizzard shad (*Dorosoma cepedianum*).

6.1.2 February 24

Site 1 Little River (WRC Ramp @ Weaver Road/SR 2144):

Approximately 1.5 hours (0.5 hrs x 3) of time was spent casting shad darts and rooster tails in the vicinity of the WRC boat ramp located off of Weaver Road. One largemouth bass was captured. A fisherman (name not provided) interviewed during this time stated that he had just begun to catch low numbers of American Shad at Cox Mill on Mill Creek, a tributary to the Neuse River in Wayne County and that the "shad runs" in the Little River near Lowell Dam were usually 2-3 weeks later than in Mill Creek. A couple (names not provided) was also interviewed who reported that they often fished from the banks at the WRC ramp and routinely catch largemouth bass and various "bream" (sunfish), and had never caught, or heard of anyone catching shad from this section of the river.

Site 2 Buffalo Creek Micro Road/SR 2130:

An approximate 250 meter (820 foot) stretch of Buffalo Creek, beginning at the bridge crossing and proceeding upstream, was sampled using electro-fishing and block-shocking to a seine net for 2,699 seconds of electro-shocking time.

Table 13. February 24 Site 2: Buffalo Creek at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Aphredoderus sayanus	pirate perch	Common
Centrarchus macropterus	flier	Uncommon
Enneacanthus obseus	banded sunfish	Rare
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Uncommon
Luxilus albeolus	white shiner	Rare
Lythrurus matutinus	pinewoods shiner	Common
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Rare
Percina roanoka	Roanoke darter	Rare

Site 3 Little Buffalo Creek Beulahtown Road/SR 2148:

The braided channel swamp upstream of the Beulahtown Road crossing of Little Buffalo Creek was surveyed for approximately 200 meters (656 feet) to the base of a large beaver (*Castor canadensis*) dam complex upstream. Electro-fishing sampling was conducted for 1,348 seconds of electro-shocking time. Two species of aquatic salamanders were captured.

Table 14. February 24 Site 3: Little Buffalo Creek at Beulahtown Rd: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Amia calva	bowfin	Common
Anguilla rostrata	American eel	Rare
Centrarchus macropterus	flier	Abundant
Elassoma zonatum	banded pygmy sunfish	Rare
Erimyzon oblongus	creek chubsucker	Very Abundant
Esox americanus	redfin pickerel	Uncommon
Gambusia holbrooki	Eastern mosquitofish	Abundant
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Uncommon
Aquatic salamanders	~	~
Amphiuma means	two-toed amphiuma	Common
Siren lacertian	greater siren	Uncommon

6.1.3 March 2

Site 1 Little River (WRC Ramp @ Weaver Road/SR 2144):

Approximately 1.5 hours (0.5 hrs x 3) of time was spent casting shad darts and rooster tails in the vicinity of the WRC boat ramp located off of Weaver Road. No fish were captured. One seine haul was conducted in the run immediately below the boat ramp. Survey effectiveness was limited due to the amount of woody debris in the river.

Table 15. March 2 Site 1: Little River at WRC Ramp: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Etheostoma olmstedi	tessellated darter	Uncommon
Lepomis auritus	redbreast sunfish	Uncommon
Lepomis macrochirus	bluegill	Common
Notropis procne	swallowtail shiner	Uncommon
Percina nevisense	chainback darter	Uncommon

Site 2 Little Buffalo Creek Beulahtown Road/SR 2148:

Little Buffalo Creek was sampled in the same reach that was surveyed on February 24. Electro-fishing and block-shocking to a seine net was conducted in the sampling area for 2,910 seconds of electro-shocking time. Three species of aquatic salamander were captured during this effort.

Table 16. March 2 Site 2: Little Buffalo Creek at Beulahtown Rd.: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Amia calva	bowfin	Common
Centrarchus macropterus	flier	Common
Enneacanthus obesus	banded sunfish	Rare
Erimyzon oblongus	creek chubsucker	Very Abundant
Esox americanus	redfin pickerel	Uncommon
Gambusia holbrooki	Eastern mosquitofish	Abundant
Hybognathus regius	Eastern silvery minnow	Rare
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Uncommon
Micropterus salmoides	largemouth bass	Uncommon
Aquatic salamanders	~	~
Amphiuma means	two-toed amphiuma	Common
Siren intermedia	lesser siren	Uncommon
Siren lacertian	greater siren	Uncommon

6.1.4 March 9

Approximately 2 hours (0.5 hours x 4 people) was spent hook and line fishing using shad darts and spinner baits immediately upstream of the former Lowell Dam. The primary focus of this visit to conduct quantitative freshwater mussel surveys and the fishing effort was done during surface intervals of the mussel survey. One largemouth bass was captured. An interview with a local fisherman (Gary Scott) was conducted. Mr. Scott stated that he had fished in the Little River periodically and shad had not “shown up” as far upstream as the Lowell dam site at that time, but were reported to be at the mouth of the Little River in Wayne County.

6.1.5 March 10

Approximately 1 hour (0.25 hours x 4 people) was spent hook and line fishing using shad darts and spinner baits immediately upstream of the Micro Road crossing of the Little River. The primary focus of this visit to was to conduct quantitative freshwater mussel surveys. This fishing effort was done during surface intervals of the mussel survey efforts. No fish were captured during this time.

6.1.6 March 23

Site 1 Little River (WRC Ramp @ Weaver Road/SR 2144):

A combination of passive and active sampling techniques was employed. The gill net was set approximately 100 meters below the ramp site in a deep run for 4 hours and no fish were caught. Active sampling was conducted in an approximately 100 meter (328 feet) reach upstream of the ramp area. Electro-fishing and block-shocking to a gill net was conducted for 489 seconds of electro-shocking time.

Table 17. March 23 Site 1: Little River at WRC Ramp: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Lepomis auritus	redbreast sunfish	Common
Lepomis cyanellus	green sunfish	Uncommon
Lepomis macrochirus	bluegill	Uncommon
Luxilus albeolus	white shiner	Uncommon
Micropterus salmoides	largemouth bass	Rare
Notropis procne	swallowtail shiner	Uncommon

Site 2 Little River (Micro Road/SR 2130):

Active sampling was conducted in an approximately 200 meter (656 feet) reach of the Little River in the vicinity of Micro Road. Electro-fishing and block-shocking samplings to a seine net were conducted for 938 seconds of electro-shocking time.

Table 18. March 23 Site 2: Little River at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus platycephalus	flat bullhead	Rare
Anguilla rostrata	American eel	Rare
Cyprinella analostanus	Satinfin shiner	Common
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Ictalurus punctatus	Channel catfish	Rare
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Uncommon
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Moxostoma pappillosum	V-lip redhorse	Rare-milting
Nocomis leptocephalus	bluehead chub	Common
Nocomis raneyi	bull chub	Common
Notropis procne	swallowtail shiner	Uncommon
Noturus furiosus	Carolina madtom	Rare
Noturus insignis	margined madtom	Common

Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Common

Site 3 Little River (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 200 meter reach upstream of Woodruff Road. Electro-fishing and block-shocking to a gill net was conducted for 1,193 seconds of electro-shocking time.

Table 19. March 23 Site 3: Little River at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Cyprinella analostanus	satinfin shiner	Uncommon
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Common
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Common
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Nocomis raneyi	bull chub	Uncommon
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Common
Percina roanoka	Roanoke darter	Rare

6.1.7 March 24

Site 1 Little River (Woodruff Road SR 2129):

The gill net was set approximately 100 meters upstream of the road crossing in a moderately deep run with sandy/gravel substrate for 6 hours and no fish were caught.

Site 2 Little River Tailrace of Atkins Mill Dam (above NC 42):

The Atkins Mill dam, which is the next upstream impediment to fish passage in the Little River, was sampled below the dam in an approximately 100 meter reach upstream of NC 42. Electro-fishing and block-shocking to a gill net was conducted for 1,049 seconds of electro-shocking time. Semi-passive techniques of dragging a gill net were used for two passes through the sampling area.

Table 20. March 24 Site 2: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~

Amia calva	bowfin	Rare
Anguilla rostrata	American eel	Common
Cyprinella analostanus	satinfin shiner	Uncommon
Dorosoma cepedianum	gizzard shad	Abundant
Erimyzon oblongus	Creek chubsucker	Uncommon
Lepomis auritus	redbreast sunfish	Common
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Common
Notemigonus crysoleucas	golden shiner	Common
Noturus gyrinus	tadpole madtom	Rare
Pomoxis nigromaculatus	Black crappie	Rare

Site 3 Buffalo Creek (Lake Wendell Road SR 1716):

Buffalo Creek was sampled in an approximately 150 meter (492 feet) reach below the Lake Wendell Dam, in the vicinity of Lake Wendell Road. Electro-fishing and block-shocking sampling was conducted for 682 seconds of electro-shocking time.

Table 21. March 24 Site 3: Buffalo Creek at Lake Wendell Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus natalis	yellow bullhead	Rare
Anguilla rostrata	American eel	Uncommon
Etheostoma nigrum	Johnny darter	Rare
Etheostoma olmstedi	tessellated darter	Rare
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Common
Notemigonus crysoleucas	golden shiner	Uncommon
Micropterus salmoides	largemouth bass	Rare
Noturus gyrinus	tadpole madtom	Rare
Pomoxis nigromaculatus	black crappie	Rare

Site 4 Long Branch (Shoeheel Road SR 2127):

Active sampling was conducted in Long Branch in an approximately 100 meter (328 feet) reach in the vicinity of Shoeheel Road using electro-fishing and block-shocking for 437 seconds of electro-shocking time.

Table 22. March 24 Site 4: Long Branch at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Aphredoderus sayanus	pirate perch	Uncommon
Centrarchus macropterus	flier	Rare

Esox americanus	redfin pickerel	Rare
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Gambusia holbrookii	Eastern mosquitofish	Abundant
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Rare
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Uncommon

Site 5 Buffalo Creek (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 200 meter (656 feet) reach in the vicinity of the Woodruff Road crossing. Electro-fishing and block-shocking sampling was conducted in the sampling area for 1,122 seconds of electro-shocking time.

Table 23. March 24 Site 5: Buffalo Creek at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Cyprinella analostanus	satinfin shiner	Common
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Common
Lythrurus matutinus	Pinewoods shiner	Abundant
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Abundant
Percina roanoka	Roanoke darter	Uncommon

6.1.8 March 31

Site 1 Little River (below former Lowell Dam):

Active sampling was conducted in an approximately 100 meter (328 feet) reach downstream of the old dam site using electro-fishing for 486 seconds of electro-shocking time.

Table 24. March 31 Site 1: Little River below Lowell Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Etheostoma olmstedi	tessellated darter	Common
Ictalurus punctatus	channel catfish	Rare
Lepomis auritus	redbreast sunfish	Abundant

Lepomis macrochirus	bluegill	Common
Lepomis microlophus	redear sunfish	Common
Lythrurus matutinus	pinewoods shiner	Abundant
Nocomis raneyi	bull chub	Uncommon
Notropis procne	swallowtail shiner	Abundant

Site 2 Little River (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 150 meter (492 feet) reach upstream of Woodruff Road using electro-fishing and block-shocking for 490 seconds of electro-shocking time.

Table 25. March 31 Site 2: Little River at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Nocomis raneyi	bull chub	Uncommon
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Uncommon
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Uncommon

Site 3 Little River Tailrace of Atkins Mill Dam (above NC 42):

The Little River was semi-passively sampled below Atkins Mill Dam in an approximately 100 meter (328 feet) reach by sweeping the gill net once through the pool below the dam.

Table 26. March 31 Site 3: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Dorosoma cepedianum	gizzard shad	Abundant
Lepomis microlophus	redear sunfish	Uncommon
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Common

6.1.9 April 6

Site 1 Little River (WRC ramp @ Weaver Road SR 2144):

A gill net was set approximately 100 meters (328 feet) downstream of the WRC ramp in a deep run for a soak time of six hours and no fish were caught.

Site 2 Little River Tailrace of Atkins Mill Dam (above NC 42):

The Little River was sampled below Atkins Mill Dam in an approximately 100 meter (328 feet) reach. Electro-fishing and block-shocking sampling to a gill net was conducted for 963 seconds of electro-shocking time.

Table 27. April 06 Site 2: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Dorosoma cepedianum	gizzard shad	Abundant
Erimyzon oblongus	creek chubsucker	Rare
Etheostoma nigrum	Johnny darter	Uncommon
Etheostoma olmstedi	tesseslatedtessellated darter	Uncommon
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Common
Lepomis microlophus	redear sunfish	Common
Lythrurus matutinus	pinewoods shiner	Rare
Micropterus salmoides	largemouth bass	Common
Moxostoma pappillosum	V-lip redhorse	Rare
Notropis albeolus	white shiner	Rare

Site 3 Little River (Old Dam Road/SR 2123):

Active sampling was conducted in an approximately 200 meter (656 feet) reach of the Little River in the vicinity of Old dam Road crossing. Electro-fishing and block-shocking sampling was conducted for 1,078 seconds of electro-shocking time.

Table 28. April 06 Site 3: Little River at Old Dam Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Etheostoma vitreum	glassy darter	Rare
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Common

Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Moxostoma pappillosum	V-lip redhorse	Rare
Nocomis leptocephalus	bluehead chub	Common
Nocomis raneyi	bull chub	Common
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Abundant
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Abundant

Site 4 Little River (Shoeheel Road SR 2127):

Active sampling was conducted in an approximately 200 meter reach of the Little River in the vicinity of Shoeheel Road. Electro-fishing and block-shocking sampling was conducted for 671 seconds of electro-shocking time.

Table 29. April 06 Site 4: Little River at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepisosteus osseusi	longnose gar	Rare
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Uncommon
Lythrurus matutinus	pinewoods shiner	Abundant
Moxostoma pappillosum	V-lip redhorse	Rare
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Common

Site 5 Little River (Micro Road SR 2130):

Active sampling was conducted in an approximately 200 meter (656 feet) reach of the Little River in the vicinity of Micro Road. Electro-fishing and block-shocking sampling was conducted for 1,518 seconds of electro-shocking time.

Table 30. April 06 Site 2: Little River at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Etheostoma vitreum	glassy darter	Rare
Lepomis auritus	redbreast sunfish	Abundant

Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Abundant
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Rare
Moxostoma cervinum	black jumprock	Rare
Moxostoma collapsum	notchlip redhorse	Common
Moxostoma pappillosum	V-lip redhorse	Common
Nocomis leptocephalus	bluehead chub	Common
Nocomis raneyi	bull chub	Common
Noturus insignis	margined madtom	Common
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Common

6.1.10 April 10

Site 1 Little River (WRC ramp @ Weaver Road SR 2144):

A gill net was set approximately 100 meters (328 feet) downstream of the WRC ramp in a deep run for a soak time of six hours and no fish were caught.

Site 2 Little River (Old Raines Mill @ Pine Street SR 1002):

To this point in the survey effort, no anadromous fish species had been captured at any of the survey locations. This lack of anadromous species was believed to have been attributed to the extreme low flow in the river. A decision was made to add sampling locations downstream of the former Lowell Dam in areas where anadromous species were known to have traversed in years past. Active sampling was conducted in an approximately 200 meter (656 feet) reach downstream of Pine Street. Electro-fishing and block-shocking sampling was conducted for 1,943 seconds of electro-shocking time.

Table 31. April 10 Site 2: Little River at Old Raines Mill : Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Etheostoma vitreum	glassy darter	Uncommon
Ictalurus punctatus	channel catfish	Rare
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Common
Moxostoma collapsum	notchlip redhorse	Uncommon

Moxostoma macrolepidotum	shorthead redhorse	Common
Nocomis raneyi	bull chub	Common
Notropis amoenus	comely shiner	Uncommon
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Abundant
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Abundant

Site 3 Little River (Raines Crossroads Road SR 2320):

This site is also located downstream of the former Lowell Dam site. Active sampling was conducted in an approximately 150 meter (490 feet) reach in the vicinity of Raines Crossroads Road. Electro-fishing and block-shocking sampling was conducted for 1,506 seconds of electro-shocking time.

Table 32. April 10 Site 3: Little River at Raines Crossroads Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Lepomis auritus	redbreast sunfish	Abundant
Lepomis microlophus	redear sunfish	Common
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Common
Moxostoma collapsum	notchlip redhorse	Common
Nocomis raneyi	bull chub	Common
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Common
Noturus gyrinus	tadpole madtom	Rare
Percina roanoka	Roanoke darter	Abundant

Site 4 Little River (Lizzie Mill Road SR 1001):

This site is also located downstream of the former Lowell Dam site. Active sampling was conducted in an approximately 150 meter (490 feet) reach in the vicinity of Lizzie Mill Road (SR 1001). Electro-fishing and block-shocking sampling was conducted for 1,762 seconds of electro-shocking time.

Table 33. April 10 Site 4: Little River at Lizzie Mill Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant

Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Common
Lepomis microlophus	redear sunfish	Abundant
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Common
Nocomis raneyi	bull chub	Common
Notropis amoenus	comely shiner	Common
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Abundant
Pomoxis nigromaculatus	black crappie	Rare
Percina roanoka	Roanoke darter	Abundant

6.1.11 April 14

Site 1 Little River (Micro Road/SR 2130):

The primary focus of this visit to the Little River involved the quantitative mussel survey, however an approximately 200 meter (656 feet) reach of the Little River was sampled (1 pass) using electrofishing for 877 seconds of shock time.

Table 34. April 14 Site 1: Little River at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Aphredoderus sayanus	pirate perch	Uncommon
Etheostoma olmstedi	tessellated darter	Abundant
Etheostoma vitreum	glassy darter	Rare
Gambusia holbrooki	Eastern mosquitofish	Common
Hypentelium nigricans	Northern hogsucker	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Uncommon
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Very Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Uncommon
Moxostoma collapsum	notchlip redhorse	Common
Notropis procne	swallowtail shiner	Very Abundant
Noturus insignis	margined madtom	Abundant
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Abundant
Scartomyzon cervinum	black jumprock	Common

6.1.12 May 9

Site 1 Little River Tailrace of Atkins Mill Dam (above NC 42):

The tailrace of Atkins Mill Dam was sampled below the dam in an approximately 100 meter reach upstream of NC 42. The pool below the dam was semi-passively sampled by sweeping a gill net slowly through the pool five times. This effort resulted in the first capture of American shad upstream of Lowell Mill since the removal of the dam. The specimen was placed on ice and transported to the North Carolina State Museum of Natural Sciences (NCSM) and deposited as a voucher.

Table 35. May 09 Site 1: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Alosa sapidissima	American shad	Rare (1)
Dorosoma cepedianum	gizzard shad	Rare
Lepomis microlophus	redear sunfish	Rare

Site 2 Buffalo Creek (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 150 meter (490 feet) reach in the vicinity of the Woodruff Road crossing. Electro-fishing and block-shocking sampling was conducted for 1,065 seconds of electro-shocking time. One spawning female American shad was captured, placed on ice, transported to the NCSM, and deposited as a voucher.

Table 36. May 09 Site 2: Buffalo Creek at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Alosa sapidissima	American shad	Rare (1)
Centrarchus macropterus	flier	Rare
Cyprinella analostanus	satinfin shiner	Common
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Esox americanus	redfin pickerel	Common
Lepisosteus osseusi	longnose gar	Rare
Lepomis auritus	redbreast sunfish	Abundant
Luxilus albeolus	white shiner	Common
Lythrurus matutinus	pinewoods shiner	Common
Moxostoma macrolepidotum	shorthead redhorse	Rare
Moxostoma pappillosum	V-lip redhorse	Rare
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Common

Site 3 Little Buffalo Creek (Old Rt. 22/SR 2143):

Little Buffalo Creek was sampled in an approximately 100 meter (328 feet) reach in the vicinity of the Old Route 22 (SR 2143) crossing. Electro-fishing and block-shocking sampling was conducted for 459 seconds of electro-shocking time.

Table 37. May 09 Site 3: Little Buffalo Creek Old Rt. 22: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Centrarchus macropterus	flier	Rare
Lepomis gulosus	warmouth	Common
Lepomis macrochirus	bluegill	Rare

6.1.13 May 11

Site 1 Long Branch (Shoeheel Road SR 2127):

An approximately 200 meter (656 feet) reach of Long Branch in the vicinity of Shoeheel Road was surveyed using electro-fishing and block-shocking to a seine net for 437 seconds of electro-shocking time.

Table 38. May 11 Site 1: Long Branch at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus platycephalus	flat bullhead	Rare
Aphredoderus sayanus	pirate perch	Uncommon
Centrarchus macropterus	flier	Rare
Cyprinella analostanus	satinfin shiner	Abundant
Enneacanthus gloriosus	bluespotted sunfish	Rare
Esox americanus	redfin pickerel	Abundant
Etheostoma olmstedi	tessellated darter	Rare
Gambusia holbrookii	Eastern mosquitofish	Abundant
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Rare
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Rare
Lepomis microlophus	redear sunfish	Rare
Luxilus albeolus	white shiner	Common
Notropis procne	swallowtail shiner	Very Abundant

Site 2 Little River Tailrace of Atkins Mill Dam (above NC 42):

Approximately 1.5 hours (0.5 hrs x 3) spent casting shad darts and rooster tails in the spillway of the Atkins Mill Dam yielded three largemouth bass as well as one gizzard shad that was hooked, but not landed. The Little River was sampled below Atkins Mill

Dam in an approximately 100 meter (328 feet) reach. Electro-fishing and block-shocking sampling to a seine net was conducted for 1,353 seconds of electro-shocking time. Several dip-net sweeps were also conducted along the banks and at the base of the dam. Although not captured, one American shad was observed swimming away from the electric field at the base of the dam.

Table 39. May 11 Site 2: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus natalis	yellow bullhead	Rare
Anguilla rostrata	American eel	Common
Cyprinella analostanus	satinfin shiner	Uncommon
Dorosoma cepedianum	gizzard shad	Abundant
Etheostoma olmstedi	tessellated darter	Uncommon
Lepomis macrochirus	Bluegill	Uncommon
Lepomis microlophus	redear sunfish	Uncommon
Luxilus albeolus	white shiner	Rare
Micropterus salmoides	largemouth bass	Rare
Nocomis raneyi	bull chub	Rare
Notropis amoenus	comely shiner	Rare
Percina nevisense	Chainback darter	Common
Scartomyzon cervinum	black jumprock	Rare

Site 3 Buffalo Creek (Lake Wendell Road SR 1716):

Buffalo Creek was sampled below the Lake Wendell dam in an approximately 200 meter (656 feet) reach in the vicinity of Lake Wendell Road using electro-fishing for 1,318 seconds of electro-shocking time.

Table 40. May 11 Site 3: Buffalo Creek at Lake Wendell Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Erimyzon oblongus	creek chubsucker	Rare
Etheostoma nigrum	Johnny darter	Rare
Etheostoma olmstedi	tessellated darter	Rare
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Rare
Lepomis gulosus	Warmouth	Rare
Lepomis macrochirus	Bluegill	Very Abundant
Lepomis microlophus	redear sunfish	Common
Notemigonus crysoleucas	golden shiner	Common
Micropterus salmoides	largemouth bass	Common
Pomoxis nigromaculatus	black crappie	Rare

Site 4 Buffalo Creek above NC 42:

Buffalo Creek was sampled in an approximately 200 meter (656 feet) reach above the NC 42 crossing using electro-fishing for 1,218 seconds of electro-shocking time. Fish were generally rare in this reach.

Table 41. May 11 Site 3: Buffalo Creek at Lake Wendell Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Erimyzon oblongus	creek chubsucker	Rare
Esox americanus	redfin pickerel	Common
Lepomis macrochirus	Bluegill	Uncommon
Umbrea pygmaea	Eastern mudminnow	Rare

6.2 Results Creel Surveys

A total of 32 creel survey questionnaires were posted at various businesses in the Little River watershed or given to fishermen when encountered. Although several people expressed interest in participating in the survey, to date, no questionnaires have been returned.

7.0 ANADROMOUS SPECIES SURVEY DISCUSSION/CONCLUSIONS

Despite extreme low flow conditions throughout this sampling effort, the anadromous surveys demonstrated that the removal of the Lowell Dam eliminated the impediment for upstream spawning runs of the American shad. The late arrival and apparent low numbers are presumed to be attributed to the extreme low flow conditions rather than any residual effect of the dam. However, more robust data is needed to draw any definitive conclusions regarding the magnitude of spawning runs.

Anadromous species surveys should resume in subsequent years during the 5-year monitoring plan, to obtain a better understanding of the magnitude of the newly restored spawning runs of American shad, as well as to determine if other anadromous species are utilizing the newly restored river reaches.

These surveys also demonstrated how seasonality effects species composition and apparent relative abundances at a particular site. Comparisons of the pre-removal and Year-1 fish community monitoring surveys conducted in summer months with the anadromous species surveys conducted in late winter to early spring, demonstrate that species such as redear sunfish, black jumprock, notchedlip redhorse and V-lip redhorse were found at more sites and generally in greater numbers during winter/spring surveys than during summer surveys. Conversely the glassy darter was more likely to be encountered during the summer months.

A total of forty two fish species were captured in the Little River during the pre-removal surveys conducted in 2005 (Lowell Pre-removal Survey report). It was stated that a more comprehensive survey effort utilizing multiple survey methodologies conducted at various times throughout the year was needed, particularly in the deeper habitats, to obtain a complete list of all fish species occurring in the Little River watershed. As anticipated, the results of the Anadromous species surveys and the Year-1 Fish Community Monitoring resulted in collection of eleven additional fish species, bringing the total to fifty-three species.

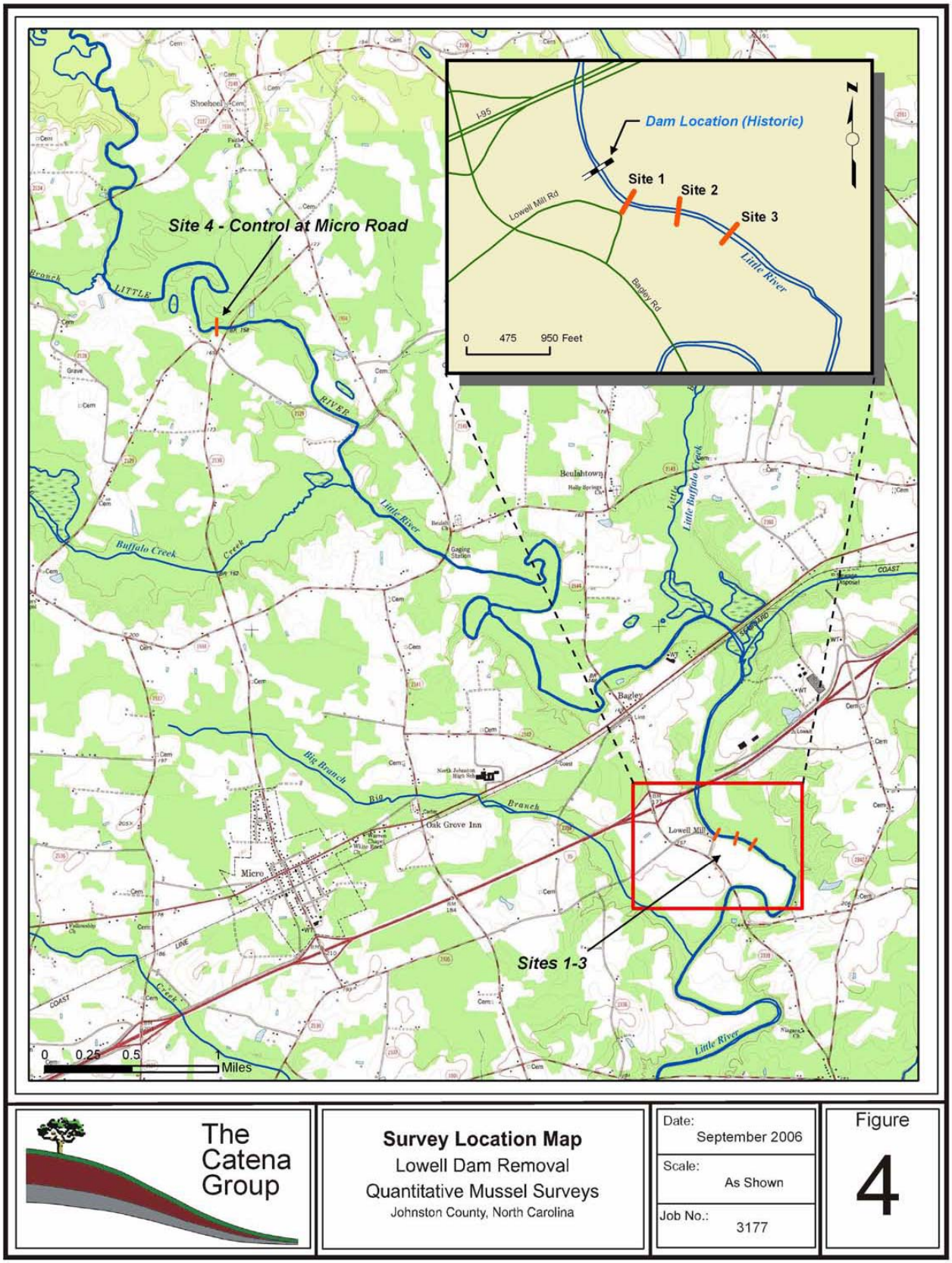
8.0 QUANTITATIVE MUSSEL SURVEY EFFORTS

Based on the results of the freshwater mussel component of the pre-removal surveys conducted in 2005 (Lowell Pre-removal surveys report), it was apparent that high densities of freshwater mussels occurred in the Little River immediately below the dam. These densities (based on Catch per unit effort) were higher than any other location sampled throughout the Little River.

8.1 Quantitative Mussel Surveys Methodology

Freshwater mussels were quantitatively sampled in the Little River at varying intervals (approximately 30, 200 and 400 meters) below the Lowell dam, as well as at an upstream control site (Micro Road/SR 2130) on December 28, 2005, and January 09, 2006, prior to dam removal (Figure 4). Transects were established at each location across the river. The river width is approximately 16 meters (52 feet) at the 400 meter transect, 18 meters (59 feet) at the 200 meter transect, 20 meters (65 feet) at the 30 meter transect and 10 meters (33 feet) at the upstream control site. Each transect of the river was divided into 16, 18, 20 and 10 (depending on the exact width of each transect) 1-m^2 quadrates respectively. The location of each transect was marked by driving rebar stakes into both banks (to serve as a semi-permanent marker) and recorded using a GPS unit with sub-meter accuracy. Transect sampling was employed to allow analysis of near shore and mid–channel habitats of the river.

Quadrates in the four study transects were surveyed for freshwater mussels using SCUBA at the three transects below the dam and wading with bathyscopes (glass-bottom view buckets) at the upstream control site. One out of every six quadrates in each study transect was randomly selected (roll of dice) to serve as controls for handling effects in winter months and were not sampled. Each mussel found in each quadrate was identified, measured (total length), and tagged before being returned to their respective quadrates. The tags (Hallprint Tags) are made of polyethylene, oval in shape, and approximately 9 mm long by 4 mm wide. Each tag is colored (e.g., green) and also has a unique 4-character code, which begins with a letter followed by 3 numbers. The tags were applied to the mussels using Instant Krazy Glue©, or another quick dry epoxy. A portable 1-m^2 quadrate constructed from 5-cm schedule 40 polyvinyl chloride (PVC) positioned along a rope stretched across the river was used to delineate each quadrate sampled.



The Catena Group	**Survey Location Map** Lowell Dam Removal Quantitative Mussel Surveys Johnston County, North Carolina	Date: September 2006 Scale: As Shown Job No.: 3177	Figure 4

The four study transects were resurveyed approximately three months after dam removal on March 9 and 10, 2006. The 3-month monitoring was conducted to assess initial mortality resulting from dam removal and to detect movement of mussels within and outside of the study transects. Survey methodology during the 3-month monitoring followed the methods used for the pre-removal surveys, however water depths had decreased at the 30 meter and 200 meter downstream transects to a level that wading with bathyscopes replaced SCUBA as the primary sampling method used. Every quadrate (including the random controls) was sampled during the 3-month monitoring. The river was also sampled for a distance of 10 meters (33 feet) upstream and downstream of the transect locations to detect movement of mussels. Recaptured (recovered) tagged mussels were recorded and returned to their respective quadrates. Untagged (immigrated) mussels which were captured during the 3-month monitoring were measured, assigned a tag, and returned to their respective quadrates as before. Mortality was assessed by the number of dead tagged shells found. Recapture of individual mussels two meters (quadrates) or greater in any direction from their original quadrate was considered movement. Mussels recovered in quadrates adjacent to their original ones were not considered to have moved, since exact location of replacement within a respective quadrate was not recorded during the initial sampling.

9.0 QUANTITATIVE MUSSEL SURVEY RESULTS

A total of 605 freshwater mussels were tagged in four study transects prior to dam removal. The eastern elliptio (*Elliptio complanata*) accounted for 98% (591) of the mussels found. Six other species comprised the remaining 2% (14) of tagged mussels. Recovery of tagged live mussels during the 3-month monitoring was highest at the upstream Control Site and the 400 meter Site (84% and 80 % respectively) and lowest at the 30 meter and 200 meter sites (45% and 59% respectively). Observed mortality of tagged mussels was 1% at the 200 Meter Transect and 0.2% at the 400 meters transect. No mortality of tagged mussels was observed at the 30 meter transect, or the upstream control transect. This data is displayed in Table 43.

Table 42. Quantitative Mussel Study 3-Month Monitoring Results

Transect	Tagged mussels pre-removal	Recovered tagged mussels	Dead tagged mussels	% of Recovered mussels showing movement
30 meter	31	14 (45.2%)	0	71.4% (10)
200 meter	96	56 (59.4%)	1 (1%)	42.1% (24)
400 meter	439	352 (80.4%)	1 (0.2%)	1.7% (6)
Upstream	38	32 (84.2%)	0	6.2% (2)

10.0 QUANTITATIVE MUSSEL SURVEY DISCUSSION/CONLUSIONS

Significant freshwater mussel mortality attributed to dam removal was not evident during the 3-month quantitative mussel survey monitoring. However, mark/recapture recovery rates of the tagged mussels decrease dramatically with increased proximity to the former dam site.

Habitat observations following dam removal identified a wedge of sediment gradually migrating downstream from the dam site, covering the substrate of the river. The low recovery rates at the 30 meter and 200 meter transects are likely attributable to this wedge of sediment. The sediment wedge had not progressed to the 400 meter transect at the time of the 3-month monitoring, however, it has done so since that time (personal observations). As mentioned above, due to water depths, SCUBA was needed to sample all transects below the dam prior to removal, but was only required at the 400 meter transect during the 3-month monitoring, because the 30 meter and 200 meter transects had been filled with sediment. This sedimentation of substrate in the transects can affect mark/recapture rates in two ways: 1) mussels become buried by the sediment and are not recovered during resurvey efforts and likely die from the effects of burial, or 2) mussels exhibit a behavioral response to the sediment and attempt to move away from the disturbance (sediment). Horizontal (across the substrate) movements of mussels are often haphazard in direction, and occur in response to habitat disturbance. These movements are often visible as "crawls" or trails made in the substrate. Numerous mussel crawls were evident in the migrating sediment wedge below the former dam site. In addition to having the lowest recapture (recovery) rates, the 30 meter and 200 meter transects also had the highest percentage of recaptured mussels exhibiting movement (71.4% and 42.1% respectively) compared to relatively little movement of recaptured mussels in the 400 meter and upstream control transects (1.7% and 6.2% respectively). Lower recapture rates and higher movement rates would be expected in future monitoring of the 400 meter transect since encroachment of the sediment wedge has taken place in this stretch of the river since the 3-month monitoring was completed.

Three months appears to not have been a long enough for dam removal related mortality to become evident. However, it is apparent that post-removal sedimentation has adversely affected mussel populations downstream of the former dam. Further monitoring of the study transects is needed to: 1) determine the extent of the initial sedimentation–related mortality, and 2) to assess changes in population density and recovery over time.

It is recommended that the study transects be re-surveyed in the late winter/early spring of 2007 (1-year following removal) to document the extent of project related mortality, and again at Year-5 post removal to document changes in population density and possible recovery.

11.0 LITERATURE CITED

NCDENR 2001. Standard Operating Procedures Biological Monitoring Stream Fish Community Assessment and Fish Tissue. Available online at http://www.esb.enr.state.nc.us/BAUwww/IBI%20Methods%202001.pdf

APPENDIX A. NCIBI SCORE SHEETS FOR EACH SITE SAMPLED YEAR-1 FISH COMMUNITY MONITORING

Table 1. NCIBI Score Site 1 (CX-1)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	23	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	220	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	5	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	6	5
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	1	3
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	2	3
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	21%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	0%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	97%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	3%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	0.45%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	56%	5
NCIBI Score		46 (Good)

Table 2. NCIBI Score Site 2 (CX-3)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	27	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	252	5
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	24%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	3%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	89%	5
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	8%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	52%	5
NCIBI Score		54 (Excellent)

Table 3. NCIBI Score Site 3 (CX- 4)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	13	3
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	204	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	0	1
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	2	3
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	48%	3
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	0%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	91%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	9%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	85%	5
NCIBI Score		38 (Fair)

Table 4. NCIBI Score Site 4 (CX- 7)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	18	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	158	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	1	3
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	27%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	1%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	94%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	5%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	56%	5
NCIBI Score		46 (Good)

Table 5. NCIBI Score Site 5 (CX-10)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	19	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	167	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	0	1
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	24%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	<1%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	96%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	4%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	61%	5
NCIBI Score		44 (Good-Fair)

Table 6. NCIBI Score Site 7(CX-16)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	21	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	253	5
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	5	5
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	1	3
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	23%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	<1%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	96%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	4%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	38%	3
NCIBI Score		48 (Good)

APPENDIX B. CREEL SURVEY QUESTIONAIRRE

Dear Fisherman:

We are conducting a survey to gather information regarding fishing activity in the Little River and it tributaries (Little River, Buffalo Creek, Little Buffalo Creek, and Long Branch). We are particularly interested in the shad, river herring, and striped bass runs now that Lowell Dam has been removed. We would appreciate it if you would take a few minutes to complete the following survey (see back of this sheet) and return it to the location you received it. Please fill out a separate survey for each day of fishing. If you would like to be included in the report that will be created with this information, please include your name at the bottom of the form. If you have any questions or comments please contact Tim Savidge at (919) 417-2314.

Thank you for your participation.

FISHING SURVEY

DATE (Month/Day): _____

START OF FISHING (Time): _____am/pm END OF FISHING (Time): _____am/pm

TOTAL TIME FISHING: HRS _____ MIN_____

WHERE DID YOU FISH? (Provide location, nearest road crossing, boat landing, etc)

Little River_____

Buffalo Creek_____

Little Buffalo Creek_____

Long Branch_____

SPECIES FISHED FOR:

American Shad _____ (number caught)

Hickory Shad _____ (number caught)

River Herring _____ (number caught)

Striped Bass _____ (number caught)

Other _____ (type and number caught)

FISHING METHOD:

Stillfishing_____ Spinfishing_____ Flyfishing_____

BAIT TYPE:

Artificial Lures/Flies_____ Live Bait (type) _____

LOCATION:

On Bank_____ Wading_____ In Boat_____

WOULD YOU LIKE TO BE IDENTIFIED IN THE ENVIRONMENTAL DOCUMENT AS A

PARTICIPANT OF THIS SURVEY? NO _____ YES _____

IF YES, PLEASE INCLUDE NAME HERE: _____