MITIGATION PLAN

FULL DELIVERY PROJECT TO PROVIDE STREAM RESTORATION
CAPE FEAR RIVER BASIN CATALOGING UNIT-03030003

CARBONTON DAM – DEEP RIVER WATERSHED
RESTORATION SITE

PREPARED FOR:

ECOSYSTEM ENHANCEMENT PROGRAM
RALEIGH, NORTH CAROLINA

JUNE 2006

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JUNE 2006

EXECUTIVE SUMMARY

INTRODUCTION

In order to provide stream channel restoration in the Cape Fear River Basin (Hydrologic Unit 03030003), Restoration Systems, LLC (RS) has removed Carbonton Dam located at the juncture of Chatham, Lee, and Moore Counties, North Carolina (Figure 1, Appendix A). The Carbonton Dam was identified and recommended for removal by the North Carolina Dam Removal Task Force (DRTF), a coalition of federal and state government agencies. The DRTF recommends large-scale dam removal as an appropriate and desirable form of compensatory stream mitigation. This dam removal 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), U.S. Fish and Wildlife Service (FWS), Environmental Protection Agency (EPA), N.C. Division of Water Quality (NCDWQ), and the N.C. Wildlife Resource Commission (NCWRC).

The former Carbonton Dam was located on the Deep River approximately 9 miles west of Sanford, North Carolina. The Deep River is a 4th-order river with a watershed upstream of the former dam location of approximately 1,000 square miles.

The on-site construction activities have freed approximately 126,673 linear feet of the Deep River and associated tributaries from the impounding effects of the dam. As a result of previously impeded streamflow within these reaches, water quality, aquatic communities, and rare and endangered species habitat were adversely impacted. Impacts to water quality within the former Site Impoundment included low dissolved oxygen concentrations, high temperatures, and increased sedimentation. The degraded water quality that has been documented within the Site Impoundment and attributed to the impounding effects of the dam prompted NCDWQ to list portions of the Deep River within the former Site Impoundment on the Year 2006 303(d) list of impaired water bodies. The aquatic communities within the former Site Impoundment were representative of an impounded, lentic condition rather than a natural free-flowing river system. Rare and endangered mussel and fish habitat was extirpated or greatly diminished within formerly impounded areas.

Many ecological and water quality benefits are anticipated as a result of the dam removal. The reintroduction of the characteristic river flow conditions 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 characteristic of unimpeded, lotic conditions. Rare and endangered species habitat is expected to expand and improve within previously impounded areas.

DAM REMOVAL

The Carbonton Dam was removed in a manner that minimized potential impacts to water resources both upstream and downstream of the dam. Gradual dewatering and phased sediment management were undertaken to avoid introducing anoxic water and nutrient-rich sediments into the receiving Deep River reaches downstream. Following removal, the dam site was stabilized with coir fiber matting, live-staked, and hydro-seeded to prevent bank erosion.

Numerous construction practices were undertaken to avoid impacts to aquatic species in the vicinity of the dam site throughout the removal process. Coffer dams were installed adjacent to equipment access points along the channel to avoid sediment erosion into the water column. Oil adsorption booms were installed downstream of active construction areas to prevent machine oil from washing further downstream. Fortunately, no hydraulic line breaks occurred during equipment operation in the river.

MITIGATION GOALS

The desired result of this project is ecological improvement within the former Site Impoundment through restoration of a natural, lotic flow conditions.

The specific goals of this project include:

- Restoration of approximately 126,673 linear feet inundated river and stream channels to natural free-flowing conditions.
- Restoration of previously inundated shallow water habitat for the Cape Fear shiner (*Notropis mekistocholas*), a federally endangered species of freshwater fish.
- Reduction or prevention of stratified water temperature profiles typical of deepwater habitats and seasonal declines in dissolved oxygen concentrations below levels measured in reference reaches.
- Restoration of appropriate in-stream substrate.
- Restoration of upstream and downstream fish passage, and reconnection of currently disjunct populations of rare aquatic species of concern.
- Restoration of lotic mussel habitat.
- Improvement in the diversity and water quality tolerance metrics for benthic macroinvertebrate communities.
- Provide compatible legal and public recreational opportunities at the site of the former dam.
- Provide academic grade data and/or peer-reviewed publications regarding the ecological consequences of large dam removal.

The removal of the Carbonton Dam is a large-scale compensatory mitigation project consistent with state and national regulatory support for environmentally beneficial dam removal. North Carolina is a leader in removing dams to improve watersheds and the environment. 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. The USACE and N.C. Division of Water Resources are planning to remove the Eno River Dam as an environmental restoration Section 206 project. Additionally, the North Carolina Clean Water Trust Fund has partnered with Piedmont Triad Water Authority to remove the Cedar Falls Dam upstream of this project on the Deep River. RS successfully removed the Lowell Mill dam in early 2006 on the Little River in Johnston County, North Carolina as part of a full delivery restoration project sponsored by the N.C. Ecosystem Enhancement Program (NCEEP).

MONITORING PLAN

The project will be monitored for five years following dam removal. Primary success criteria of the project include improvements in: 1) rare and endangered aquatic species, 2) water quality, and 3) the aquatic community (**Table 1**). Reserve success criteria include: 1) downstream benefits below the dam, and 2) 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. Cross-sectional surveys, channel substrate analyses, and habitat assessment will be performed at each station to verify improvements in aquatic habitat. Sampling sites for aquatic species (benthic macroinvertebrates, fish, mussels, and snails) have also been established within the former Site Impoundment and in reference areas to catalogue changes in the aquatic community. NCDWQ Ambient Monitoring Station (AMS) data will be collected to demonstrate improvements in water quality. Annual Monitoring Reports summarizing project monitoring data will be submitted to EEP each monitoring year for review.

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

Primary Success Criteria	**Channel Restored (feet)**	**Mitigation Ratio**	**SMU**
1) Rare and Endangered Aquatic Species 2) Water Quality, 3) Improved Aquatic Community	126,673 feet of free-flowing river and tributaries **under the crest pool**	0.7:1	88,671
Reserve Success Criteria	**Channel Restored (feet)**	**Mitigation Ratio**	**SMU**
Downstream Benefits Below the Dam	~ 500 feet below dam	0.7:1	350
Human Values 1) Scientific value 2) Human recreation	-----	Up to 20 percent bonus	Up to 25,335
Total Potential SMUs			114,356
Total Commited SMUs			**90,494**

[1] Primary success criteria will be monitored to verify and confirm positive changes to functional criteria 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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Re-established riffles within the former Carbonton Dam Impoundment
Source: EcoScience Corporation 2005 and 2006

MITIGATION REPORT

FULL DELIVERY PROJECT TO PROVIDE STREAM RESTORATION
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CARBONTON DAM - DEEP RIVER WATERSHED
RESTORATION SITE

1.0 INTRODUCTION

In order to provide compensatory stream mitigation credits in the Cape Fear River Basin (Hydrologic Unit 03030003), Restoration Systems, LLC (RS) has removed Carbonton Dam located at the juncture of Chatham, Lee, and Moore Counties, North Carolina (**Figure 1, Appendix A**). To successfully accomplish the goals of the project, RS enlisted the services of several firms, which have provided scientific and engineering expertise in support of their effort. 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 (Appendix B). The Carbonton Dam was designated as the second-highest priority privately owned dam for removal in North Carolina. The dam removal 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 (EPA), N.C. Division of Water Quality (NCDWQ), and the N.C. Wildlife Resource Commission (NCWRC).

1.1 PROJECT LOCATION

The former Carbonton Dam was located on the Deep River approximately 9 miles west of Sanford, North Carolina (**Figures 1 and 2, Appendix A**). The Deep River is a 4th-order river with a watershed upstream of the former dam location of approximately 1,000 square miles. For the purposes of this document, the 5.5-acre land parcel that supports the dam will be hereafter referred to as the “Site.” All proposed construction activities mentioned in this report occurred on-Site, unless specifically mentioned otherwise.

The on-Site construction activities freed approximately 126,673 linear feet of the Deep River and associated tributaries from the impounding impact of the dam. These benefited stream reaches will be hereafter referred to as the “Site Impoundment.” The limits of the Site Impoundment have been identified as any stream reach of the Deep River or associated tributaries located above the Carbonton Dam with a thalweg elevation less than 227.6 feet above mean sea level (MSL)

1.2 PRE-EXISTING CONDITIONS

1.2.1 Watershed Characteristics

The former Carbonton Dam and its associated river and streams are located within the Piedmont physiographic region and the Triassic Basin ecoregion of North Carolina. This ecoregion is characterized by irregular plains with low rounded hills and contains less relief and wider valleys than other areas of the Piedmont. Soils contain more clay than is typical in neighboring ecoregions due to the Lower Mesozoic sedimentary parent material that consists of unmetamorphosed shale, sandstone, mudstone, siltstone and conglomerates (Horton and Zullo 1991). The clay has a high shrink-swell capacity (Griffith *et al*. 2002). Because of the unusual geology and minor relief, streams in this ecoregion are characterized by low base flows.

The Deep River originates in the southeast corner of Forsyth County and the southwest corner of Guilford County and flows southeast through Randolph County before flowing into Moore County. Urban development is high in the headwaters of the Deep River near the communities of the Triad (Greensboro, Winston Salem, and High Point), but generally decreases along the length of the river as it flows towards the former Carbonton Dam.

The former Site Impoundment is part of Cape Fear local subbasin 03-06-10 (NCDWQ 2005). Land use within the subbasin is characterized by mature upland forest and pine plantations (71 percent), agriculture (17 percent), early successional forest (4 percent), and bottomland forest (4 percent). Elevations adjacent to the former Site Impoundment range from a low of approximately 228 feet National Geodetic Vertical Datum (NGVD) at the crest of the former dam to a high of 392 feet NGVD at the top of a ridge on the north side of the river near the upper limits of the former Site Impoundment.

1.2.2 Dam and Impoundment

The dam was a concrete masonry structure built early in 1921. The Site Impoundment formerly covered approximately 116 acres with water depths up to 25 feet and bank-to-bank pond widths from 150 to 260 feet. The project facilities included: 1) 16-foot high by 260-foot long buttressed concrete spillway, which included a concrete ogee spillway on the northern bank; 2) powerhouse including two 500 megawatts (MW) turbine/generator units; and 3) overhead transmission lines 200 yards in length. The designed purpose of the dam was to supply local communities with power for domestic and industrial purposes. The power generated from the Site was interconnected with the Little River plant and provided electric power to the towns of Liberty, Cumnock, and Siler City. Carolina Power and Light (CP&L) acquired the plant in 1927. The Federal Energy Regulatory Commission (FERC) issued a license for the construction FERC Project Number 3155 in 1982. The Project license was subsequently transferred to the Cox Lake Carbonton Associates. Personal communication with Mr. Mike Allen, the most recent owner and operator of the dam, suggests that the intended method of operating the dam was to fill the pool, then fully open the turbine gates and peak the power generation capacity of the plant until the Site Impoundment was drained. The gates would then be closed, and the Site Impoundment would be allowed to refill. Once full, the process began yet again. This mode of operation severely disrupted the river ecosystem. Rapidly changing river levels would have resulted in substantial stress to aquatic communities, while subjecting the downstream channel to incision and bank erosion. These stresses were exacerbated during the summer when the river naturally has low flow, higher temperatures, and low dissolved oxygen. At the time of its removal, the dam was still capable of operating in this manner, but was prevented from doing so by regulations that restrict the operation of the hydroelectric facility today. Before ceasing operation, the dam was restricted to engaging the turbines only when the river stage was sufficient to power the turbines without draining the impoundment. These restrictions were the result of both energy-related and environmentally based regulations.

The former Site Impoundment occurred within the channel of the Deep River, which is characterized by steep banks with occasional areas of bank failure in locations where mature trees have been toppled by storms or flood flows. The majority of the banks were forested with riparian vegetation typical of the region, such as box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), and sycamore (*Platanus occidentalis*). The lentic flow that characterized the Site Impoundment resulted in a stratified water column, where velocities were low near the surface, and stagnant at depths below the crest of dam elevation. Water depths persisted up to 25 feet, and water clarity ranged from 1 to 5 feet. The water quality varied seasonally, with low dissolved oxygen, elevated fecal coliform levels, stratified temperatures, and high chlorophyll-*a* levels resulting in habitat impairment within the Site Impoundment occurring during the summer due to warmer temperatures and lower river base flow. Using the classification system described by Cowardin *et al*. (1979), the former Site Impoundment was classified as a lacustrine, limnetic water body with an unconsolidated bottom characterized by mud outside of the relict channel (L1UB3), but characterized by gravel and sand within the thalweg (L1UB1/2).

The upstream limits of the impounding effect of the former Carbonton Dam were located in the field in 2005 in support of the generation of the Restoration Plan (Restoration Systems 2005). The former Site Impoundment limits were identified through interpolation of remote sensing data generated specifically for this project by GeoData Corporation. The GeoData mapping products (hi-resolution mapping) were commissioned by RS, and consist of hi-resolution color-infrared stereoscopic aerial photography (dated January 2005) and 2-foot interval hypsographic contours 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, channel bed elevations were tied into the hi-resolution mapping using Trimble Geo-XT sub-meter Global Positioning System (GPS) coordinates, and the upstream limits of waters affected by the former dam were determined. The upper limits of selected waters were visited, field-verified, and photographed to verify the method of determining the limits of the impoundment described above, and applied to all affected reaches.

1.2.3 Deep River Below Carbonton Dam

Multiple transits of the Deep River below the former dam occurred in 2005 during pre-removal monitoring activities. These investigations provided an evaluation of the reference condition of the Deep River with lotic flow. The reference reach was evaluated from the Site, downstream to the crossing of Rosser Road, north of US 421. The channel below the former dam has steep banks that are well vegetated with riparian vegetation similar to the communities adjacent to the former Site Impoundment. Flow ranges from sluggish in the summer months to velocities that exceed 5 feet/second in riffle areas during higher flows. The lotic river ranges from approximately 120 to 160 feet in width, with water depths up to approximately 5 feet. During baseflow, water clarity typically extends to the bed depth except in deeper pool areas. The substrate consists of boulders, cobble, gravel, and sand with the particle distribution skewed towards coarser materials in riffles and finer substrate in pools. Using the classification system described by Cowardin *et al.* (1979), the Deep River below the former dam is best classified as a lower perennial, riverine system with a stream bed of cobble and gravel and sand (R2SB3/4).

1.2.4 Water Resources

1.2.4.1 Best Usage Classification

North Carolina streams have been assigned a best usage classification by the NCDWQ, which reflects water quality conditions and potential resource usage. Unnamed tributaries receive the same classification as the named streams into which they flow. The upper reaches of the former Site Impoundment of the Deep River are currently classified as **WS-V HQW** before reaching the confluence with Big Governor's Creek. Downstream of the confluence with Big Governor's Creek, the Deep River changes to **WS-IV**. A classification of **WS-V** indicates waters protected as water supply sources, which are generally upstream of and draining to **WS-IV** waters. **WS-V** has no categorical restrictions on watershed development or wastewater discharges. The supplementary classification **HQW** identifies waters for protection that maintain quality higher than state water quality standards. A classification of **WS-IV** indicates waters used as water supply sources for drinking, culinary or food processing purposes for those users where a **WS-I**, **-II**, or **-III** classification is not feasible. **WS-IV** waters are generally located in moderately to highly developed watersheds or protected areas. Big Governor's Creek, McLendon's Creek, and Lick Creek are all classified as **C**. A classification of **C** indicates waters that are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. All other tributaries associated with the former Site Impoundment assume the best usage classification of the nearest classified, downstream water.

1.2.4.2 Water Quality

Water quality parameters within the former Site Impoundment have been measured at regular intervals by the Upper Cape Fear River Basin Association (UCFRBA) and by NCDWQ at an Ambient Monitoring Station (AMS) located near N.C. Highway 42 (NC42) at the Carbonton Dam. Water quality parameters that are monitored include temperature, specific conductivity, dissolved oxygen, pH, fecal coliform, chlorophyll-*a*, turbidity, and total suspended solids (TSS). According to these data, fecal coliform and dissolved oxygen periodically attain levels that are detrimental to native aquatic communities. The most recent NCDWQ AMS data indicate that the former Site Impoundment and associated main tributaries are support-threatened or not-supporting their intended uses, and were proposed for listing on the NC 2006 Section 303(d) list.

1.3 RESTORATION SUMMARY

1.3.1 Mitigation Goals

The desired result of this project is ecological improvement within the former Site Impoundment through restoration of natural, lotic flow conditions. The ecological improvement will be evaluated through sampling that will examine the former Site Impoundment for measurable benefits in aquatic fauna diversity or tolerance, improved water quality, and the re-development of habitat and possible habitation by federally protected species. Several criteria will be evaluated to demonstrate the reestablishment of conditions representative of a lotic environment, including flow conditions, water chemistry, and aquatic community changes. These criteria will be monitored in order to demonstrate the achievement of certain goals of the project.

The specific goals of this project include:

- Restoration of approximately 126,673 linear feet inundated river and stream channels to natural free flowing conditions.
- Restoration of previously inundated shallow water habitat for the Cape Fear shiner (*Notropis mekistocholas*), a federally endangered species of freshwater fish.
- Reduction or prevention of stratified water temperature profiles typical of lentic, deepwater habitats and seasonal declines in water dissolved oxygen levels below levels measured in reference reaches.
- Restoration of appropriate in-stream substrate.
- Restoration of upstream and downstream fish passage, and reconnection of currently disjunct populations of rare aquatic species of concern.
- Restoration of lotic mussel habitat.
- Improvement in the diversity and water quality tolerance metrics for benthic macro-invertebrate communities.
- Provide compatible legal and public recreational opportunities at the Site of the former dam.
- Provide academic grade data and/or peer-reviewed publications regarding the ecological consequences of large dam removal.

The removal of the Carbonton Dam is a large-scale compensatory mitigation project consistent with state and national regulatory support for environmentally beneficial dam removal. North Carolina is a leader in removing dams to improve watersheds and the environment. The Quaker Neck and Cherry Hospital dams were removed in 1998, and the Rains Mill dam was removed in 1999. The Quaker Neck dam removal project received the 2001 Governors Conservationist of the Year award and was publicized nationwide for its environmental benefits. The USACE and N.C. Division of Water Resources are planning to remove the Eno River Dam as an environmental restoration Section 206 project. Additionally, the North Carolina Clean Water Trust Fund has partnered with Piedmont Triad Water Authority to remove the Cedar Falls Dam upstream of this project on the Deep River. RS successfully removed the Lowell Mill dam in early 2006 on the Little River in Johnston County, North Carolina as part of a full delivery restoration project sponsored by the N.C. Ecosystem Enhancement Program (NCEEP).

The demolition of the Carbonton Dam is expected to generate at least 90,494 Stream Mitigation Units (SMUs) for use by NCEEP. The majority of the credits by this project will be generated by evaluating the ecological benefits that occur in the Deep River over the five-year monitoring period post-removal. Bonus factors include downstream benefits and human values such as recreation and scientific research. **Table 1** displays the amount of SMU credits that are proposed associated with this project. The primary success criteria are being monitored in accordance with the DRTF guidance (Appendix B). The mitigation ratios have also been derived from the DRTF guidance. The amount of channel restored was determined through methods described in Section 1.1.2 and the Restoration Plan (Restoration Systems 2005). The number of SMUs were determined by multiplying the amount of channel impacted by the mitigation ratios. While up to 114,356 SMUs may potentially be created in accordance with the DRTF guidance, the project will only be evaluated for the amount of credit that is committed to NCEEP. Any reserve credit may be used to offset any potential loss of credits from other aspects of the project.

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

Primary Success Criteria	**Channel Restored (feet)**	**Mitigation Ratio**	**SMU**
1) Rare and Endangered Aquatic Species 2) Water Quality, 3) Improved Aquatic Community	126,673 feet of free-flowing river and tributaries **under the crest pool**	0.7:1	88,671
Reserve Success Criteria	**Channel Restored (feet)**	**Mitigation Ratio**	**SMU**
Downstream Benefits Below the Dam	~ 500 feet below dam	0.7:1	350
Human Values 3) Scientific value 4) Human recreation	-----	Up to 20 percent bonus	Up to 25,335
Total Potential SMUs			114,356
Total Commited SMUs			**90,494**

[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.

2.0 DAM REMOVAL

With the exception of Sections 2.1 ("Pre-Removal Aquatic Species Surveys") and 2.6 ("Impacts to Water Resources"), information for this section was provided by MMI and incorporated into the document by ESC. MMI was responsible for construction plan development, including phased dewatering and construction activities, for the Carbonton Dam removal. ESC has written sections 2.1 and 2.5 with supporting information received from the TCG and BE.

2.1 PRE-REMOVAL SURVEYS

Dewatering management strategies were developed from pre-dewatering dissolved oxygen measurements, impounded sediment toxicity analyses, and precautionary federally protected species surveys below the dam, all of which were performed in October 2005.

2.1.1 Precautionary Federally Protected Aquatic Species Surveys

Precautionary aquatic surveys for federally protected species were performed at the Site by TCG. Surveys were performed to catalog protected species within the immediate construction footprint of the dam removal effort, 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 are outlined in Sections 3.2.5,. Table 2 displays aquatic species surveyed during pre-removal monitoring activities at the Site.

This sampling was performed within the tailrace directly below the Carbonton dam. The area consists primarily of bedrock adjacent to the dam and shallow gravel shoals and bars, with sparse patches of water willow present. The site was seined for fish, but due to high water velocity, mussel surveys were not able to be conducted. Seine hauls were conducted up to the dam over the bedrock areas. This site contained several lotic-adapted shiner species, including eight Cape Fear shiner. These individuals were captured along a sand bar in moderate current.

Table 2: Aquatic Species Found at the Tailrace of the Carbonton Dam

Scientific Name	Common Name	Abundance/CPUE
Freshwater Snails and Clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	common
Freshwater Fish	~	**Relative Abundance**
Cyprinella analostana	satinfin shiner	uncommon
Cyprinella nivea	whitefin shiner	uncommon
Dorosoma cepedianum	gizzard shad	uncommon
Nocomis leptocephalus	bluehead chub	uncommon
Notropis alborus	whitemouth shiner	common
Notropis altipinnis	highfin shiner	common
Notropis amoenus	comely shiner	rare
Notropis hudsonius	spottail shiner	uncommon
Notropis mekistocholas	Cape Fear shiner	common (8)
Notropis procne	swallowtail shiner	abundant
Notropis scepticus	sandbar shiner	common
Notemigonus crysoleucas	golden shiner	common

An informal Section 7 consultation was conducted with the FWS. The FWS concluded that project implementation as designed, along with strict adherence to BMPs would satisfactorily minimize the risk of take to the Cape Fear shiner.

Several measures were taken during dam removal 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 rare and protected species will be substantially enhanced as a result of the dam removal at the Site, and that these species will be free to colonize the upstream Deep River and contributing tributary reaches previously impeded by the dam.

2.1.2 Precautionary Sediment Toxicity Analyses

In October 2005, RS funded the FWS toxicologist, John Augspurger, PhD, to perform Phases I and II sediment toxicity sampling in accordance with FWS established protocols. The entire report of Dr. Augspurger's work is included in Appendix C. An excerpt from his report is provided below:

> Seven sediment samples from within the impounded reach of Carbonton Dam on the Deep River (Moore, Chatham and Lee Counties, North Carolina) were collected in October 2005 and analyzed for elemental contaminants. Ninety-six 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 results

exceeded the *probable effects concentrations* (*PECs*, concentrations above which adverse effects to sediment dwelling organisms may be expected). Two of the seven nickel results (or about four percent of the overall sample results) fell between the TEC and PEC screening values, but they were near the low end of this range (at or below the geometric mean of the screening values). Based on review of existing data (tier 1) and results of sediment chemistry (tier 2), contamination in surface sediments behind Carbonton Dam is unlikely to be a concern, either in-place or upon mobilization. From a toxicological perspective, no additional sediment analyses are needed.

2.2 DEWATERING

Phased and controlled dewatering (lowering) of the Site Impoundment was implemented to ensure water level control during project implementation. The dam removal process was developed to include a dewatering phase in order to utilize the safest and most environmentally sound methods to prepare for dam removal. Phased dewatering was initially proposed in the Restoration Plan (Restoration Systems 2005). The Carbonton Dam contained mud gates and head gates that were planned to be used as water control devices to facilitate the phased dewatering without the need to breach the dam spillway. The dewatering sequence planned for initial dewatering of the Site Impoundment to the maximum extent possible through the mud gates of the powerhouse. This was facilitated by directing flow through the existing mud gates located in the southern water well of the powerhouse structure, as well as through the turbine draft tubes in the southern water well. The mud and head gates allowed dewatering to occur in a controlled and reversible manner until the substrate could be evaluated to ensure that the project could continue as planned.

The dewatering of the Site Impoundment was initiated on October 15, 2005. Once the Site Impoundment had been drained, the planning team had better access to the Site, which facilitated project planning. The dewatering of the Site Impoundment facilitated:

1. More comprehensive engineering evaluations of the powerhouse and dam
2. Exposure of sediment and substrate behind the dam spillway and within the former Site Impoundment to facilitate development of a substrate management plan
3. Reduction of the potentially hazardous conditions present at the Site when the Site Impoundment was full and the dam was under pressure.
4. Enhanced sediment transport and substrate reorganization within the Site Impoundment from re-established lotic flow.
5. Recruitment of riparian vegetation along stream banks within the former Site Impoundment.
6. Inspection of the bridge piers at NC42.

As the final step to complete the dewatering of the Site Impoundment, creation of a breach in the dam was initiated on November 11, 2005. The breach was created on the main buttress spillway, and extended from the powerhouse north and included spillway cells 1-5 (see Page 8 of As-Built Drawings, Appendix D).

2.2.1 Coordination

To reduce potential downstream aquatic impacts, RS and the resource agencies agreed that October 15, 2005 was the earliest date to begin dewatering. This was to ensure there was a lower water temperature, higher dissolved oxygen, and lower biochemical oxygen demand (BOD) in the Site Impoundment and river below the dam. The Carbonton Dam is a former hydroelectric generating facility that falls under the licensing authority of the Federal Energy Regulatory Agency (FERC), which has control over decommissioning and demolition of licensed dams. Therefore, coordination of the dewatering approach and timing involved local, state, and federal resource agencies.

2.2.2 Powerhouse Preparation

Before dewatering began the previous dam owner refurbished the powerhouse head gates, the southern turbine draft tube, and the mud gates to enable discharge of the Site Impoundment through the powerhouse in a controlled manner. The head gates were rearranged so that the southern water room (wet well) could be closed off and repairs could be made to the mud gates to make them operational. The southern turbine was also removed, and its draft tube fitted with two fabricated "flap" covers, each covering one-half the tube diameter (Photo 1). Excess trash was dredged behind the intake trash racks to facilitate free flow to the full depth of the trash rack and head gates. Prior to this, sediment and woody debris had blocked all but the upper one- to four-feet of the southern trash racks.

Photo 1: Repaired mud gates and flap covers on draft tube
In southern water well
Source: Restoration Systems 2005

2.2.3 Dewatering

Once the Site had been prepared, final coordination and approval was sought from regulatory agencies for dewatering of the Site Impoundment. The Restoration Plan (Restoration Systems 2005) described that the dewatering was primarily going to occur through the mud gates. However, during the preparation activities within the powerhouse, it was determined that the initial dewatering should be directed through the southern wet well draft tube by raising the new flap covers, which allowed river discharge through the submerged exit race on the downstream side of the powerhouse. The southern draft tube, with the new flap covers, was deemed to provide better control over the initial dewatering, in case a situation arose that forced the cessation of the dewatering process. In addition, by raising and lowering the flap covers, there was sufficient control to throttle the discharge as desired. While water from the Site Impoundment was being discharged through the powerhouse, the trash racks protecting the water wells required nearly continuous cleaning to reduce blockages and pressure (head) loss at the upstream end of the powerhouse (Photos 2 and 3).

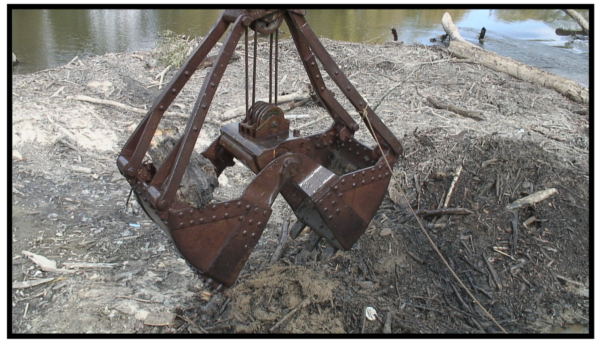


Photo 3

Photo 2

Photos 2 and 3.Cleaning trash racks protecting southern water well during dewatering
Source: Restoration Systems 2005

Dewatering exclusively through the southern draft tube continued until the end of October 2005, when the level in the water room fell to the top of the draft tube (approximately four feet above the bottom of the water well). Due to the dewatering pathway through the powerhouse, approximately three feet of pressure (head) loss occurred while draining exclusively through the southern draft tube. Thus, the lowest level that the Site Impoundment could be drained through the southern draft tube was still several feet higher than the minimum level possible in the southern wet well. Although much of the sediment that had accumulated immediately behind the dam became visible, the water level of the Site Impoundment was still too high to facilitate inspection of the powerhouse and the spillway, and also too high to allow for satisfactory investigation of the substrate behind the spillway. To reduce the level of the Site Impoundment further, the mud gates located at the base of the southern water well were raised to increase flow through the powerhouse (Photos 4 and 5).

Photo 5

Photo 4

Photos 4 and 5. *Dewatering through the mud gates within the powerhouse*
November 2005
Source: Restoration Systems

The addition of the mud gates to the dewatering pathways improved the drainage of the Site Impoundment; however, the limited flow capacity available through the powerhouse caused the river to remain elevated for several days whenever a rainstorm occurred. Without the ability to pass the entire river stage through the powerhouse, the Site Impoundment could not be fully drained, which prolonged the dewatering and complicated the dam removal effort because the dam remained under pressure from the head of the Site Impoundment. In order to demolish the dam during the fall/winter of 2005-2006, it was necessary to complete the staged dewatering, investigations, and substrate management as soon as possible. Prolonged high water in the Site Impoundment threatened the progress of the dam removal, which might have been delayed until the next annual low-water period (i.e., late summer/fall 2006).

The 2005 pre-dewatering surveys described in the Restoration Plan (Restoration Systems 2005) indicated that the dam spillway consisted of a reinforced-concrete slab supported by vertical buttresses on the downstream (east) side. The 1921 construction photographs depicted three mud gates resting against the upstream (west) face of the spillway that appeared to be approximately 15-foot-wide concrete slabs. Additional reconnaissance was performed after the initial dewatering on the downstream (east) side of the dam spillway, which revealed at least one mud gate was in place. The operability of the mud gates located on the dam spillway was unknown, since the sediment wedge behind the dam covered them. The decision was made to uncover at least one gate to determine whether it could be successfully opened to increase the discharge from the Site Impoundment and contribute to the staged dewatering.

In early November 2005, a tracked backhoe was used to uncover the southernmost mud gate on the dam spillway and slide the gate aside (Photo 6). This action successfully increased the river discharge by a substantial amount, further dewatering the Site Impoundment. Consultations with the FWS and other resource agencies ensued to discuss the contingency of locating and opening the other two mud gates that were located on the dam spillway. The project planning team believed that opening the other two gates would facilitate dewatering of the Site Impoundment much more efficiently, and would provide additional flow capacity for higher river stage events. It was determined that the increased capacity could facilitate the substrate investigations, dam demolition planning, and dam demolition activities, even at higher river stages. All three mud gates located on the dam spillway were ultimately removed, contributing to the dewatering of the Site Impoundment by mid-November (Photo 7). Once all three spillway mud gates were opened, further inspection of the spillway revealed that an approximate four-foot

Photo 6. Uncovered mud gates on dam spillway

Photo 7. Dewatering through mud gates on dam spillway

Source: Restoration Systems 2005

high concrete ledge at the base of the mud gate openings restricted the river discharge and caused a backwater into the impoundment. The project planning team determined that the Site Impoundment could be lowered nearly another four feet if the ledge was removed, which would eliminate the head loss though the mud gates on the dam spillway. Additional coordination was undertaken with the resource agencies to determine whether the dam spillway should be breached in addition to the ongoing dewatering effort through the mud gates. After the successful coordination with the local agencies and FERC, approximately 85 feet of the southern end of the spillway (cells 1 through 5 [See Sheet 8, Appendix C]) were demolished using backhoes and a backhoe-mounted hydraulic hammer (Photo 8). These fully removed cells of the spillway restored the Deep River to lotic conditions during normal base flow periods (Photo 9).

Photos 8 and 9. Constructed notch in cell 1-5 on the southern end of the buttress spillway
Source: Restoration Systems 2005

After successful dewatering of the former Site Impoundment, the project planning team had full access to the river behind the dam, which facilitated a more complete substrate investigation, additional river stage capacity after rain events, and a lower water surface elevation to complete demolition planning efforts and facilitate demolition of the spillway.

2.3 SUBSTRATE MANAGEMENT

An important aspect of the dam demolition process was the study, planning, and disposal of large woody debris, trash, sediment, and old dam construction materials that were present within the river channel immediately adjacent and upstream of the dam spillway. Before and during dewatering, the substrate was characterized between the spillway and the NC42 bridge by performing:

- Hand probing of substrate (mid March 2005).
- Fathometer recordings, noting woody or timber remains, and/or hard bottom (stone or bedrock) veneers and possible crib dam (mid March 2005).
- Underwater SCUBA investigations of the bottom, including the locations of the suspected timber mass and crib dam locations (early August 2005).
- Visual inspection and characterization.
- Hand probing with augers and soil samplers.
- Tests pits in the spillway sediment wedge using a track excavator.

During project planning coordination, side-scan sonar, bottom-penetrating radar, and bottom-penetrating sonar from UNC-Wilmington were considered prior to the dewatering effort to evaluate the character of the submerged substrate. However, equipment problems and the timing/availability of the equipment prevented substrate investigation using these methods.

The August 2005 dive inspection of the river bottom between the NC42 bridge and the spillway found that the substrate appeared to consist of mud, rip-rap-sized rock, woody remains, sediment, and at least one bedrock outcrop. Turbid water made precise identification of the substrate impossible, but divers encountered what appeared to be the top of a timber and rock structure that was similar to crib dams seen in 1921 photographs of the dam and powerhouse construction.

After successful dewatering of the Site Impoundment occurred in late November 2005, the following types of substrate were revealed within the former Site Impoundment:

- Woody remains from logs, brush, tree trunks, and other items that had washed down the Deep River and accumulated into a 1/4-acre woody debris "island" above and below the NC42 bridge (Photo 11).
- Timber and rock remaining from the crib cofferdams that were used during the spillway and powerhouse construction during the 1920's.
- Bedrock outcrops along the north riverbank.
- Sand and fine to medium gravel that had been transported down the Deep River and settled into a wedge covering the face of the spillway (Photo 10).

The spillway sediment wedge was investigated using test pits, soil augers, and visual physical characterization. The upstream river substrate was also investigated by hand probing and soil augers where possible. The major feature encountered was the large woody debris island, which extended from just above the NC42 highway bridge to approximately 100 feet above the spillway sediment wedge (see Sheet 6, Appendix D). The debris island was composed of tree trunks, tree limbs, sand, and gravel. The debris island was a concern because of the perceived risk that a high river stage could dislodge and transport the debris downstream, possibly causing blockages in the Deep River below the dam Site.

Photo 10. Substrate behind dam spillway after

Photo 11. Woody debris island near NC42 bridge

dewatering

Source: Restoration Systems 2005

The substrate evaluation resulted in a determination of which materials would be removed from the river channel before demolishing the remaining spillway. It was desirable to remove as much of the woody debris as possible that lay on the substrate island below the NC42 bridge. However, the spillway sediment wedge was composed of mostly sand, and fine and medium gravel, which could be used to provide excellent bed load for the sediment-starved Deep River below the dam Site. In consultation with the FWS and other resource agencies, it was determined that the best action would be to allow the material in the spillway sediment wedge to reenter the river system in an incremental manner by removing the woody debris from the debris island and replace it with the substrate from the spillway sediment wedge. This was accomplished by:

1. Removing as much of the woody debris island as was practical. To minimize undesirable downstream impacts during the work, the operation was restricted to above the low waterline. Also, no heavy equipment would operate in the vicinity of the NC42 bridge, because of concerns working in the North Carolina Department of Transportation (NCDOT) right-of-way and potential damage to the bridge piers.
2. Removing the sediment wedge from behind the spillway and depositing it on top of the debris island so that the sand and gravel could be reintroduced into the Deep River during elevated river stage events that will erode the island.
3. Temporarily relocating the woody debris to an upland site north of the spillway, and cutting or burning the wood at a later date.
4. Removing and disposing of the timbers from the former crib dam, and reusing the stone from the crib wherever possible.

In all, approximately 1,500 cubic yards of woody debris were removed from the debris island above the spillway. In addition, the NCDOT cooperated with the substrate management by removing the woody debris in the vicinity of the NC42 bridge. Operating from the bridge, the NCDOT crew used a grapple to snag tree trunks and limbs to haul them up to the bridge for disposal.

The sediment wedge behind the spillway consisted of approximately 2,000 cubic yards of sand and fine-to-medium gavel that was relocated onto the debris island to facilitate slow reintroduction into the river system.

2.4 DAM REMOVAL

The process for the demolition of the Carbonton Dam was carefully planned from beginning to end. One of the most important aspects of the planning was the coordination that occurred between RS, the engineer (MMI), the contractor (BE), and the resource agencies. Since many aspects of the dam removal couldn't be planned beforehand, adaptive management of the demolition was used because the exact engineering obstacles could not be foreseen and presented themselves in the field during the demolition process.

Pre-demolition activities included a survey of the dam site by a licensed blasting firm before finalizing the demolition plans. The survey confirmed that it was not feasible to remove the spillway or powerhouse using explosives, and it was decided to instead demolish the dam using conventional demolition methods and equipment.

Before demolition began, state government representatives approached RS with a plan to retain the powerhouse as an amenity in the future public park that will be located along the south riverbank. After consultation with FERC, the powerhouse was removed from the demolition plan until the final disposition of that structure could be determined.

Site activities began in October 2005, when BE began repairing the southern water room in the powerhouse for dewatering. For demolition purposes, the site activities began in December 2005 and included the installation of erosion and sedimentation controls, as well as the construction of the northern equipment access road from NC42 to the north bank of the Deep River.

The Carbonton Dam spillway was removed in a staged approach. Each step of the demolition process was carefully considered, which often resulted in a field-based adaptive management. Considerations included worker safety, impacts to water quality, disturbances to aquatic resources, and ease of demolition. Pre- and post-demolition river velocities were also modeled to evaluate potential scour on the NC42 bridge piers. The model was used to determine the potential for substrate transport and bank erosion in the vicinity of the dam once it was removed.

Construction equipment access was established from both the south and the north (see Sheet 3, Appendix D). The primary demolition staging area was located on the north bank, in a cleared area outside the highest bank of the Deep River. Heavy equipment was removed from the river channel on a daily basis in case of unexpected high river flows.

The staging area on the southern bank was generally limited to operations during dewatering and removal of equipment in the powerhouse. All of the spillway demolition, removal of material from the woody debris island, and the sediment/substrate excavation, relocation, and grading was accomplished from the north staging area. The north access was also used for removing the concrete rubble from the river and transporting it to the south side of the Deep River.

Demolition activities began when the spillway was breached at the end of November 2005. Demolition occurred in stages from the powerhouse toward the northern bank, with tracked backhoes operating upstream of the dam spillway on top of the sediment wedge and bedrock (Photos 12 and 13). During the demolition, large concrete rubble pieces were transported to the staging area above the river via tracked trucks.

Photos 12 and 13. Two stages of spillway breach to facilitate dewatering
Source: Restoration Systems 2006

The buttress spillway was completely demolished and removed by February 3, 2006. Approximately 800 cubic yards of concrete in the spillway were removed from the river, and portions of the spillway concrete were used to construct a toe wall (Photo 14). This revetment was built along the toe of the southern bank, directly upstream of the powerhouse where the slope was re-graded and the riverbed was dredged to prepare for dewatering (Photo 15).

Photo 14. Bank toe protection created from dam spillway debris

Photo 15. Regraded southern bank of the Deep River behind the powerhouse. Slope was revegetated

Source: Restoration Systems 2006

The remaining concrete from the spillway buttresses and face slab was broken into football-size pieces and transported to a staging area above the southern riverbank. There, the broken and crushed concrete remains are temporarily stored, and will be used as fill for rough grading the park site or as base material for parking lots and other areas.

During demolition, RS decided to avoid demolition of the concrete ogee spillway that was constructed on bedrock at the left riverbank was retained (Photo 16). The ogee spillway is 30 feet long, and its base lies above the normal flow of the river and will not interfere with the flow conditions or with the reintroduction of sediment from the substrate island back into the river. Retaining the ogee spillway saves an element of the historic Carbonton Dam, and it will be visible from the future public park on the south riverbank (Photo 17).

Photo 16. After dam removal, the ogee spillway was retained
Source: EcoScience Corporation 2006

Photo 17/ Ogee spillway in pre-removal photo
Source: Restoration Systems 2005

A structural evaluation of the powerhouse is underway, the results of which will help determine the ultimate use of the powerhouse and what structural repairs are necessary for it to be used as a conference center/retreat associated with the future public park. Power generators and other ancillary equipment on the third floor of the powerhouse were removed by the dam owner and disposed of or salvaged as appropriate. The power line across the Deep River over the former spillway still exists and will be removed by RS once a final plan for the powerhouse is proposed, in conjunction with the park development on the south bank.

All but *de minimus* material was retrieved from the riverbed during the demolition activities, and to protect rare, threatened, and endangered species below the dam, all activities were performed from above the spillway.

2.5 DAM SITE STABILIZATION

The many bedrock outcroppings and steep slopes along the north side of the river limited heavy equipment access to a single construction driveway above the spillway. This area was re-graded and replanted after demolition was completed.

The banks of the Deep River at the powerhouse site were graded and temporarily reinforced with coir fiber erosion control matting. The banks were hydro-seeded once grading operations ceased and exposed slopes were planted with live stakes. The sand and gravel island below the NC42 bridge was also graded and seeded.

In addition to using the concrete waste material as fill in the disposal areas, concrete slabs were used to create toe protection and a temporary revetment wall to stabilize the riverbank immediately upstream of the powerhouse. The final configuration of that riverbank will depend on how the powerhouse is modified to retain it as an amenity of the new public park. It is likely that the riverbank will be re-graded once the final disposition of the powerhouse is decided, and will then be stabilized with erosion control matting and hydoseeding.

RS also purchased an additional three acres adjacent to the powerhouse site on the south side of the Deep River, which will be incorporated into the site that will become the new public park. The park plans are being finalized, but they will include removing the driveway that leads to the powerhouse and re-grading and landscaping of the area between NC42 and the top of riverbank.

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 Deep River channel, coffer dams were installed adjacent to fill and excavations areas in the dam vicinity 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 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 (none 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 monitoring activities described herein will document the success in meeting the stated mitigation goals. Year 1 monitoring is already underway, and will be performed annually through the five-year period or until success criteria are achieved. Each year, an Annual Monitoring Report will be produced to document improvements in water quality, the aquatic community, rare and endangered species, and cultural resources within the former Site Impoundment.

3.1 MITIGATION MONITORING METHODS

3.1.1 Channel Cross Sections

A network of 51 cross-sections was established within the region of the former Site Impoundment during Year 2005 baseline monitoring (**see Figure 3, Appendix A**). These cross-sections are located on the Deep River and its tributaries at stations established prior to dam removal. Thirty-three (33) permanent channel cross-sections have been established throughout the former Site Impoundment and on tributaries where functional restoration is expected to occur. Seventeen (17) permanent cross-sections have been established on reference reaches above and below the former Site Impoundment to facilitate success evaluation of the project. 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. Each cross-section location was surveyed in 2005 (pre-removal), and will subsequently be revisited annually throughout the monitoring period. Pre-removal survey data will be compared to post-removal data to assess changes in the channel dimensions as the natural, unimpeded hydrologic conditions return to the river.

Both complex and simple cross-sections have been performed. Complex cross-sections are performed on stream reaches in which stream width is too large for successful data collection using simple techniques. These cross-sections are often performed at stations where access via boat is practical and utilize some combination of total station or laser level equipment. Simple cross-sections are performed on narrow stream reaches with challenging access and utilize level measuring tapes and a pocket rod. Narrow stream width allows a simple cross-section to be performed without the use of surveying equipment.

3.1.2 Sediment Grain Size Distribution

Sediment grain size distribution was analyzed at all 51 monitoring stations in 2005. Sediment samples collected from within the Site Impoundment and within the reference reaches were collected or analyzed prior to dam removal. These data will be used to identify the restoration of habitat for lotic-adapted benthic macroinvertebrates, fishes, mussels, and snails.

Sediment grain size distribution will be assessed at each channel cross-section location. For water depths less than 3 feet (i.e., areas where water is not prohibitively deep to prevent wading), 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 (Photo 18). 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.

Photo 18. Sediment sampling within the Site Impoundment
Source: EcoScience Corporation 2005

3.1.3 Photography and Videography

Digital photography and videography data were collected to document pre-removal baseline conditions. These data will continue to be collected during the monitoring period and will be used to support success evaluation for stream and river physical properties and endangered aquatic species, stream stability, and habitat assessment criteria. A video transect was also performed prior to dewatering to serve as a resource for comparison following dam removal. The transect was correlated to sub-meter GPS and extends from the former dam Site to a point approximately 10 miles upstream within the Site Impoundment.

At each cross-section station, four photographs will be taken: one facing upstream from the cross-section center, 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 post removal monitoring, additional riffle areas that were previously submerged by the Site Impoundment are expected to become visible. These areas will be photographed and located with GPS technology. These areas will also be visited annually during post-removal monitoring to assess the anticipated enhanced habitat within the former Site Impoundment as a result of dam removal.

3.1.4 Flow Velocity

Flow velocity was analyzed at all 51 monitoring stations during 2005 (Photos 19 and 20). Using similar methods, flow velocity measurements will be made at each monitoring station during each subsequent year of the monitoring period. It is anticipated that flow velocities will increase in each formerly impounded stream reach and that variability in flow between pools and riffles will be established. To collect these data, a Swoffer velocity probe is used to measure the velocity in five different locations along the channel cross-section of each station. The probe measurement is made 1 foot below the water surface. If water depths exceed 4 feet, then two measurements are made at each location, where the first measurement is made 1 foot below the water surface, and the second measurement is made 1 foot above the channel bottom.

Photo 19. Impounded (lentic)

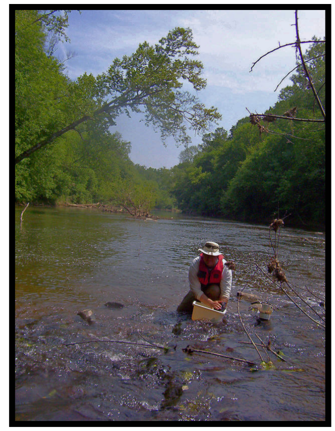
Photo 20. Lotic reference

Source: EcoScience Corporation 2005

Due to the large number of stations, it is impossible to sample them all at the same river stage. Thus, the data are compared to a daily standard that is sampled from the Site each day that other stations are being visited.

3.1.5 Benthic Macroinvertebrates

Benthic macroinvertebrates were collected at seventeen (17) of the monitoring stations in 2005. The pre-removal Year 2005 monitoring occurred in April and May. The stations sampled for benthic macroinvertebrates occur on the Deep River and its tributaries, in both the former Site Impoundment and in reference lotic reaches. The sampling method utilized was the Standard Qualitative Method as described in NCDWQ (2003), with modification for deep water (boat) sampling implemented within the Site Impoundment and deep pools in reference reaches (Photos 21 and 22). It is expected that deep water sampling will be used less frequently during future sampling efforts. All collected samples during the monitoring period will be sent to a NCDWQ certified laboratory for identification.



Photos 21 and 22. Sweep net and rock wash sampling for benthic macroinvertebrates at a reference station
Source: EcoScience Corporation 2005

3.1.6 Fishes

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 five lotic stations located outside of the former Site Impoundment (**Figure 3**, **Appendix A**). Fish surveys were not conducted within the former Site Impoundment as it was determined, in conjunction with FWS, that these lentic areas contain a predictable suite of impoundment-adapted species that have been previously documented by the NCWRC and FWS, and therefore should not require an initial inventory.

The methods utilized in Year 2005 included a three-person team that performed fish surveys with access to the Site Impoundment provided via canoe or powerboat. 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 midpoints of each survey site were recorded using a hand-held Garmin etrex Vista GPS unit. All reference station locations were accessed via canoe, and similar survey methods were employed. All future sampling during the monitoring period is anticipated to utilize methods as modified for encountered habitats as described herein. Additional sampling stations within the former Site Impoundment will be established, and the data will be compared against data collected by the NCWRC and the FWS from the former Site Impoundment.

In wadeable water, seine netting was the primary method used to sample fish, as it is the most effective survey method for the targeted Cape Fear shiner (the shiner). Seine netting is an effective method in shallow riffles and runs, as well as shallow pools; generally the preferred habitat of the shiner. This method is not as effective in deeper pools or riffles with a very strong current, therefore fish species preferring these habitats were not effectively sampled. Other sample methods included capturing fish in hand held dip nets against the shoreline or bottom structures as well as visual census surveys. Visual census survey methods using mask/snorkel were also employed. These methods often provide more accurate estimates on abundance of some species than more traditional methods, such as mark recapture and depletion (Hankin and Reeves 1988, personal observations).

Each habitat type in a given survey reach was sampled at least once. Seine hauls were performed by dragging the net upstream through the riffle/run. Pools were sampled by the team making fast pulls in a downstream direction and herding fish towards the banks, or sand/gravel bars. All captured fish were placed into water buckets until they could be identified to species level and counted. Specimens that did not recover from the sampling methods were preserved in 95-percent ethanol. Additionally, some shiner species were collected and preserved in 95-percent ethanol for laboratory identification to confirm field identification. The remaining fish were released. Habitat notes were recorded at each collection site. Each fish species observed or captured was assigned a designation of the following categories of relative abundance: abundant, common, uncommon and rare. Fish surveys will be conducted using these methods at selected stations (See Figure 3, Appendix A) during the monitoring period.

3.1.7 Mussels

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 this document. Ten sampling locations were established from a sub-set of all the stations used for channel geomorphology data collection.

A three-person survey team was used to survey for mussels at each of 10 stations (**Figure 3**, **Appendix A**). Watercraft (canoes, powerboats) were used to access all of the sites surveyed in the Deep River. The length of each survey site was 200 meters. The midpoints of each survey site were recorded using a hand-held Garmin etrex Vista GPS unit.

All appropriate habitat types within a given survey reach were searched thoroughly via visual surveys using glass bottom buckets (batiscopes) and/or mask/snorkel in the shallow water habitats and SCUBA at each of the impounded sites. Tactile methods were also employed when appropriate. Where SCUBA was used, one of the three person survey team members provided surface support to the two 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) by species. CPUE is defined as the number of individuals found per person hour of search time. All species that are monitored by the NC Natural Heritage Program (NCNHP) were measured (total length). Representative photographs were taken of each collected mussel species. These methods will be used by TCG in each monitoring event during the five-year monitoring period.

3.1.8 Snails

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 surveys were conducted at 10 stations in conjunction with the mussel survey efforts with similar methodology, as described in **Section 3.1.7**. Snails were hand picked 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 survey site. These methods will be used by TCG in each monitoring event during the five-year monitoring period.

3.1.9 Habitat Assessment

Habitat assessment data was collected at all 51 monitoring stations to evaluate aquatic habitat to support improvement in community populations. Forms that evaluate the quality and character of the sampled habitat niches were completed to provide a comparable score that describes the habitat available at that station. Prior to dam removal, habitat assessment data were collected at all monitoring cross-sections and will be compared to data collected annually throughout the five-year monitoring period. Changes in the biotic community are anticipated as the natural lotic flow conditions are restored to the Deep River and its previously impounded tributaries, thereby diversifying available benthic habitats.

3.1.10 Water Quality

The AMS data from the NC 42 station will be compared to the monthly sampling that occurs at a reference station in Ramseur, NC. Thus, the conditions at the time of sampling at each monitoring station will be documented relative to the dam Site, and the data from the dam Site will be comparable to at least ten years of consistent monthly monitoring by the NCDWQ. This technique will allow for detection of substantial differences between water quality parameters between the pre- and post-removal conditions of the former Site Impoundment, as well as a comparison to a reference reach of the Deep River. Year 2005 pre-removal data from each monitored station will be compared to post-removal data in order to assess changes in water quality as lotic conditions return to the river.

4.0 MAINTENANCE AND CONTINGENCY PLAN

Stream bank areas of the Deep River that were disturbed at the Carbonton Dam Site as a result of dam removal activities will be evaluated throughout the five-year monitoring period for signs of erosion. Any areas of erosion observed will be stabilized with coir fiber matting and re-seeded with appropriate seasonal erosion control grasses to prevent additional erosion.

It is anticipated that changes in the Deep River base level as a result of dam removal within the former Site Impoundment may result in bank erosion along some reaches of the Deep River or its tributaries. In order to monitor potential erosion, the former Site Impoundment will be reconnoitered following discharge events equal to or greater than 1500 cubic feet per second (cfs) as measured at the Ramseur USGS gage station (gage # 02100500). Observed areas of erosion will be documented with photography and/or videography. Additionally, the substrate island comprised of sediments that were removed from behind the dam spillway will also be monitored after any event $\geq$ 1500 cfs . The substrate island was designed and built with the expectation that sediments will migrate downstream from the island area to the sediment starved areas of the Deep River located downstream. The purpose of the discharge correlated evaluations will be to monitor the rate of erosion.

Erosion evaluation results 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. The written summaries from each erosion event that occurs during each year of monitoring will be available in an appendix of each respective annual monitoring report.

5.0 MITIGATION SUCCESS CRITERIA

The success criteria presented herein have been designed to facilitate success determination in accordance with the dam removal guidance (Appendix B). Mitigation success criteria for the parameters outlined in the monitoring protocols above (Section 3.0) are summarized in Table 3. Improvements in desirable water quality parameters, a measurable improvement in species diversity or pollutant intolerance indices for lotic adapted aquatic species, or restoration of habitat for the federally endangered Cape Fear shiner will be used to evaluate the success of this project. The remaining monitoring data will not be used as specific success criteria by themselves, but will supplement other collected data to evaluate the success of the water quality, endangered species, or aquatic habitat criteria.

Evaluation of improvements in water quality within the former Site Impoundment will be based on comparisons of pre-removal baseline and monitoring period data for: 1) ambient water quality parameters, and 2) pollution tolerance and species diversity of aquatic organisms. A similar comparison of baseline and monitoring period data will be used to judge improvements to the aquatic community. Specific data used in this analysis are: overall species diversity, diversity of sensitive invertebrate species (EPT taxa), and habitat evaluation parameters. Improvements to the habitat available to rare and endangered species will be evaluated though comparisons of requisite habitat parameters (flow, substrate, vegetation, clarity) to conditions that become established within the former Site Impoundment as the Deep River returns to lotic conditions. Based upon anticipated coordination with the FWS, success for the rare and endangered species criterion may be derived through transplantation of aquatic populations of rare mussels, the discovery of specimens of the Cape Fear shiner, or through perceived connection of the previously disjunct populations of the shiner, and/or documentation of established habitat within the limits of the former Site Impoundment.

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 ≥ 5.0 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
Reserve success criteria:	Downstream benefits below dam	Deep 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

5.1 WATER QUALITY

5.1.1 Ambient Monitoring Stations Network

Aside from the *in situ* sampling occurring at each monitoring cross-section, physical water quality parameters are currently collected at an AMS located within the former Site Impoundment at NC42, immediately upstream of Carbonton Dam. These data have been obtained from NCDWQ, and data coverage exists on a monthly basis back at least 10 years. Data collected by the AMS are not standard for all samples, but are always sampled at 0.1 meter depth and can include: water temperature (ºC), dissolved oxygen (mg/L), pH (field measured), conductance at 25ºC (µmhos/cm), turbidity (NTU), fecal coliform bacteria (number of colonies/100 milliliters), suspended residue (total suspended solids) (milligrams/Liter), ammonia as nitrogen (milligrams/Liter), total Kjeldahl nitrogen (milligrams/Liter), nitrite and nitrate as nitrogen (milligrams/Liter), total phosphorus (milligrams/Liter), and assorted metals. These data will provide acceptable coverage of physical water chemistry and parameters throughout monitoring activities. Water quality trends from these data, and comparisons made against the state standards established by NCDWQ's "Redbook" will be used to support success evaluation.

5.1.1.1 Dissolved Oxygen

Dissolved oxygen AMS data were collected on a monthly basis and analyzed for the period of time between March 16, 1992 and October 14, 2005. The NCDWQ standard for dissolved oxygen in Class WS-IV waters is an instantaneous value of no less than 4.0mg/L, or a daily average of no less than 5.0 mg/L. **Table 4** provides the minimum, maximum, and mean values for dissolved oxygen, as well as the number of samples the recorded value fell below the state standard.

Table 4. Summary of dissolved oxygen data recorded at NC42 over the Carbonton Dam impoundment between March 16, 1992 and October 14, 2005.

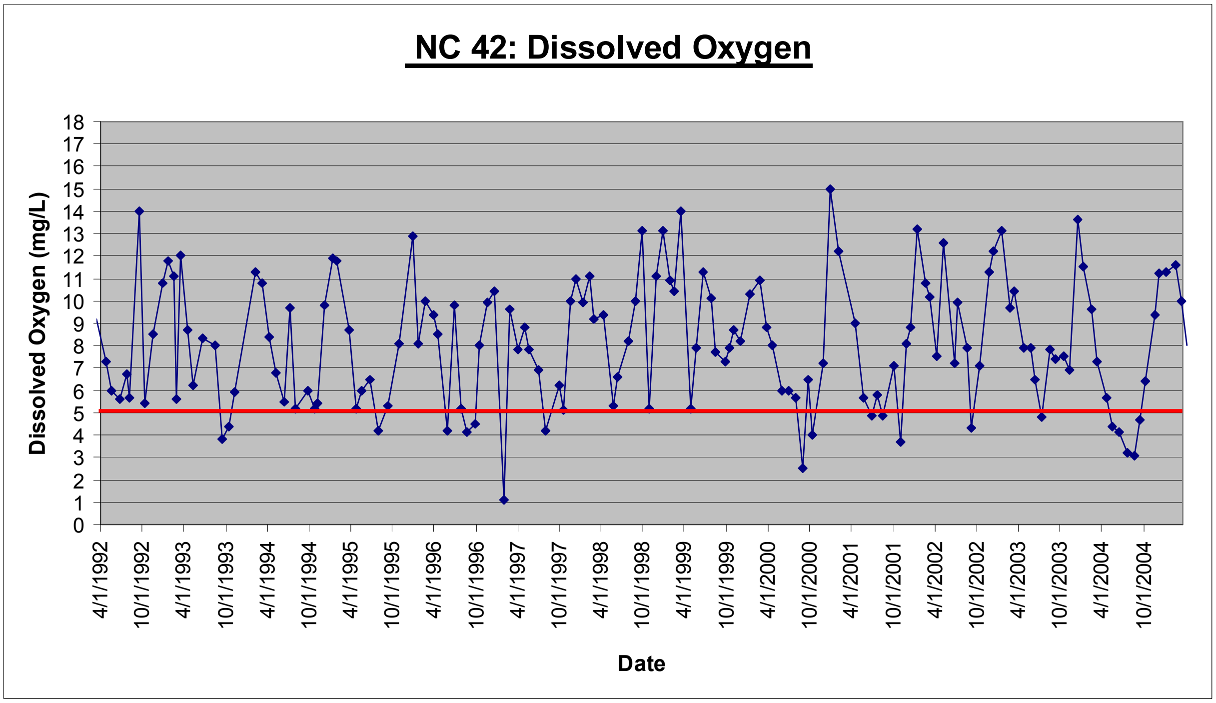
Minimum Value	1.1 mg/l
Maximum Value	15 mg/l
Mean Value	8.07 mg/l
Number of Samples Below State Standard	22

Graphs 1 and 2 depict the dissolved oxygen levels within the Site Impoundment and at a reference location on the Deep River in Ramseur. From visual interpretation of these graphs, it can be seen that the reference station at Ramseur has no recorded dissolved oxygen levels that fell below 5 mg/L, while the Site Impoundment had 22 (see also **Table 4**).

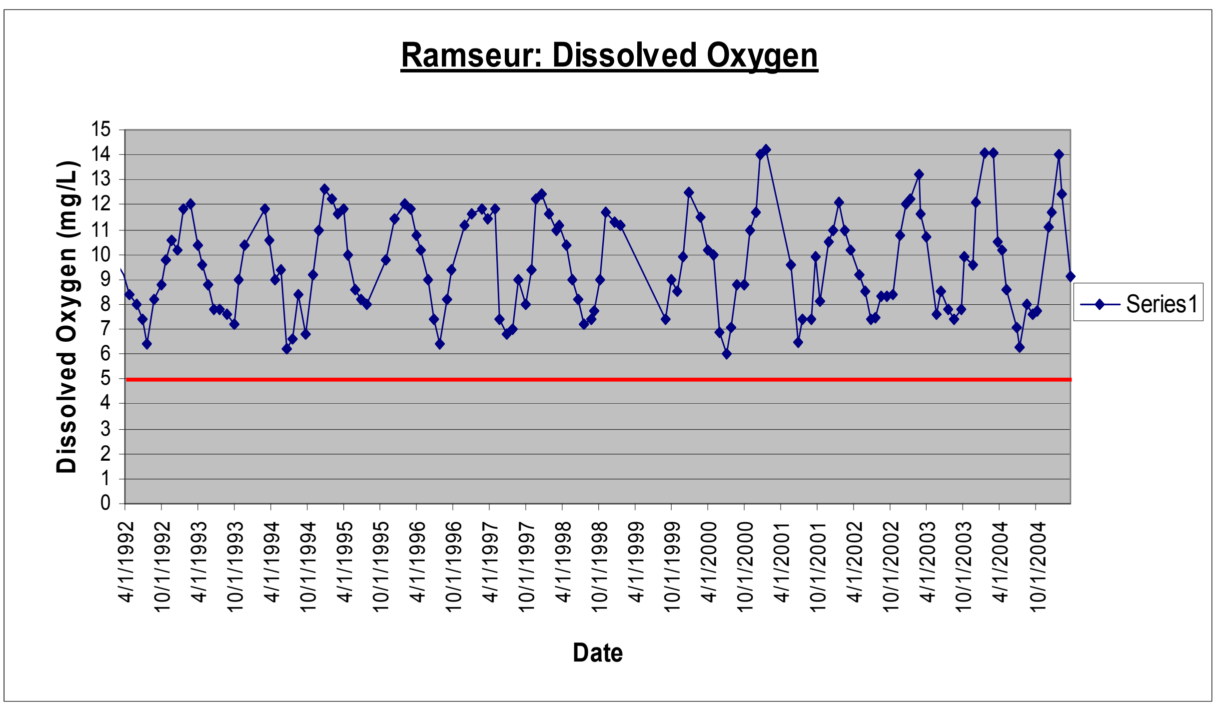
Throughout the five-year monitoring period following dam removal, it is expected that mean dissolved oxygen values recorded at NC42 will increase as the river returns to lotic conditions. It is also expected that the number of days below the state standard will decrease as free-flowing conditions replace lake-like flows.

Dissolved oxygen concentrations fluctuate seasonally, with higher concentrations characteristic of winter months and lower concentrations of summer months. In order to achieve success criteria, the AMS station within the former Site Impoundment must consistently measure dissolve oxygen concentrations greater than or equal to 5.0 mg/L. Exceptions to this criterion will be made if dissolved oxygen concentrations measured at the reference station are also below 5.0 mg/L within the same sampling timeframe.

Graph 1. Recorded dissolved oxygen levels at NC42 over the Deep River from March 16, 1992 through October 14, 2005.



Graph 2. Recorded dissolved oxygen levels at Ramseur on the Deep River from March 16, 1992 through October 14, 2005.



5.1.1.2 Temperature

Water temperature is important because of its influence on aquatic species and water chemistry. Stratification of water temperature is related to seasonal fluctuations of air temperature and has a non-linear relationship with dissolved oxygen saturation. Warmer water holds less oxygen than cool water. In the summer months, water temperature is greater and available oxygen is decreased. The stratification of water temperature was measured within the Site Impoundment during the 2005 monitoring period. Temperature values recorded in the Site Impoundment prior to dewatering demonstrated a stratified temperature regime, and the low flow behind the dam also contributed to the variable temperatures. Values recorded in the top 1 foot of the river were higher than those recorded near the streambed. This difference, combined with a low dissolved oxygen concentration, can be stressful on aquatic species. Water temperature values will be gathered at each station throughout the five-year monitoring period. As free flowing water replaces the previously impounded river, stratified water temperatures are expected to be either absent or greatly reduced, and high temperatures in combination with low dissolved oxygen are not expected to occur. In order to achieve success, the former Site Impoundment cannot exceed the state standard of 90 degrees Fahrenheit during the monitoring period. Exceptions to this criterion will be made if the temperature at the reference station is also above 90 degrees Fahrenheit within the same sampling timeframe.

5.1.1.3 Fecal Coliform

Fecal coliform AMS data was collected and analyzed for the period of time between March 16, 1992 and October 14, 2005. The NCDWQ standard for fecal coliform in Class WS-IV waters is an average value of no more than 200/100ml in any 30-day period. **Table 5** shows the minimum, maximum, and mean values for fecal coliform, as well as the number of samples the recorded value exceeded the state standard.

Table 5. Summary of fecal coliform data recorded at NC42 over the Carbonton Dam impoundment between March 16, 1992 and October 14, 2005.

Minimum Value	3 /100ml
Maximum Value	6300 /100ml
Mean Value	396.66 /100ml
Number of Samples Exceeding State Standard	31

Fecal coliform levels within most of the available reference AMS stations also show elevated fecal coliform levels during various periods. This suggests that the dam removal may improve, but will not be capable of preventing fecal coliform levels from exceeding the state standard within the former Site Impoundment. Larger watershed scale issues face the Deep River regarding this metric. These data will be monitored over the 5 year period, but no success criteria are proposed.

5.1.2 Biotic Indices

After identification of collected macroinvertebrates, the North Carolina Tolerance Values or Hilsenhoff Tolerance Values were assigned to each of the collected species. These Tolerance Values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant of organic wastes. The biotic indices of each station sampled for benthic macroinvertebrates were tallied, and then summary data were generated for comparison between impounded and reference stations. These summary data are provided in **Table 6**, and depict that the mean biotic index of the impounded stations is 0.93 higher than the mean of the reference stations. Success for this particular mitigation goal is defined as follows: the mean biotic index of the impounded stations must be within one standard deviation of the mean biotic index of the reference stations. For this project to be deemed successful for the Water Quality criterion of credit determination, the mean biotic index of the impounded stations will need to be at or below **6.65**.

Table 6. Benthic Macroinvertebrate Summary Data from Year 2005

	IMPOUNDED STATIONS	REFERENCE STATIONS
	Biotic Index	Biotic Index
High	7.97	6.91
Low	5.67	4.78
Mean	**6.83**	**5.90**
Median	6.79	5.99
Standard Deviation	0.83	0.75
Standard Deviation of Reference mean (**Success Criterion**)	**6.65**	

5.2 AQUATIC COMMUNITIES

To determine success for the Aquatic Communities habitat criterion, the former Site Impoundment will be monitored for benthic macroinvertebrates, fishes, mussels, and snails, as well as the quality of available microhabitats that develop.

5.2.1 Benthic Macroinvertebrates

To determine the success of the project for the re-establishment of an appropriate benthic macroinvertebrate community, several indices of community health will be utilized. **Table 7** provides the summary data for the benthic macroinvertebrate stations that were sampled in the Site Impoundment, as well as in the reference reaches both within the Deep River and its major tributaries. The comparative metrics utilized for the success evaluation include the total number of organisms collected, the total taxa represented in the samples, the richness (diversity) of taxa from the Ephemeroptera (mayflies), Trichoptera (caddisflies), and Plecoptera (stoneflies) orders (hereafter referred to as EPT taxa), and the biotic index of organic waste tolerance. Upon evaluation of the pre-dewatering data (**Table 7**), the total number of organisms does not appear to be a viable metric for evaluating the success of the project for two reasons. First, healthy aquatic systems are characterized by high abundance and high diversity, but then transition to high abundance with low diversity once impaired. Thus, the total number of organisms can be high regardless of the quality of water or diversity of available habitats. Second, the methods utilized were the Standard Qualitative Method (NCDWQ 2003); therefore, the absolute abundance is not appropriate for comparison. However, a comparison of the community diversity, the richness of EPT taxa, and the biotic indices of stations from the Site Impoundment and reference reaches indicate that the there is the potential for measurable improvement for which the Site Impoundment can be monitored to determine the success of the project in restoring a viable and diverse benthic macroinvertebrate community.

Table 7. Benthic macroinvertebrate summary data from Year 2005 collections.

	IMPOUNDED				REFERENCE			
	Total Organisms	Total Taxa	EPT Richness	Biotic Index	Total Organisms	Total Taxa	EPT Richness	Biotic Index
High	403.00	62.00	10.00	7.97	1168.00	70.00	24.00	6.91
Low	97.00	18.00	1.00	5.67	237.00	41.00	14.00	4.78
Mean	223.33	39.78	5.89	6.83	549.75	54.88	19.13	5.90
Median	207.00	43.00	6.00	6.79	404.00	56.00	19.00	5.99
Standard Deviation	96.69	12.02	2.76	0.83	340.66	10.33	3.14	0.75
Success Criterion	**-------**	**44.55**	**15.99**	**6.65**				

Table 7 demonstrates that the mean total taxa of the formerly impounded stations needs to increase by 4.77 species to be quantitatively similar to the reference mean. Additionally, the mean EPT richness of the formerly impounded stations needs to increase by 10.1 species to be quantitatively similar to the reference mean. The biotic index of the two sample types will be compared for water quality, but water quality success is expected to also benefit the aquatic community.

5.2.2 Fish

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 5 survey stations will be compared by CPUE for a qualitative change to the 11 stations (**Figure 3, Appendix A**) that will be sampled over the post-removal monitoring period. It should be noted that only the lotic stations were sampled pre-removal for fishes, and that Figure 3 depicts all 11 stations that will be sampled during the five-year monitoring period. The data will also 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 if survey data at stations within the former Site Impoundment indicate a shift in fish community composition towards free-flowing, lotic conditions characteristic of reference survey stations. Such evaluations will be performed by TCG personnel.

For the rare and endangered aquatic species criterion, the documented presence of rare fish fauna, especially the Cape Fear shiner, in areas previously characterized as the Site Impoundment will be used to evaluate success. If no individuals of rare fish taxa are observed within the post-removal monitoring period, habitat analyses will be used as a surrogate.

5.2.3 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 11 survey stations (**Figure 3, Appendix A**) will be compared by CPUE for a qualitative change. Additionally, taxonomic 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 free-flowing, lotic conditions characteristic of reference survey stations.

Achievement of success criteria will be evaluated by TCG personnel to determine if fish communities within the former Site Impoundment are transitioning towards those characteristic of lotic conditions.

For the rare and endangered aquatic species criterion, the documented presence of rare mussel fauna in areas previously characterized as the Site Impoundment will be used to evaluate success. If no individuals of rare mussel taxa are observed within the post-removal monitoring period, habitat analyses will be used as a surrogate.

5.2.4 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 11 stations (**Figure 3, Appendix A**) 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 free-flowing, lotic conditions characteristic of reference survey stations. Achievement of success criteria will be evaluated by TCG personnel to determine if fish communities within the former Site Impoundment are transitioning towards those characteristic of lotic conditions.

5.2.5 Habitat Assessment

Habitat assessment data will be used to support success evaluation for the Aquatic Community and Threatened and Endangered Aquatic Species criteria. Habitat Assessment scores, sediment size class, and flow velocity data will be used to support improvement in aquatic community populations as well as demonstrate the presence of habitat for the Cape Fear shiner. It is anticipated that the habitat NCDWQ Habitat Assessment Form scores will quantitatively increase as the physical parameters of the Site Impoundment become more indicative of a lotic flow conditions. Thus, success evaluation will be based upon comparisons of quantitative habitat values between the former Site Impoundment and those of the lotic reference stations. More specifically, success is defined as a perceived progression of the former Site Impoundment habitat values toward those of the lotic reference stations.

Sediment Size Class Distribution

The pre-removal sediment size class sampling confirmed that there is a distinct difference in the grain sizes of impounded reach substrates when compared to the reference stations. This relationship is true for both the main stem of the Deep River and its tributaries. The median grain size (D50) is 22.16 mm (79-percent) coarser in the reference reaches of the Deep River than reaches sampled from within the Site Impoundment. For tributaries, the median grain size is 2.69 mm (97-percent) coarser in the reference reaches than tributary reaches within the Site Impoundment. **Table 8** provides the distribution of sediment grain sizes for both reference and impounded reaches of the Deep River and its tributaries. The D16 value is a metric that describes the sediment size where 84-percent of all sampled grains were larger, the D50 value is the median grain size, and the D84 value is a metric that describes the sediment size where only 16-percent of all sampled grains were larger. In combination, these metrics allow comparisons of the smaller, median, and larger grain size classes between the impounded and reference reaches.

Table 8. Mean Values of Size-class Indices for Impounded and Reference Stations on the Deep River and Tributaries

Impounded Stations						Reference Stations					
Deep River			Tributaries			Deep River			Tributaries		
D16 (mm)	D50 (mm)	D84 (mm)	D16 (mm)	D50 (mm)	D84 (mm)	D16 (mm)	D50 (mm)	D84 (mm)	D16 (mm)	D50 (mm)	D84 (mm)
3.67	5.73	11.88	0.08	0.10	2.19	2.59	27.89	104.11	0.17	2.79	13.82

It is anticipated that the D16, D50, and D84 values from within the former Site Impoundment will all coarsen over the monitoring period. No specific quantitative threshold is currently proposed for this metric; however, these data will be valuable in determining the re-establishment of appropriate habitat for fishes, mussels, and specific feeding guilds of macroinvertebrates.

Flow Velocity

The pre-removal flow velocity measurements confirmed the lentic flow conditions within the Site Impoundment as described in the Restoration Plan (Restoration Systems 2005). Additionally, the flow data describe the distinct difference between the flow conditions of reference and impounded stations. **Table 9** provides the Year 2005 flow data that demonstrate a substantial difference between flow conditions at lentic and lotic stations.

Table 9. Summary of data for measured flow velocities within the Site Impoundment and reference reaches. These data include the maximum, minimum, mean (average), and standard deviation flow velocities. For each flow regime, summary data are provided for one-foot below the water surface [surface] and one-foot above the stream bottom at stations with a maximum depth greater than 4-feet [depth].

	Site Impoundment		**Reference Reaches**	
	Max Flow Velocity (m/sec) [surface]	Max Flow Velocity (m/sec) [depth]	Max Flow Velocity (m/sec) [surface]	Max Flow Velocity (m/sec) [depth]
HIGH	0.16	0.34	0.29	1.51
LOW	0.00	0.00	0.00	0.00
MEAN	**0.03**	**0.03**	**0.07**	**0.62**
Standard Deviation	0.04	0.07	0.09	0.57

5.3 PROTECTED SPECIES

Some populations of fauna and flora have been in, or are in, the process of decline due to either natural forces or their inability to coexist with human activities. Federal law (under the provisions of the Endangered Species Act of 1973, as amended) requires that any action likely to adversely affect a species classified as federally protected, be subject to review by the FWS. Other species may receive additional protection under separate state laws. Informal Section 7 consultation with the FWS resulted in their concurrence with a "Not Likely to Adversely Affect" for the project. The FWS has written correspondence (see **Appendix E**) that supports this project and indicates that the Section 7 consultation has already been completed based on their preliminary understanding of how the project was to proceed. RS consulted with the FWS on behalf of the Cape Fear shiner, throughout the dewatering and demolition process, and the agency agrees with the biological conclusions provided during the Restoration Plan (Restoration Systems 2005).

As stated in the monitoring success criteria for fish and mussels (Sections 5.2.2 and 5.2.4), the documented presence of any 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 (CULTURAL RESOURCES)

The term "cultural resources" refers to prehistoric or historic archaeological sites, structures, or artifact deposits over 50 years old. "Significant" cultural resources are those that are eligible or potentially eligible for inclusion in the *National Register of Historic Places*. Evaluations of site significance are made with reference to the eligibility criteria of the National Register (36 CFR 60) and in consultation with the North Carolina State Historic Preservation Office (SHPO). A file search was conducted at two SHPO offices (the Office of State Archaeology [OSA] and the Survey & Planning Branch) in order to determine whether cultural resource investigations have been conducted within the project vicinity, and to determine whether significant cultural resources have been documented within the Site Impoundment.

As described in the Restoration Plan (Restoration Systems 2005), the demolition of the Carbonton Dam was evaluated by SHPO. The dam and powerhouse were evaluated through a National Register eligibility determination. The resulting study determined the facility was eligible for listing in the National Register under Criterion A, and certain mitigation measures were necessary prior to its removal.

RS has concurred with a Memorandum of Agreement (MOA) between the SHPO and the USACE. Mitigation measures were performed by RS to offset the impacts to these historic structures. These measures included a photographic recordation of the dam and the planned installation of an interpretive display recalling the history of the dam once the park (see Section 5.4.1) is developed on the Site. In addition, in an effort to be sensitive to the need for a permanent record of the structure, RS has generated an architectural survey drawing of the dam and powerhouse. The original commitment to undertake these measures and the successful implementation has allowed RS to obtain a letter of concurrence for Section 106 approval from SHPO (Appendix F).

5.4.1 Public Recreational Usage

RS has retained a landscape architect who is developing a basic park concept in coordination with the Deep River Parks Association (DRPA). The DRPA is a non-profit 503(c)(3) Corporation that presently owns and operates a public park in Lee County and manages McIver's Landing at Planck Road. The proposed park boundary at the Site will protect approximately 5 acres of river floodplain and contain approximately 715 linear feet of public-access frontage on the Deep River. The intention is that the Site be a passive recreation area consisting of vehicle parking, picnicking sites, bank fishing, and improved access to the river's edge where for kayakers and canoeists. **Figure C** (**Appendix A**), *Park Concept Plan,* depicts a preliminary footprint of the park and the facilities that RS will provide before turning the land over to the TLC. The proposed park is still in the planning phases, and the details and implementation will be completed prior to the end of the monitoring period. The amount of credit to be derived from the successful implementation of the park has not yet been determined, but will be used to offset any potential loss of credits from other aspects of the project.

Additionally, once the park has been designed and implemented, RS will place interpretive signs at the park to memorialize the Carbonton Dam, and describe the cultural and natural history of the area. RS has received interest from N.C. Department of Cultural Resources to place identical signs at the nearby House in the Horseshoe State Historic Site which is located on the former Site Impoundment Historic construction photographs, schematics of the dam, and modern pictures of the dam removal will likely be incorporated into the interpretive message.

5.4.2 Scientific Research

The former Site Impoundment is subject to a study by Adam Riggsbee, Phd and a UNC Chapel Hill PhD Candidate Jason Julian. RS has provided UNC with funding for any research project the University deems necessary. The projects that have been undertaken by the Candidates involve the physical processes that control the availability of light near the river bottom, and how the available light affects primary and secondary productivity. The research may be beneficial in measuring the positive impacts to biological productivity that occurs from lowering the water levels after dam removal to facilitate light penetration to the river bed. Additional research investigates the role of sediment suspensions (resulting from dam removal) on nutrient and organic matter availability within the downstream water column. This research is still underway, and the details of the study and its findings will be completed prior to the end of the monitoring period. The amount of credit to be derived from the successful support of this research by Restoration Systems has not yet been determined, but will be used to offset any potential loss of credits from other aspects of the project.

6.0 REFERENCES

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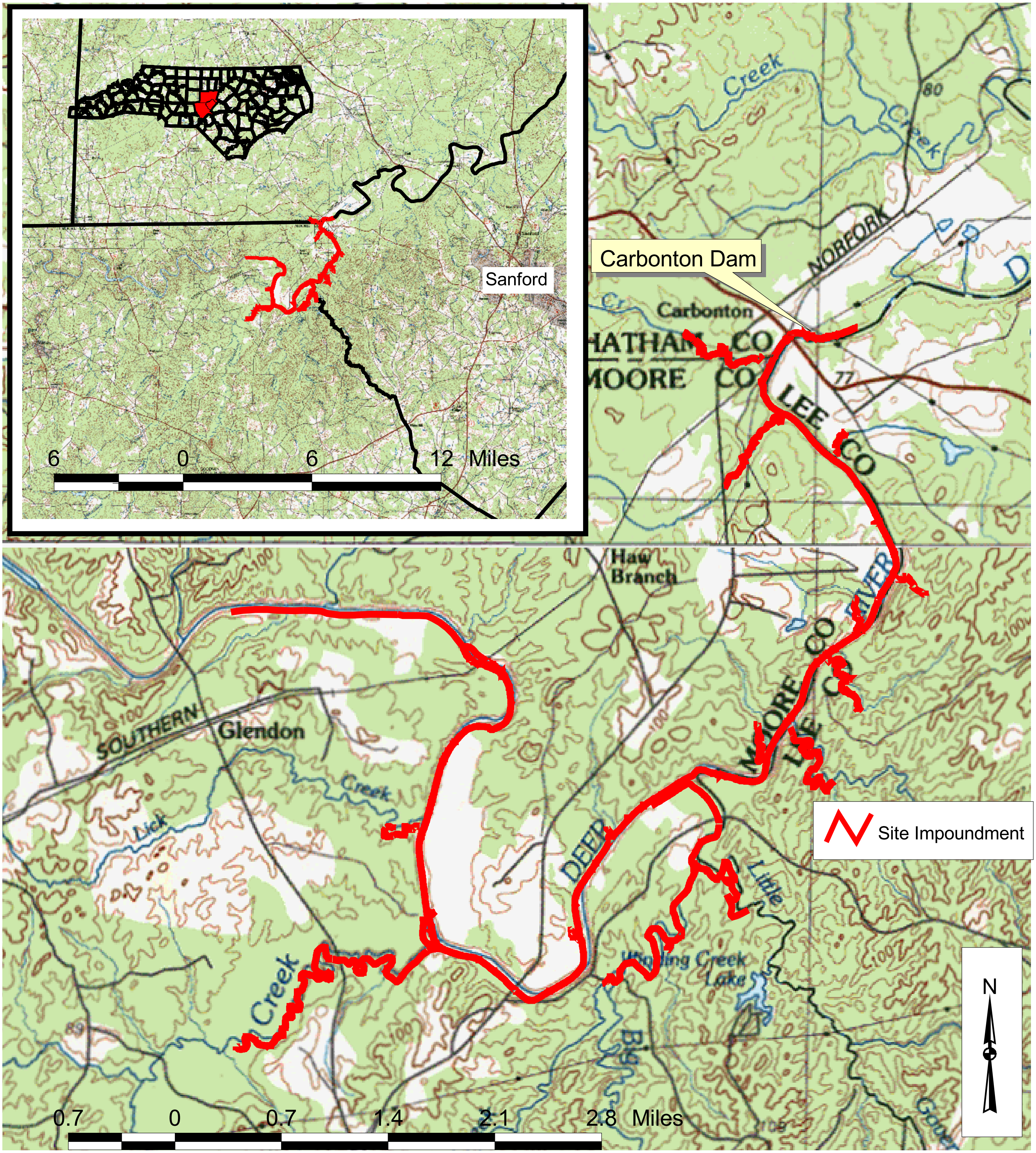
APPENDIX A: FIGURES



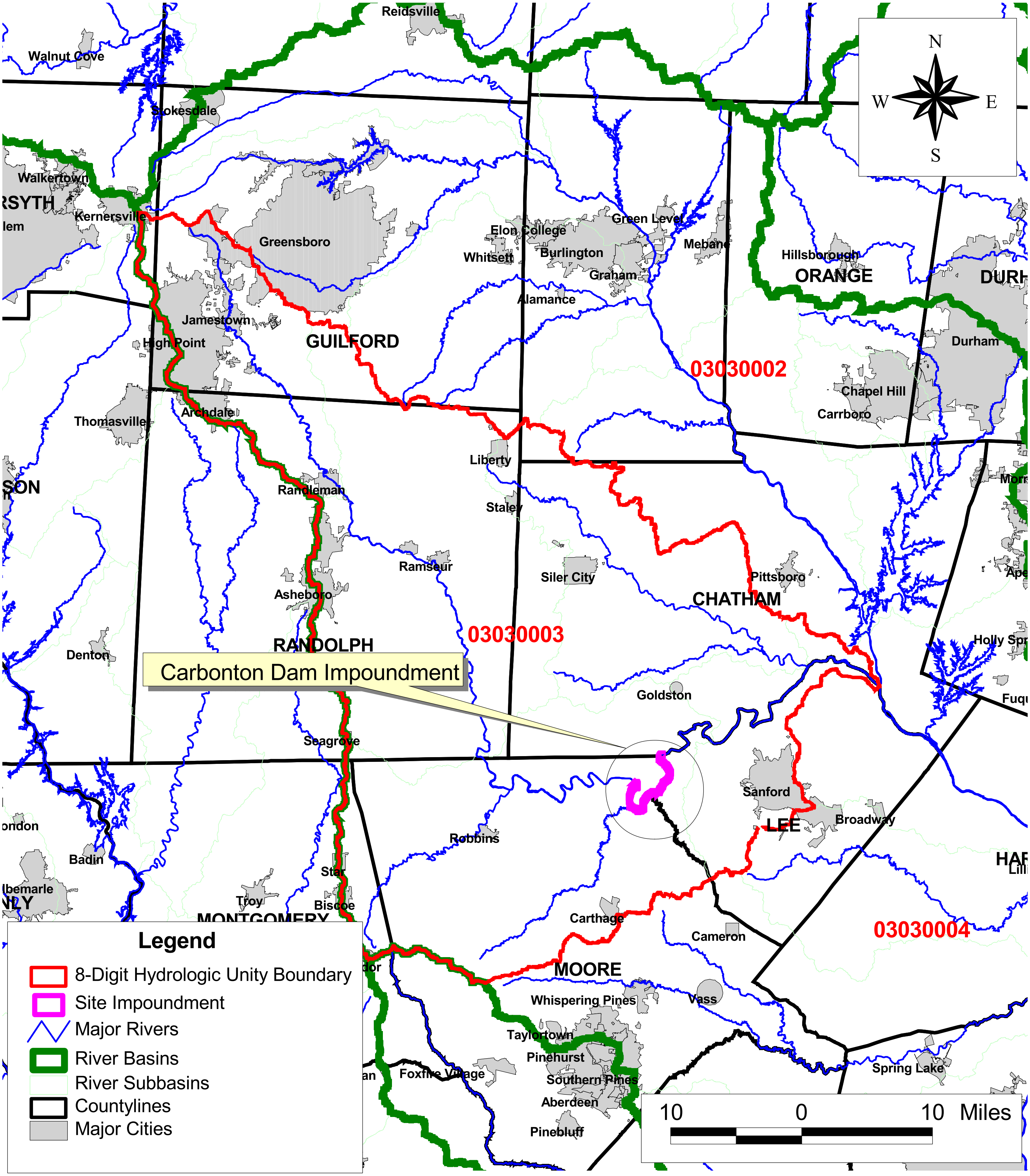
EcoScience

Site Location

Deep River- Carbonton Dam
Restoration Site

Lee, Chatham, and Moore
Counties, North Carolina

FIGURE 1	Drawn By: MTC	Date: July 2005
	Chkd By: APS	Project No: 05-235.03
	SCALE: AS SHOWN	



EcoScience Corporation

Raleigh, North Carolina

Hydrologic Units

Deep River-Carbonton Dam Restoration Site

Chatham, Lee, and Moore Counties,
North Carolina

Drawn By: MTC

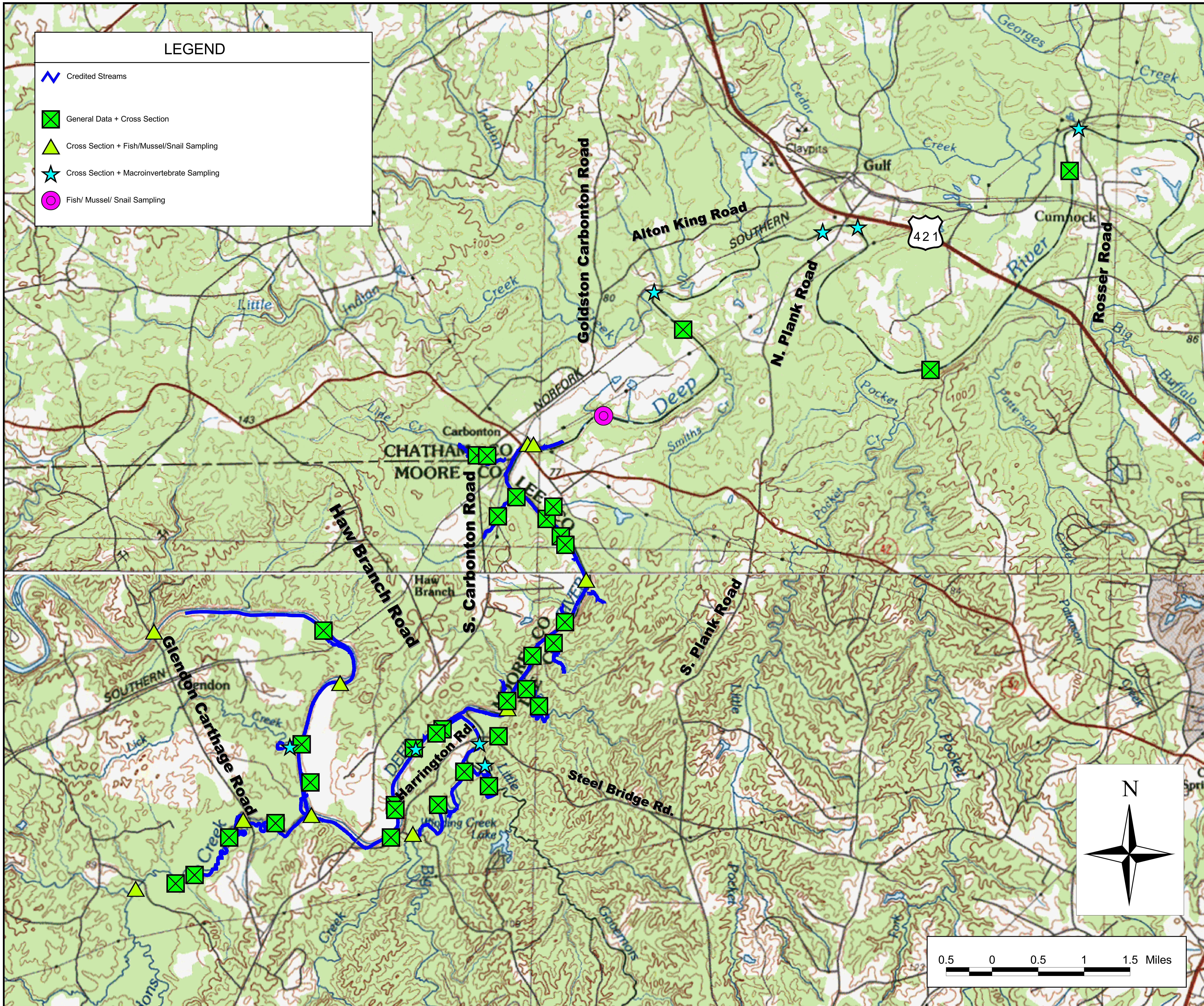
Chkd By: GRM

Date: July 2005

Project: 05-235

FIGURE

2



EcoScience Corporation
Raleigh, North Carolina

CLIENT:

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

Ecosystem Enhancement PROGRAM

PROJECT:

Deep River Carbonton Dam Restoration Site

Chatham, Lee and Moore Counties, North Carolina

TITLE:

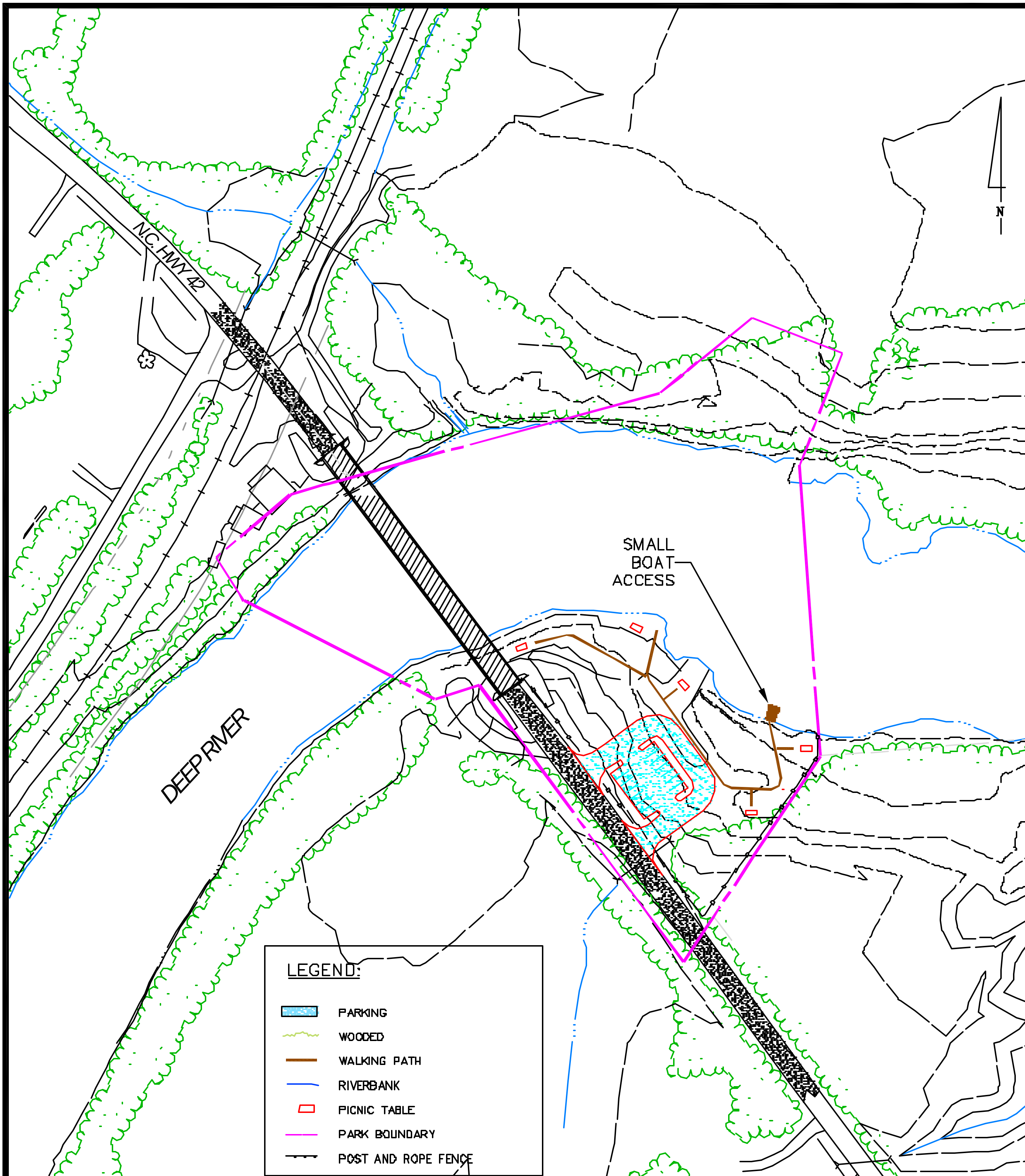
Monitoring Station Locations

Dwn By:	Ckd By:
JDG	MTC
Date:	Scale:
SEP 2006	AS SHOWN

ESC Project No.: 06-288.02

FIGURE

3



Restoration Systems, LLC
Natural Resource Restoration & Conservation
Engineering, Landscape Architecture and Environmental Science
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PARK CONCEPT PLAN

DEEP RIVER
CARBON DAM RESTORATION SITE
CARBONTON, NORTH CAROLINA

DATE: 8/1/05
SCALE: N.T.S.

FIGURE: 9

APPENDIX B: AGENCY GUIDANCE ON DAM REMOVAL

Determining Appropriate Compensatory Mitigation Credit for Dam Removal Projects

Developed cooperatively by US Army Corps of Engineers (COE), Wilmington District, US Fish and Wildlife Service (Service), US Environmental Protection Agency (EPA), Region IV, NC Division of Water Quality (DWQ), and NC Wildlife Resources Commission (WRC)
Version-4.0
March 22, 2004

Although dam removal projects would be expected to result in the restoration of natural stream systems that had been previously impacted, there is no established procedure to identify when and how dam removal can be utilized as compensatory mitigation for loss of streams and stream functions due to permitted development projects. The following guidance has been prepared to address these issues and is intended to provide the regulated community of North Carolina with joint and consistent District and DWQ Guidance.

The intent of this guidance is to provide a consistent method to determine mitigation credit derived from appropriate dam removal projects across the state.

This guidance is intended to apply to the removal of larger dams. Removal of smaller dams (generally involving impoundments of 10 acres of surface area or less) may provide project specific compensatory mitigation opportunities, utilizing channel restoration that follows the typical natural channel design methods. The DWQ will use this guidance as a working policy. The Wilmington District also intends to use this guidance, but will do so only after the Corps follows its normal public interest review process, which provides for opportunity for public notice and comment. These guidelines should not be construed as affecting the applicability of the Clean Water Act (CWA) 404 (b)(1) Guidelines, found at 40 CFR Part 230, the Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army (DA) concerning the Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines, or the review process outlined in DWQ's rules (15A NCAC 2H.0506).

Although the agencies believe that there is benefit in dam removal projects, use of dam removal projects as compensatory mitigation should be used cautiously and on a limited basis until a better understanding of the benefits and consequences of dam removal projects is gained. It is anticipated that this guidance will be subject to periodic review and revision based on the review and monitoring of these projects. This guidance relates to dam removal projects only and is not intended to address other types of potential compensatory stream mitigation projects.

Debit/Credit Process

All considerations for compensatory mitigation credit for dam removal should be evaluated through the mitigation bank process involving a Mitigation Bank Review Team (MBRT) and subsequent execution of a Mitigation Banking Instrument (MBI). For proposals by the Ecosystem Enhancement Program (EEP), evaluation will be done by the EEP Program Assessment and Consistency Group (PACG) in accordance with the EEP Memorandum of Agreement (MOA). It is expected that all proposals will be adequately described in a planning document that is subject to review and approval by the appropriate agencies. Once it has been determined that a project may proceed under these guidelines, specific DA permit requirements for removal of the dam and any associated structures will be determined by the U.S. Army Corps of Engineers.

I. General criteria that will be considered when determining mitigation credit.

A. **Water quality issues:** Documented impairments to water quality in the impoundment that would be alleviated by removal of the dam. These include low dissolved oxygen levels, elevated temperatures (especially for trout or cool water ecosystems), elevated chlorophyll a, nutrient or toxicant levels or downstream flow interruptions. Other considerations include listing of the waterbody on the state's 303(d) list, or known, repeated violations of water quality standards, or High Quality Water (HQW) or Outstanding Resource Water (ORW) classification above or below the dam.

B. **Rare, endangered and threatened aquatic species:** State or Federally listed rare, endangered or threatened aquatic species that are likely to colonize the restored stream reach. Long-term monitoring (beyond 5 years) may be needed in order to demonstrate that this criterion has been met. If monitoring fails to demonstrate suitable habitat improvements or the presence of appropriate species, as described in the approved mitigation plan, then credit amount and/or release of future credits may be adjusted. In some instances, reintroduction of species by the appropriate agencies may be done in conjunction with the project.

C. **Establishment of an appropriate aquatic community:** Removal of the dam may result in the restoration of the appropriate aquatic community. Success criteria for this category may be based upon a demonstrated improvement of water quality from "good" to "Very Good" within the monitoring period. Use of DWQ's Benthic Macroinvertebrate stream rating system or similar metrics may be used to measure this criterion. Finally, restoration of non-anadromous fish use (such as Darters) may also receive mitigation credit on a case-by-case basis. The credit would be based upon documentation of restoration of the fragmented aquatic habitat.

D. **Anadromous fish passage:** Documented re-establishment of anadromous fish use of streams upstream of the removed dam. If monitoring fails to demonstrate the presence of anadromous species, as described in the approved mitigation plan, then credit amount and/or release of future credits may be adjusted accordingly. In some, but not all cases, the applicant may be credited at a ratio of 5:1 for this criterion. However, the final decision will be determined as outlined in the Debit/Credit Process.

When reviewing projects pertaining to either endangered/threatened species and/or anadromous fish criteria, the MBRT and/or PACG will solicit the expertise of the appropriate Federal agency (USFWS) and/or the National Marine Fisheries Service (NMFS) for federally listed species and the NCWRC and/or the North Carolina Division of Marine Fisheries (NCDMF) for state listed species to determine the viability of the restoration of endangered or threatened species and/or their habitat or anadromous fish of the project and will provide feedback with regard to the monitoring and the success criteria established by the project proponent.

II. Additional site-specific factors that may be considered during the review of dam removal projects for mitigation credits

A. **Wooded buffers:** Although wooded buffers are less critical for temperature control, aquatic food chain support and physical stability on larger rivers, this guidance recognizes the benefits that wooded buffers provide and encourages their establishment, where possible. More favorable mitigation credits will be supported where fully protected, wooded buffers (planted or otherwise protected) are established on both sides of the waterbody. Buffers of at least 50 feet (30 feet in the mountains) are needed for water quality benefits while buffers up to 300 feet wide are often cited as valuable for wildlife habitat and corridors or where threatened or endangered species are present. The provision of wooded buffers will be treated as a significant factor for the amount of credit available from the site as described in Table 1.

B. **Human values:** If the project is designed to provide direct human benefits including recreational benefits (such as parks, trails, marked canoe trails, boat access, and signage for environmental education) or scientific research conducted beyond the required monitoring of the project, then additional credit may be generated as follows:

An additional 20% bonus (with no more than 10% for each category and up to no more than the maximum credit) could be available.

The purpose of this provision is to encourage dam removal applicants to provide these additional benefits to the public from the dam removal. These activities offered by the applicant may offset any negative local public perception associated with the dam's removal, if any. The provision of new recreational opportunities may also help offset any change in existing recreational uses such as traditional hunting or boating.

C. **Calculation of compensatory mitigation for dam removal.**

1. **Selection of projects**: Not all dam removal projects will be suitable for compensatory mitigation. If the dam removal does not meet any of the four general criteria listed above (e.g., water quality issues in the lake, endangered and threatened aquatic species, reestablishment of improved aquatic life and/or anadromous fish passage), then it is unlikely that the Federal and State agencies will support removal of the dam as compensatory mitigation.

2. **Maximum Potential Credit:**
With the exception of III, below, the maximum potential credit (in linear feet) that may be generated by a single project will be the length of stream restored to flowing condition measured from the dam to the upstream edge of the normal pool as indicated by the elevation of the crest of the dam for run-of-river dams or the outfall, whichever is lower in elevation. Restoration of flow in any perennial tributaries to the impoundment may also be counted. Any intermittent streams that would no longer be flooded may be credited at one-half of their length. Alternatively, a functional habitat-based calculation may be used on a case-by-case basis when the either the MBRT or the PACG agree that such a calculation is appropriate. Regulatory agencies agree that such a calculation is appropriate.

3. **Credit for demonstrated downstream benefits:**
A length of river immediately downstream of the dam may exhibit aquatic life and stream bank stability benefits due to the restoration of natural flows. Credit may be available for this reach on a case-by-case basis based on monitoring

and evaluation by the appropriate agency review. The pool removal credit and the downstream benefit credit combine to establish the maximum potential credit. The amount of available credit associated from removal of the impoundment and the downstream benefit credit will be determined by either the MBRT or the PACG.

4. Baseline Mitigation Credit calculations: To establish the baseline mitigation credit, the maximum potential credit (as calculated above) will be adjusted based on the number of general criteria met and the length and width of any buffer that is protected (via conservation easement, etc.) adjacent to the restored stream.

If one criterion is met, 50% of the maximum credit will be available. In the event that 2 or 3 of the criteria are met, then the maximum credit will be 70%. Should all 4 criteria be present, then 100% of the maximum credit will be available. Furthermore, additional credit beyond 100% for buffer establishment and/or preservation will be determined on a case-by-case basis.

Table 1. Adjustment of Baseline Mitigation Credit based on the extent of protected buffers

Percent of Corridor Protected	Average Width[1]	Divide baseline credit by
100[2] to 75%	50 to 150 feet	0.75
	150 to 300 feet	0.70
74 to 50%	50 to 150 feet	0.85
	150 to 300 feet	0.80
49 to 25%	50 to 150 feet	0.95
	150 to 300 feet	0.90
24 to 0%	50 to 150 feet	1.0
	150 to 300 feet	1.0

[1] A minimum width of 30 feet can be substituted for the 50-foot threshold for projects in the mountains.
[2] Note that to facilitate calculation of buffer credits, the extent of the pre-project perimeter of the impoundment is equivalent to 100% of the buffer.

Only in exceptional cases, where sufficient documentation exists, will the baseline credit be increased to an amount that exceeds the maximum credit as above referenced Section C II.

It is acknowledged that it may be difficult to obtain easements (or other protective mechanisms) from all landowners along a channel. In addition, the acquisition and legal protection of buffers may take several years. Project sponsors are encouraged to propose what is likely to be obtained when the plan is submitted for review. Additional credit would be made available during the monitoring period as additional buffer is protected.

If these categories of buffer protection are not available, adjustments may be made on a case-by-case basis. These adjustments could be modified if the protection efforts target areas with special ecological functions and/or values that are identified by conservation groups such as the NC Natural Heritage Program. Areas that are already protected by conservation easements or public purchase can be utilized toward the protected buffer percentages. Additional credit may be provided on a case-by-case basis, if it is determined that the buffers need to be planted. Similarly, in river basins where DWQ administers riparian buffer protection rules that protect the wooded buffer, these credit multipliers would likely be recalculated on a buffer width after subtracting the area of the protected buffer.

5. Case-by-case process for unique situations: The agencies acknowledge that there may be unusual and unique dam removal scenarios (such as provision of a buffer substantially larger than suggested herein or removal of an urban dam with on-site, watershed based stormwater management), which will require additional flexibility and extensive inter-agency coordination. In these cases, a special Mitigation Banking Review Team may need to be established to address these scenarios.

D. **Other factors to consider on a case-by-case basis in the Debit/Credit Process:**

1. **Wetlands:** Removal of some dams will result in a net gain of wetland acreage while others will result in a net decrease in wetland acreage. A careful evaluation of the effect that the removal of a dam would have on wetlands should be made. This would involve considering wetland functions, values, and eco-region context, as well as possible restoration of these functions prior to dam removal. Protection of any drained wetland areas through conservation easements would be helpful. Any net increase of wetland acreage may be counted as wetland mitigation credit while any net decrease could result in the need for compensatory mitigation to offset those impacts.

2. **Sediment:** The dam should be removed gradually to lessen the downstream impact of any accumulated sediment on downstream biota. Preferably the site should be dewatered and the dam gradually notched over a large portion of the monitoring period. Other methods of gradually lowering the water level will also be considered. Fish and other aquatic moratoria may provide useful guidance for the timing of dam removal. Monitoring of sediment stability in newly exposed stream banks will be necessary to determine if temporary planting will be needed to control erosion. If the sediments are believed to contain toxicants such as heavy metals and toxic organic chemicals, then testing will be needed prior to removal of the dam. If levels of toxicants are problematic, then management of these sediments (including removal and appropriate disposal) will be needed before dam removal. However, if it is determined that the release of those toxicants would be detrimental to the aquatic environment, the MBRT or PACG may exclude the project from further consideration.

3. **Monitoring:** The purpose of monitoring is to document the projected benefits of the dam removal, identify any problems encountered and propose solutions, as well as, justify the amount

of credit and the credit release schedule for the project. Monitoring of the biological, chemical and physical effects of dam removal will be required before, during, and after dam removal. Annual reports to the relevant agencies are also required. Action plans should then be developed, approved by the permitting agencies and implemented to address any problems found during the monitoring period. Monitoring should be done for five (5) years after the initiation of dam removal with one year of pre-dam removal monitoring to document baseline conditions. Monitoring should consider fish and macrobenthos monitoring, limited water chemistry monitoring, as well as stream bank stability and reestablishment of a stable channel within the now-drained impoundment. Finally, the monitoring plan must document how the project has resulted in an improvement to any of the criteria upon which the project was based. Existing data may be useful in this regard. If monitoring doesn't support the expected credits based on the criteria listed above, then the number of credits should be adjusted, as appropriate.

4. Remedial action: If problems are identified before, during or after dam removal, a remedial action plan must be developed which adequately addresses these issues. For instance, if the newly exposed stream banks are experiencing erosion, then a temporary seeding of a non-invasive annual plant may be needed until the native vegetation can stabilize these sites. Similarly, if downcutting occurs in the tributaries to the dam, measures to stabilize these streams may be necessary. Monitoring programs must be designed to identify these (and other) potential problems so they can be addressed adequately. If active measures are needed, then the use of natural channel design is recommended.

5. Long-term protection of the dam site: The dam site will need to be protected with a conservation easement to ensure that construction of a new dam will not occur. The extent of long-term protection of the remainder of the restored stream corridor will determine, in part, the mitigation credits as outlined in the buffer protection portions of this guidance.

6. **Rare, threatened and endangered species:** Dam removal in habitat known to support state or Federally listed rare, threatened or endangered species must be coordinated with the appropriate state and Federal agencies to ensure that upstream and downstream habitat is not adversely affected.

7. **Exotic species:** The upstream habitat should be thoroughly surveyed to ensure that exotic flora and fauna are not released downstream and that exotic fauna do not invade the area of the drained impoundment.

8. **Downstream flow alteration:** Following the removal of a dam, possible downstream flow alterations should be examined. Possible alterations could include changes in the regulated floodplain, alterations in the downstream channel morphology and low flow implications for wastewater dischargers.

9. **Existing physical constraints:** Existing features such as roads parallel to the channel, utilities or structures need to be considered with respect to the practical amount of buffer that can be restored or protected. If some of these features cannot be moved, then the maximum of possible buffer credit should be adjusted accordingly.

10. **Downstream flooding:** In most situations, it is likely that dam removal will have a negligible effect on downstream flooding. However, if this factor is of concern to the public or the agencies, then a modeling effort may be needed to evaluate this factor.

11. **Water Supply protection:** It is unlikely that dams will be approved for removal as compensatory mitigation if they are being actively used as water supplies. In any event, project proponents should check the

classification of the water to be certain that it is not being used as a water supply.

E. Credit Release Schedule:

For dam removal projects when credit release schedules are appropriate (i.e., mitigation banks), the agencies propose to follow the recently agreed upon, joint federal and state credit release schedule for stream mitigation as outlined below. This schedule has been modified slightly to reflect the definitional differences between more typical stream mitigation and dam removal since some provisions for stream mitigation do not apply to dam removal projects.

<u>Initial crediting: 15%</u>

Execution of MBI (where appropriate)
Approval of final mitigation plan
Delivery of financial assurances
Recordation of preservation mechanism

<u>Construction release (initiation of gradual dewatering of the lake): 10%</u>

Upon initiation of initial physical and biological monitoring (25% cumulative)

<u>After year 1:</u> 10% if a bankfull event has not occurred; 20% if bankfull event has occurred, if channel is stable and other success criteria (if any) are met (cumulative 35% and 45%). This assumes that the project is satisfying the criteria upon which it was based.

<u>After year 2:</u> 10% if first bankfull event occurred in previous year or a bankfull event does not occur in this year; 20% if bankfull event has occurred and if the restored stream channel is stable and other success criteria (if any) are met (cumulative 45% and 55%). This assumes that the project continues to satisfy the criteria upon which it was based.

<u>After year 3:</u> 10% or 20% (same as year 2) (cumulative 55% to 65%). This assumes that the project continues to satisfy the criteria upon which it was based.

<u>After year 4:</u> 10% or 20% (same as year 2 and year 3), (cumulative 65% to 75%). This assumes that the project continues to satisfy the criteria upon which it was based.

After year 5: 25% if at least one bankfull event has occurred in the previous year(s). 35% if the first bankfull event occurs in year 5 and the agencies make a determination of success as defined in the mitigation plan. This assumes that the project continues to satisfy the criteria upon which it was based.

The above release schedule is to be utilized as a guideline, but can be modified by either the MBRT in the event that monitoring reveals that identified success criteria are being met prior to the outlined release schedule.

APPENDIX C: SEDIMENT TOXICITY ANALYSES

Preliminary Evaluation of Sediment Chemistry Data (Tier 2) for Deep River near Carbonton Dam

USFWS, Raleigh Field Office

Summary

Seven sediment samples from within the impounded reach of Carbonton Dam on the Deep River (Moore, Chatham and Lee Counties, North Carolina) were collected in October 2005 and analyzed for elemental contaminants. Ninety-six 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 results exceeded the *probable effects concentrations* (*PECs*, concentrations above which adverse effects to sediment dwelling organisms may be expected). Two of the seven nickel results (or about four percent of the overall sample results) fell between the TEC and PEC screening values, but they were near the low end of this range (at or below the geometric mean of the screening values). Based on review of existing data (tier 1) and results of sediment chemistry (tier 2), contamination in surface sediments behind Carbonton Dam is unlikely to be a concern, either in-place or upon mobilization. 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 September 2005, the U.S. Fish and Wildlife Service's Raleigh Field Office distributed a draft report, ***Tier 1 Preliminary Evaluation of Sediments within the Carbonton Dam Impounded Reach, Moore County, North Carolina***. That document reviewed existing information on the potential for sediment contamination in the impounded reach of the Deep River upstream of Carbonton Dam. Information reviewed included sources of contamination, pathways of contaminant transport, and the physical nature of the sediments behind the dam. We were fortunate to find high quality sediment chemistry for Deep River sediments upstream and downstream of Carbonton Dam (Howard 2003, NCDWR 2005). The review indicated no major pollutant sources or contaminant concerns upstream of the dam.

Although a strong argument could be made that tier 2 testing was not necessary based on the results of this tier 1 assessment, it was recommended that a limited number of samples be collected and analyzed to generate site-specific data on the chemical and physical quality of the sediments behind Carbonton Dam. The recommendations and a draft sediment sampling and analyses plan were circulated to regulatory agencies for review (USFWS 2005) prior to implementation of the sediment sampling. The following summary presents the sediment sampling methods, analytical results, and an interpretation of the findings.

Methods

Sample locations:

Factors considered in determining the number and location of samples included the absence of contaminant concerns in record reviews and the intent of the sampling (to provide current analytical data to support the inference of low contaminant burdens based on historical data). Physical factors considered included the area of potentially affected sediments behind the dam, distribution of sediments, and the length / breadth of the impounded reach. Seven sites spanning the entire impounded reach were sampled (Table 1 and Figure 1). Three of these were from behind the dam with the remaining samples further upstream in the impounded reach at quiescent areas, such as inside channel bends, where fine-grained sediments (which have the greatest potential to accumulate contaminants) would settle.

Sediment sample collection:

Samples were collected 10/10/05 and 10/11/05. 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. 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, and a final rinse with distilled / demineralized water) before sampling each site. Aliquants of the homogenate were put into certified clean I-Chem Research glass jars with Teflon-lined lids. An aliquant was also put into a 4-L HDPE container in the event that additional testing is conducted. Samples were stored in a cooler on ice (~ 4 ^oC) in the field and frozen upon reaching the Service lab in Raleigh until they were delivered to the analytical lab on 10/12/05. Samples were collected, transported, and stored under chain of custody.

Sediment chemical analyses:

Chemical and Environmental Technologies, Inc. (CET) of Cary, North Carolina performed the analyses. CET has the North Carolina Laboratory Certification for the requested analyses. Sediment samples were analyzed for elemental contaminants (As, Cd, Cu, Cr, Hg, Ni, Pb and Zn) by inductively coupled plasma mass spectrometry, inductively coupled plasma atomic emission spectrometry, and cold vapor atomic absorption. 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

The report from CET is reprinted in Appendix A and summarized here. Review of quality control samples (laboratory blanks, spiked samples, and duplicates) indicates good 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).

Ninety-six 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, copper, mercury, lead, and zinc. No samples exceeded the PECs for any elemental contaminant, meaning there were no samples of obvious toxicological concern. The only TEC exceedences were for nickel analyses in two samples. We computed a geometric mean of the nickel TEC and PEC and defined it as a "median effects concentration", or "MEC". The nickel concentrations in the two samples are at or below the MEC (Figure 2g).

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 PECs. This means there were no sediment contaminant concentrations of obvious concern. Ninety-six percent of all elemental contaminant results were also less than the TECs, concentrations below which adverse effects to sensitive aquatic organisms should not occur, and are therefore considered toxicologically insignificant. Two of the seven nickel results (or about four percent of the overall sample results) fell between the TEC and PEC screening values, but they were near the low end of this range (at or below the geometric mean of the screening values). 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. The two Deep River samples that exceeded the TEC were at or below the MEC.

Based on the results of the tier 1 review (USFWS 2005) and tier 2 sampling, contamination in surface sediments behind Carbonton Dam is 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.

References:

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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.

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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.

Deep River Sediment Collection
Samples collected by Tom Augspurger, USFWS on 10/10/05 and 10/11/05 (with help from Mike Wicker, USFWS, and Jay Sinclair, Restoration Systems, on 10/11/05)

Carbonton 1 – Right bank (facing downstream) at inside bend about 0.5 miles downstream from RR trestle (10/10/05; 12:05 pm)
N 35.48331˚
W 079.38183˚

Carbonton 2 – Left bank (facing downstream) at inside bend of Horseshoe, about 1 mile downstream from confluence with McLendon Creek (10/10/05; 1:00 pm)
N 35.45689˚
W 079.37730˚

Carbonton 3 – Left bank (facing downstream) at inside bend about 0.3 miles downstream from Adam Riggsbee's secondary veg site (10/11/05; 9:40 am)
N 35.47768˚
W 079.35184˚

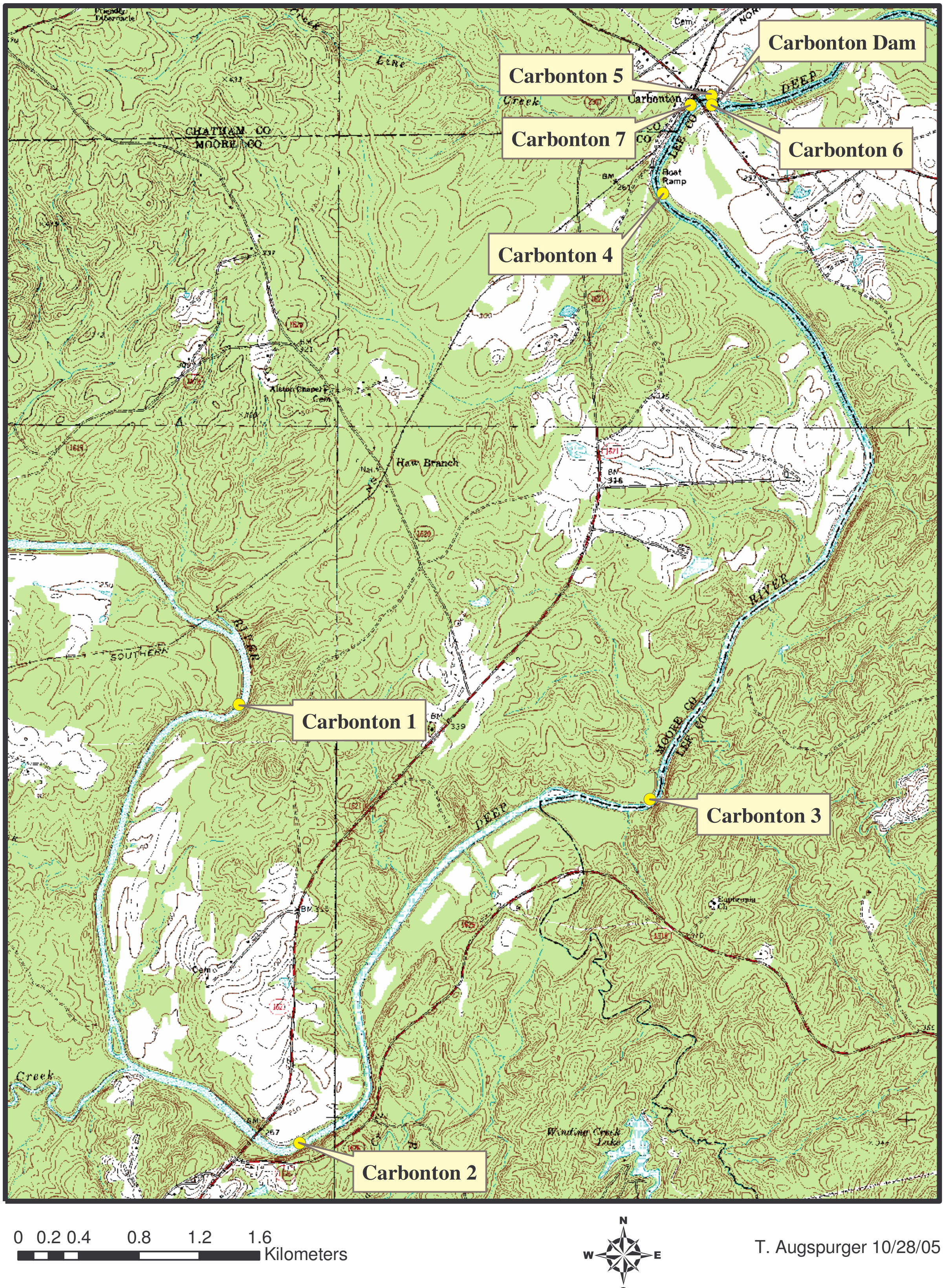
Carbonton 4 – Right bank (facing downstream) at inside bend just upstream of boat ramp (10/10/05; 3:15 pm)
N 35.51424˚
W 079.35104˚

Carbonton 5 – Left bank (facing downstream) near Adam's primary veg site between Hwy 42 bridge and dam (10/11/05; 10:30 am)
N 35.52015˚
W 079.34752˚

Carbonton 6 – Right bank (facing downstream) in front of powerhouse (10/11/05; 12:30 pm)
N 35.51958˚
W 079.34750˚

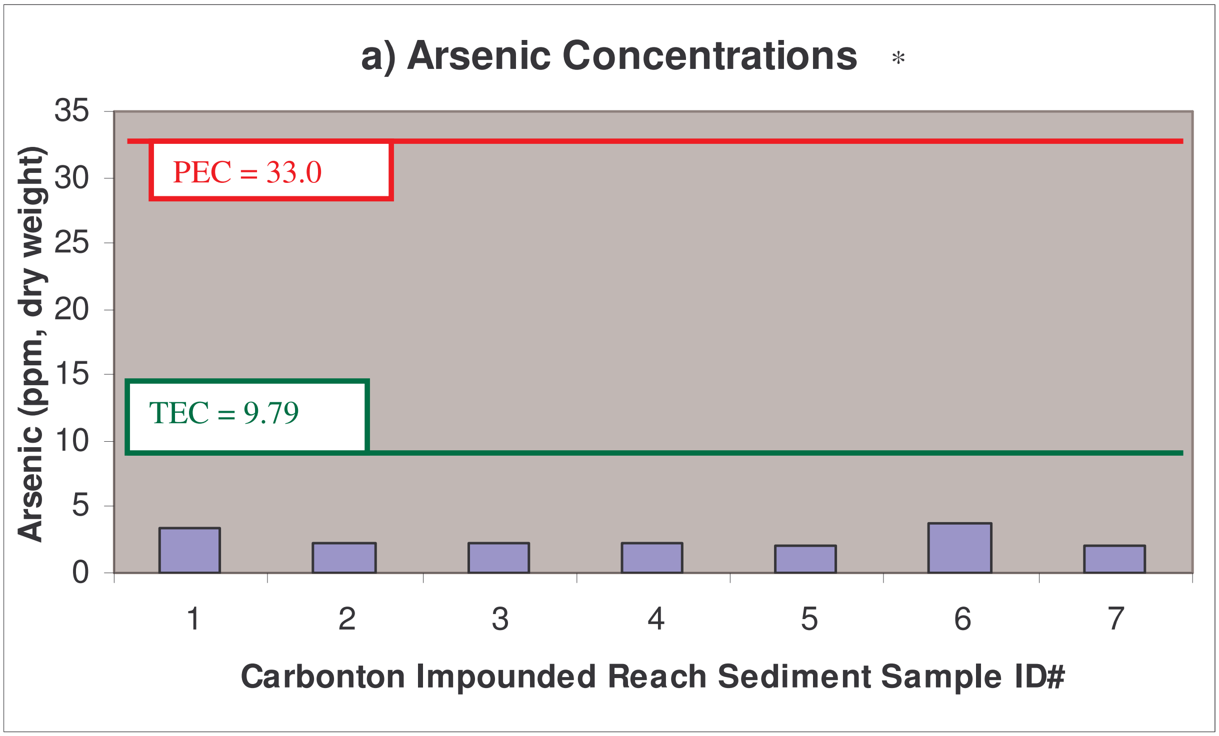
Carbonton 7 – Right bank (facing downstream) at inside bend between boat ramp and Hwy 42 bridge (10/11/05; 1:00 pm)
N 35.51955˚
W 079.34905˚

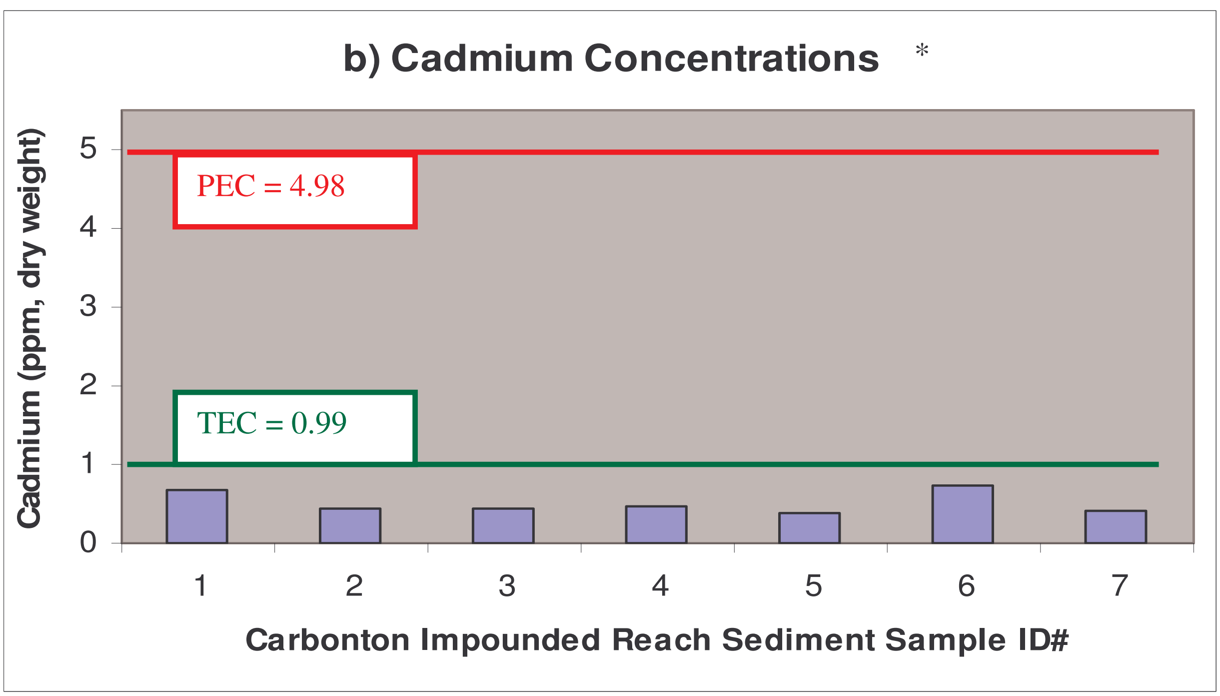
Figure 1. Deep River Sediment Sampling Points, October 2005



T. Augspurger 10/28/05

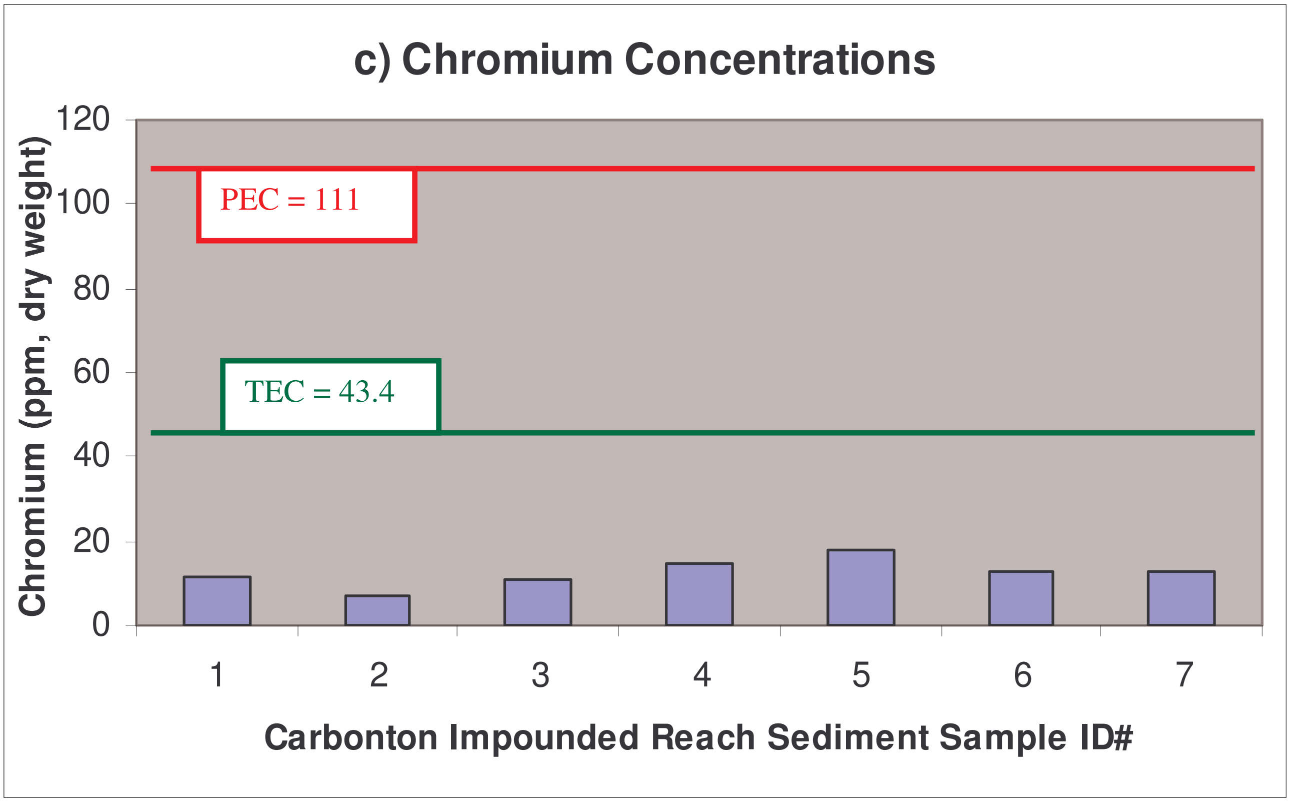
Figure 2 (a-h). Elemental contaminant concentrations of sediments collected within the Carbonton Dam impounded reach. For each element, results are compared to threshold-effects concentration (TEC) guidelines of MacDonald et al. (2000) -- values below which adverse effects to sensitive aquatic organisms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





* Arsenic was only detected in sample 5, and cadmium was not detected in any sample, the results provided are the sample-specific detection limits (i.e., arsenic and cadmium are known to be less than these values)

Figure 2 (cont.)



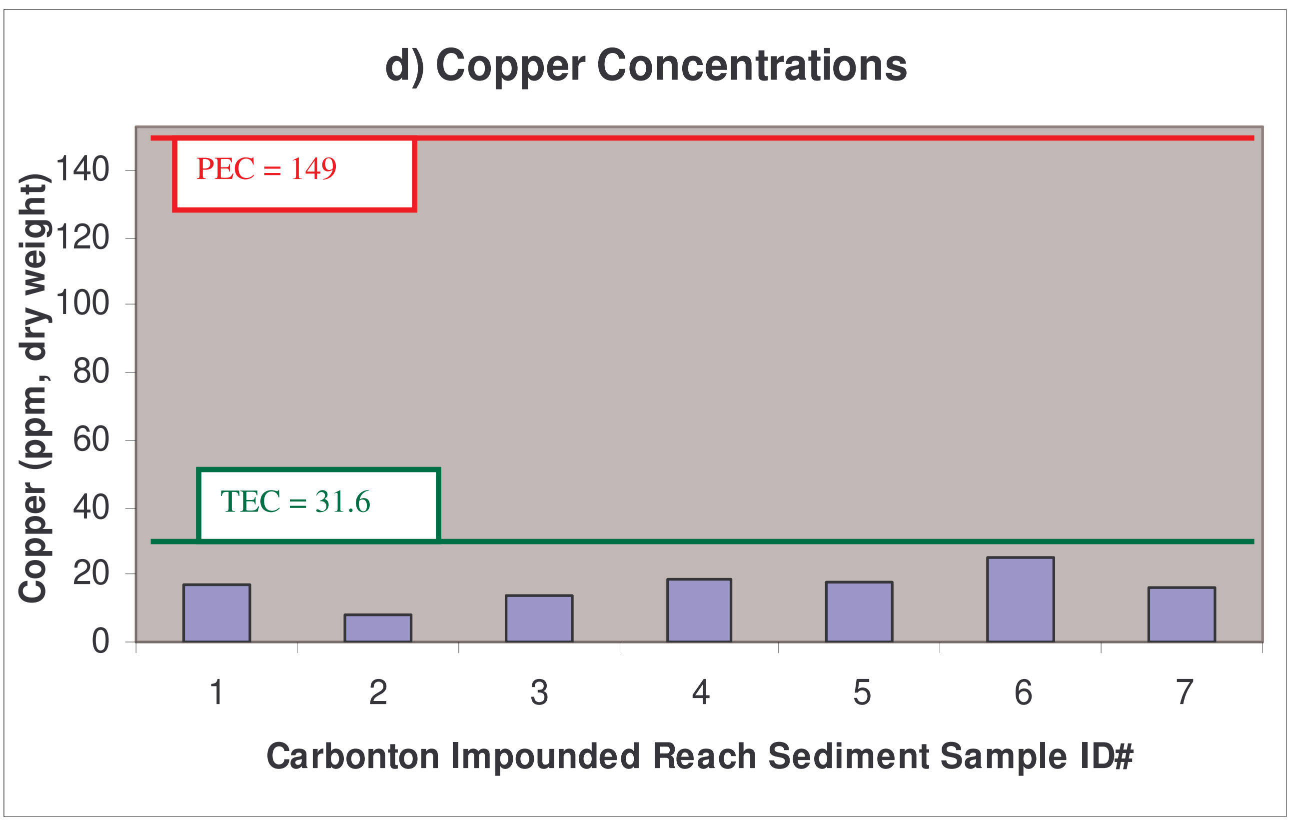
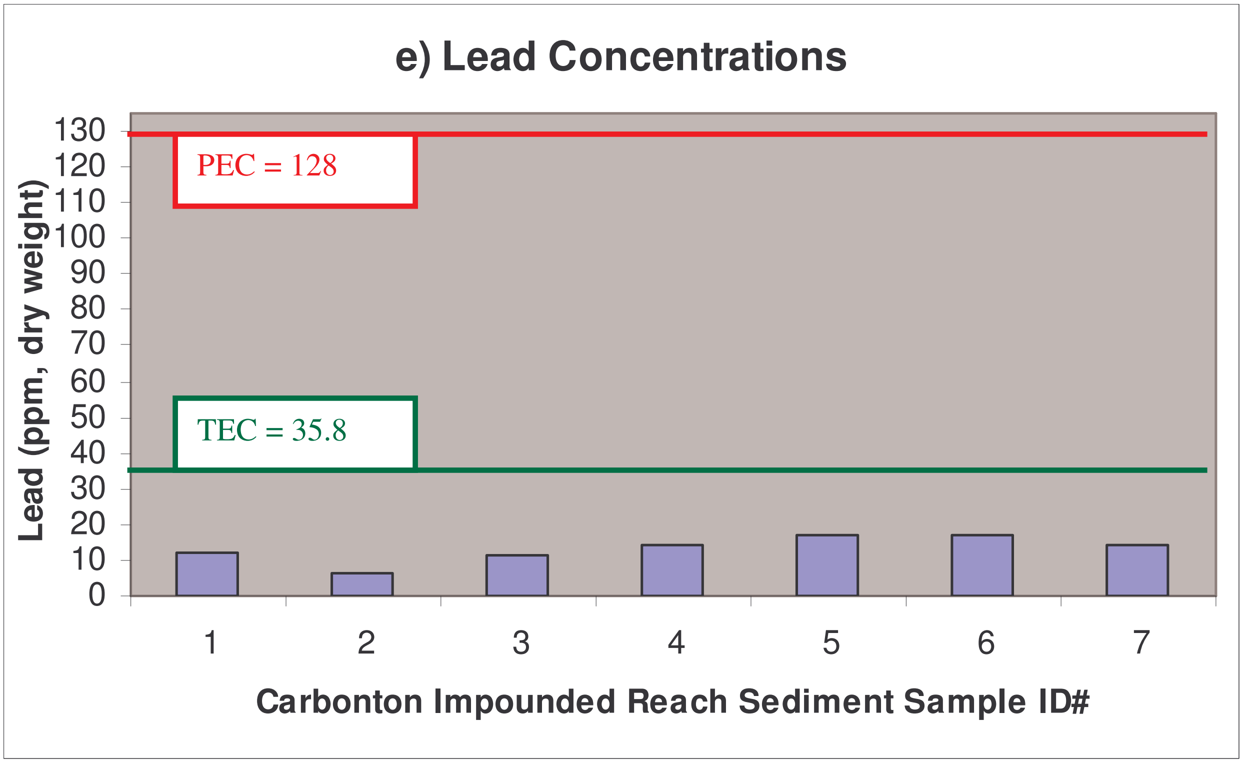


Figure 2 (cont.)



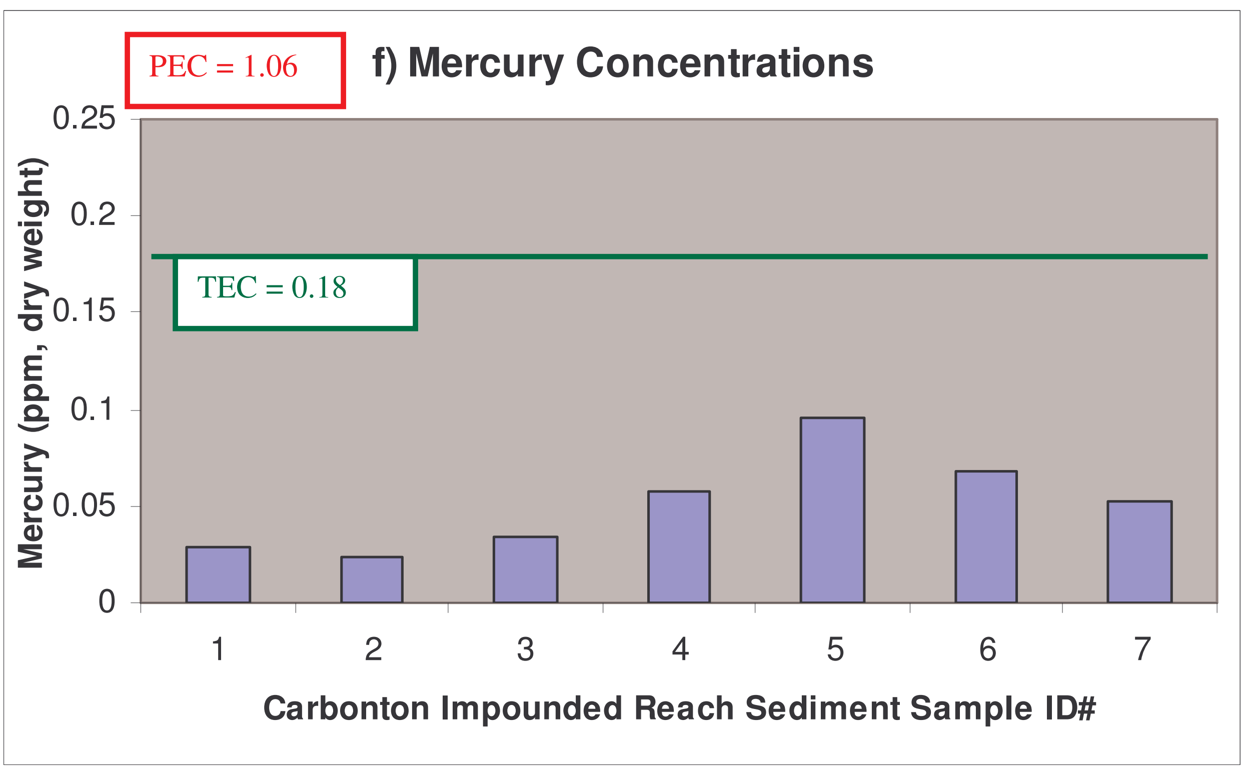
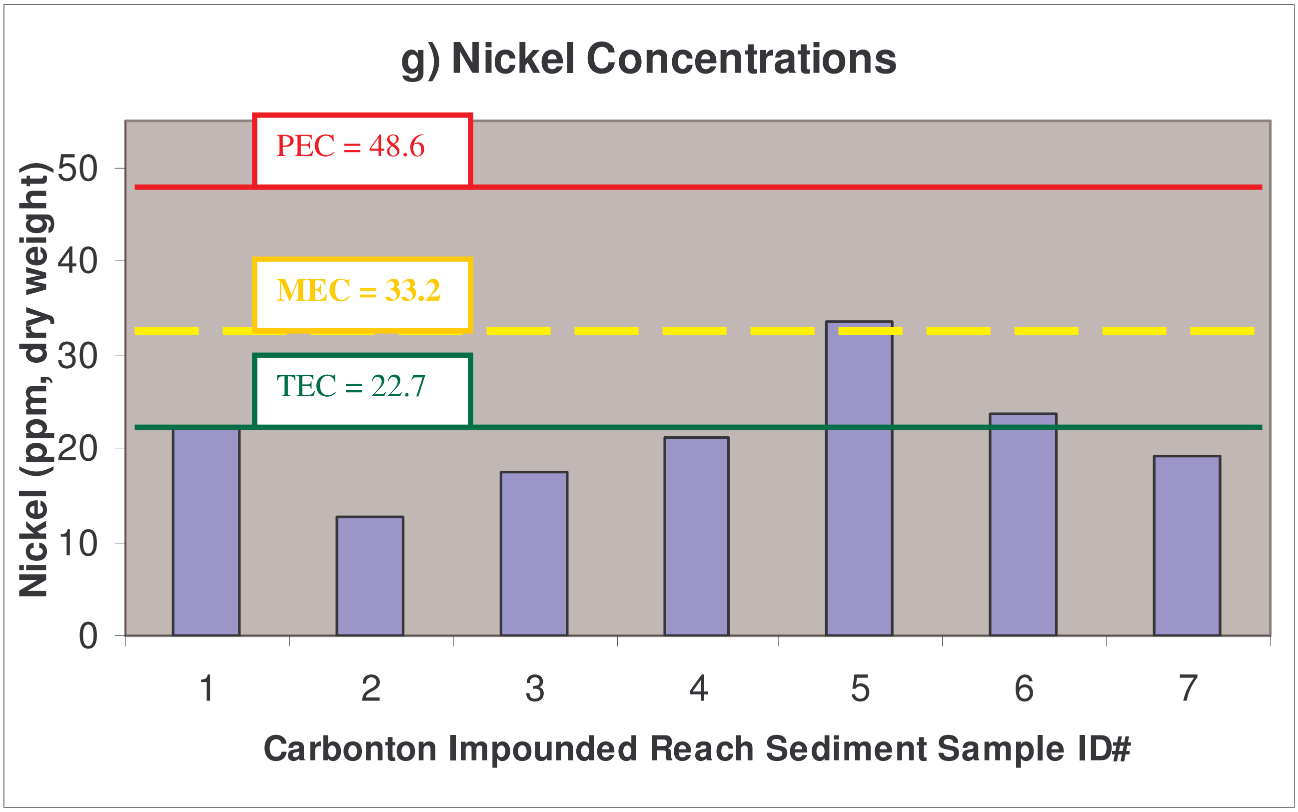
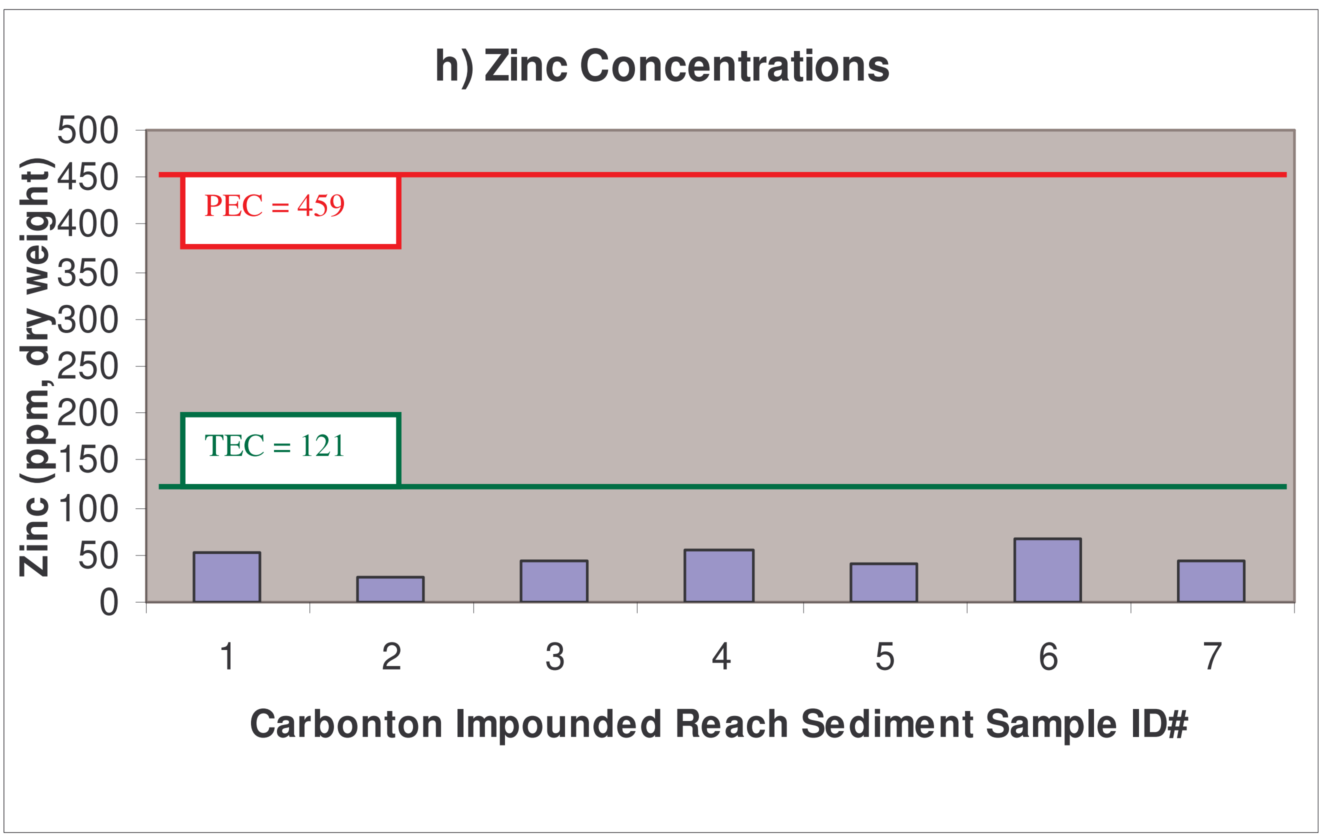


Figure 2 (concluded)





Appendix A. Analytical Chemistry Report and Chain of Custody Forms

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

ENVIRONMENTAL ANALYTICAL SERVICES

FINAL REPORT OF ANALYSES

RESTORATION SYSTEMS
Attn: RANDY TURNER
1101 HAYNES ST.
SUITE 107
RALEIGH, NC 27604-

REPORT DATE: 10/20/05

SAMPLE NUMBER- 230874 SAMPLE ID- CARBONTON 1 SAMPLE MATRIX- SO
DATE SAMPLED- 10/10/05 TIME SAMPLED- 1205
DATE RECEIVED- 10/12/05 SAMPLER- T AUGSPURGER RECEIVED BY- MNH
TIME RECEIVED- 1330 DELIVERED BY- T AUGSPURGER

Page 1 of 1 PROJECT NAME : DEEP RIVER SEDI

ANALYSIS	METHOD	SAMPLE PREP DATE	BY	ANALYSIS DATE	BY	RESULT	UNITS	PQL
PERCENT SOLIDS	2540G			10/13/05	ELH	35.6	NA	
PERCENT MOISTURE				10/13/05	ELH	64.4	percent	0.1
VOLATILE SOLIDS IN SOLIDS				10/17/05	ELH	11.0	percent	
ALUMINUM IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	12,000	mg/kg	3.40
IRON IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	17,400	mg/kg	13.6
MERCURY IN SOLID	7471	10/19/05	JFL	10/20/05	JFL	0.029	mg/kg	0.011
ARSENIC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 3.40	mg/kg	3.40
CADMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 0.68	mg/kg	0.68
CHROMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	11.8	mg/kg	3.40
COPPER IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	17.3	mg/kg	1.36
LEAD IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	11.8	mg/kg	1.36
MANGANESE IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	329	mg/kg	3.40
NICKEL IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	22.2	mg/kg	3.40
ZINC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	51.0	mg/kg	3.40

PQL = Practical Quantitation Limit
Results followed by the letter J are estimated concentrations.
All results for soil and sludge samples are reported on a dry weight basis as required by the NC DEM Laboratory Certification Section. Wet Weight Concentration = (dry weight conc.)(percent solids)/100.

NC DENR CERTIFICATIONS: DWQ - 96; PUBLIC WATER SUPPLY - 37724
* PLEASE REFER TO ENCLOSED REPORT GEOTECHNOLOGIES, INC.

LABORATORY DIRECTOR

P.O. Box 12298 • Research Triangle Park, NC 27709
Telephone (919) 467-3090

Shipping: 102-A Woodwinds Industrial Court • Cary, NC 27511
Fax (919) 467-3515

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

ENVIRONMENTAL ANALYTICAL SERVICES

FINAL REPORT OF ANALYSES

RESTORATION SYSTEMS
Attn: RANDY TURNER
1101 HAYNES ST.
SUITE 107
RALEIGH, NC 27604-

REPORT DATE: 10/20/05

SAMPLE NUMBER- 230875 SAMPLE ID- CARBONTON 2 SAMPLE MATRIX- SO
DATE SAMPLED- 10/10/05 TIME SAMPLED- 1300
DATE RECEIVED- 10/12/05 SAMPLER- T AUGSPURGER RECEIVED BY- MNH
TIME RECEIVED- 1330 DELIVERED BY- T AUGSPURGER

 PROJECT NAME : DEEP RIVER SEDI

ANALYSIS	METHOD	SAMPLE PREP DATE	BY	ANALYSIS DATE	BY	RESULT	UNITS	PQL
PERCENT SOLIDS	2540G			10/13/05	ELH	54.8	NA	
PERCENT MOISTURE				10/13/05	ELH	45.2	percent	0.1
VOLATILE SOLIDS IN SOLIDS				10/17/05	ELH	5.6	percent	
ALUMINUM IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	5640	mg/kg	2.18
IRON IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	10,300	mg/kg	8.70
MERCURY IN SOLID	7471	10/19/05	JFL	10/20/05	JFL	0.023	mg/kg	0.006
ARSENIC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	<2.18	mg/kg	2.18
CADMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 0.44	mg/kg	0.44
CHROMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	7.08	mg/kg	2.18
COPPER IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	8.43	mg/kg	0.87
LEAD IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	6.64	mg/kg	0.87
MANGANESE IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	311	mg/kg	2.18
NICKEL IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	12.7	mg/kg	2.18
ZINC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	24.9	mg/kg	2.18

PQL = Practical Quantitation Limit
Results followed by the letter J are estimated concentrations.
All results for soil and sludge samples are reported on a dry weight basis as required by the NC DEM Laboratory Certification Section. Wet Weight Concentration = (dry weight conc.)(percent solids)/100.

NC DENR CERTIFICATIONS: DWQ - 96; PUBLIC WATER SUPPLY - 37724
* PLEASE REFER TO ENCLOSED REPORT GEOTECHNOLOGIES, INC.

LABORATORY DIRECTOR

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

ENVIRONMENTAL ANALYTICAL SERVICES

FINAL REPORT OF ANALYSES

RESTORATION SYSTEMS
Attn: RANDY TURNER
1101 HAYNES ST.
SUITE 107
RALEIGH, NC 27604-

REPORT DATE: 10/20/05

SAMPLE NUMBER- 230876 SAMPLE ID- CARBONTON 3 SAMPLE MATRIX- SO
DATE SAMPLED- 10/11/05 TIME SAMPLED- 0940
DATE RECEIVED- 10/12/05 SAMPLER- T AUGSPURGER RECEIVED BY- MNH
TIME RECEIVED- 1330 DELIVERED BY- T AUGSPURGER

Page 1 of 1 PROJECT NAME : DEEP RIVER SEDI

ANALYSIS	METHOD	SAMPLE PREP DATE	BY	ANALYSIS DATE	BY	RESULT	UNITS	PQL
PERCENT SOLIDS	2540G			10/13/05	ELH	49.9	NA	
PERCENT MOISTURE				10/13/05	ELH	50.1	percent	0.1
VOLATILE SOLIDS IN SOLIDS				10/17/05	ELH	6.8	percent	
ALUMINUM IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	11,800	mg/kg	2.24
IRON IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	16,300	mg/kg	8.95
MERCURY IN SOLID	7471	10/19/05	JFL	10/20/05	JFL	0.034	mg/kg	0.007
ARSENIC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 2.24	mg/kg	2.24
CADMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 0.45	mg/kg	0.45
CHROMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	10.9	mg/kg	2.24
COPPER IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	13.8	mg/kg	0.90
LEAD IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	11.1	mg/kg	0.90
MANGANESE IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	348	mg/kg	2.24
NICKEL IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	17.4	mg/kg	2.24
ZINC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	43.5	mg/kg	2.24

PQL = Practical Quantitation Limit
Results followed by the letter J are estimated concentrations.
All results for soil and sludge samples are reported on a dry weight basis as required by the NC DEM Laboratory Certification Section. Wet Weight Concentration = (dry weight conc.)(percent solids)/100.

NC DENR CERTIFICATIONS: DWQ - 96; PUBLIC WATER SUPPLY - 37724
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LABORATORY DIRECTOR

P.O. Box 12298 • Research Triangle Park, NC 27709
Telephone (919) 467-3090

Shipping: 102-A Woodwinds Industrial Court • Cary, NC 27511
Fax (919) 467-3515

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

ENVIRONMENTAL ANALYTICAL SERVICES

FINAL REPORT OF ANALYSES

RESTORATION SYSTEMS
Attn: RANDY TURNER
1101 HAYNES ST.
SUITE 107
RALEIGH, NC 27604-

REPORT DATE: 10/20/05

SAMPLE NUMBER- 230877 SAMPLE ID- CARBONTON 4
DATE SAMPLED- 10/10/05
DATE RECEIVED- 10/12/05 SAMPLER- T AUGSPURGER
TIME RECEIVED- 1330 DELIVERED BY- T AUGSPURGER

SAMPLE MATRIX- SO
TIME SAMPLED- 1515
RECEIVED BY- MNH

 PROJECT NAME : DEEP RIVER SEDI

ANALYSIS	METHOD	SAMPLE PREP DATE	BY	ANALYSIS DATE	BY	RESULT	UNITS	PQL
PERCENT SOLIDS	2540G			10/13/05	ELH	50.2	NA	
PERCENT MOISTURE				10/13/05	ELH	49.8	percent	0.1
VOLATILE SOLIDS IN SOLIDS				10/17/05	ELH	5.9	percent	
ALUMINUM IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	16,900	mg/kg	2.35
IRON IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	21,800	mg/kg	9.38
MERCURY IN SOLID	7471	10/19/05	JFL	10/20/05	JFL	0.057	mg/kg	0.008
ARSENIC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 2.35	mg/kg	2.35
CADMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 0.47	mg/kg	0.47
CHROMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	14.6	mg/kg	2.35
COPPER IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	18.4	mg/kg	0.94
LEAD IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	14.3	mg/kg	0.94
MANGANESE IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	305	mg/kg	2.35
NICKEL IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	21.2	mg/kg	2.35
ZINC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	54.4	mg/kg	2.35

PQL = Practical Quantitation Limit
Results followed by the letter J are estimated concentrations.
All results for soil and sludge samples are reported on a dry weight basis as required by the NC DEM Laboratory Certification Section. Wet Weight Concentration = (dry weight conc.)(percent solids)/100.

NC DENR CERTIFICATIONS: DWQ - 96; PUBLIC WATER SUPPLY - 37724
* PLEASE REFER TO ENCLOSED REPORT GEOTECHNOLOGIES, INC.

LABORATORY DIRECTOR for A. Kirk Thomas

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

ENVIRONMENTAL ANALYTICAL SERVICES

FINAL REPORT OF ANALYSES

RESTORATION SYSTEMS
Attn: RANDY TURNER
1101 HAYNES ST.
SUITE 107
RALEIGH, NC 27604-

REPORT DATE: 10/20/05

SAMPLE NUMBER- 230878 SAMPLE ID- CARBONTON 5
DATE SAMPLED- 10/11/05
DATE RECEIVED- 10/12/05 SAMPLER- T AUGSPURGER
TIME RECEIVED- 1330 DELIVERED BY- T AUGSPURGER

SAMPLE MATRIX- SO
TIME SAMPLED- 1030
RECEIVED BY- MNH

Page 1 of 1 PROJECT NAME : DEEP RIVER SEDI

ANALYSIS	METHOD	SAMPLE PREP DATE	BY	ANALYSIS DATE	BY	RESULT	UNITS	PQL
PERCENT SOLIDS	2540G			10/13/05	ELH	61.8	NA	
PERCENT MOISTURE				10/13/05	ELH	38.2	percent	0.1
VOLATILE SOLIDS IN SOLIDS				10/17/05	ELH	4.8	percent	
ALUMINUM IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	19,400	mg/kg	1.85
IRON IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	25,400	mg/kg	7.39
MERCURY IN SOLID	7471	10/19/05	JFL	10/20/05	JFL	0.096	mg/kg	0.006
ARSENIC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	2.01	mg/kg	1.85
CADMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 0.37	mg/kg	0.37
CHROMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	17.8	mg/kg	1.85
COPPER IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	18.2	mg/kg	0.74
LEAD IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	16.7	mg/kg	0.74
MANGANESE IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	542	mg/kg	1.85
NICKEL IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	33.7	mg/kg	1.85
ZINC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	42.1	mg/kg	1.85

PQL = Practical Quantitation Limit
Results followed by the letter J are estimated concentrations.
All results for soil and sludge samples are reported on a dry weight basis as required by the NC DEM Laboratory Certification Section. Wet Weight Concentration = (dry weight conc.)(percent solids)/100.

NC DENR CERTIFICATIONS: DWQ - 96; PUBLIC WATER SUPPLY - 37724
* PLEASE REFER TO ENCLOSED REPORT GEOTECHNOLOGIES, INC.

LABORATORY DIRECTOR for A. Keith Thomas

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

ENVIRONMENTAL ANALYTICAL SERVICES

FINAL REPORT OF ANALYSES

RESTORATION SYSTEMS
Attn: RANDY TURNER
1101 HAYNES ST.
SUITE 107
RALEIGH, NC 27604-

REPORT DATE: 10/20/05

SAMPLE NUMBER- 230879 SAMPLE ID- CARBONTON 6 SAMPLE MATRIX- SO
DATE SAMPLED- 10/11/05 TIME SAMPLED- 1230
DATE RECEIVED- 10/12/05 SAMPLER- T AUGSPURGER RECEIVED BY- MNH
TIME RECEIVED- 1330 DELIVERED BY- T AUGSPURGER

 PROJECT NAME : DEEP RIVER SEDI

ANALYSIS	METHOD	SAMPLE PREP DATE	BY	ANALYSIS DATE	BY	RESULT	UNITS	PQL
PERCENT SOLIDS	2540G			10/13/05	ELH	33.8	NA	
PERCENT MOISTURE				10/13/05	ELH	66.2	percent	0.1
VOLATILE SOLIDS IN SOLIDS				10/17/05	ELH	17.8	percent	
ALUMINUM IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	14,600	mg/kg	3.69
IRON IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	25,200	mg/kg	14.7
MERCURY IN SOLID	7471	10/19/05	JFL	10/20/05	JFL	0.068	mg/kg	0.010
ARSENIC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 3.69	mg/kg	3.69
CADMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 0.74	mg/kg	0.74
CHROMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	12.6	mg/kg	3.69
COPPER IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	25.1	mg/kg	1.47
LEAD IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	17.3	mg/kg	1.47
MANGANESE IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	650	mg/kg	3.69
NICKEL IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	23.7	mg/kg	3.69
ZINC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	67.5	mg/kg	3.69

PQL = Practical Quantitation Limit
Results followed by the letter J are estimated concentrations.
All results for soil and sludge samples are reported on a dry weight basis as required by the NC DEM Laboratory Certification Section. Wet Weight Concentration = (dry weight conc.)(percent solids)/100.

NC DENR CERTIFICATIONS: DWQ - 96; PUBLIC WATER SUPPLY - 37724
* PLEASE REFER TO ENCLOSED REPORT GEOTECHNOLOGIES, INC.

LABORATORY DIRECTOR Jennifer A. Kirk for A. Kirk Thomas

P.O. Box 12298 • Research Triangle Park, NC 27709
Telephone (919) 467-3090
Shipping: 102-A Woodwinds Industrial Court • Cary, NC 27511
Fax (919) 467-3515

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

ENVIRONMENTAL ANALYTICAL SERVICES

FINAL REPORT OF ANALYSES

RESTORATION SYSTEMS
Attn: RANDY TURNER
1101 HAYNES ST.
SUITE 107
RALEIGH, NC 27604-

REPORT DATE: 10/20/05

SAMPLE NUMBER- 230880 SAMPLE ID- CARBONTON 7 SAMPLE MATRIX- SO
DATE SAMPLED- 10/11/05 TIME SAMPLED- 1300
DATE RECEIVED- 10/12/05 SAMPLER- T AUGSPURGER RECEIVED BY- MNH
TIME RECEIVED- 1330 DELIVERED BY- T AUGSPURGER

 PROJECT NAME : DEEP RIVER SEDI

ANALYSIS	METHOD	SAMPLE PREP DATE	BY	ANALYSIS DATE	BY	RESULT	UNITS	PQL
PERCENT SOLIDS	2540G			10/13/05	ELH	56.3	NA	
PERCENT MOISTURE				10/13/05	ELH	43.7	percent	0.1
VOLATILE SOLIDS IN SOLIDS				10/17/05	ELH	5.5	percent	
ALUMINUM IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	13,400	mg/kg	2.05
IRON IN SOLID	6020	10/13/05	JFL	10/14/05	JFL	18,500	mg/kg	8.19
MERCURY IN SOLID	7471	10/19/05	JFL	10/20/05	JFL	0.052	mg/kg	0.006
ARSENIC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 2.05	mg/kg	2.05
CADMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	< 0.41	mg/kg	0.41
CHROMIUM IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	12.8	mg/kg	2.05
COPPER IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	16.3	mg/kg	0.82
LEAD IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	14.1	mg/kg	0.82
MANGANESE IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	304	mg/kg	2.05
NICKEL IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	19.1	mg/kg	2.05
ZINC IN SOLID	6020	10/13/05	JFL	10/18/05	JFL	44.9	mg/kg	2.05

PQL = Practical Quantitation Limit
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NC DENR CERTIFICATIONS: DWQ - 96; PUBLIC WATER SUPPLY - 37724
* PLEASE REFER TO ENCLOSED REPORT GEOTECHNOLOGIES, INC.

LABORATORY DIRECTOR Scott F. Lee / Tony B. Lichtenauer

CASE NARRATIVE - QC REPORT

Restoration Systems , Project Name: 59943, Description: Carbonton

Sample duplicated and spiked was CET ID# 230874, Sample description CARBONTON 1

ELEMENT	BLANK (ppm) *	LCS recoven	REP1(mg/Kg)	REP2(mg/Kg)	RAPD%	SPIKE RECOVERY	SAND A (mg/Kg) +	ASSIGNED VALUE	% RECOVERY
Al	0.634	66.7%	12,100	11,200	7.72%	117%	7690	6680	86.9%
As	< 0.005	65.6%	< 3.40	< 3.18	0.00%	#	0.95	< 5	N/A
Cd	< 0.001	64.6%	< 0.68	< 0.64	0.00%	#	< 0.48	N/A	N/A
Cr	< 0.005	104.0%	11.8	10.6	10.70%	#	5.32	6.9	77.1%
Cu	< 0.002	85.0%	17.3	15.6	10.30%	#	1.5	2.2	74.3%
Fe	0.056	102.8%	17,400	15,700	10.30%	#	4727	4380	108%
Hg	< 0.0002	95.1%	0.029	0.032	9.80%	82.0%	N/A	N/A	N/A
Pb	< 0.002	131.0%	11.8	11.3	4.32%	#	6.72	6.2	108%
Mn	< 0.005	100.0%	329	298	9.89%	#	16.8	17.9	93.90%
Ni	< 0.005	92.2%	22.2	17.9	21.40%	#	4.71	1.53	308% @
Zn	< 0.005	82.8%	51.03	37.13	31.50%	139%	5.66	6.5	87.1%

* reported as mg/L in digest

MATRIX >> 10 TIMES SPIKE LEVEL

+ OBTAINED FROM HIGH PURITY STANDARDS

@ NOTE:CERTIFIED VALUE FOR TOTAL DIGESTION FOR Ni IS 3.3 mg/Kg. Recovery = 143%

CET

CHEMICAL & ENVIRONMENTAL TECHNOLOGY, INC.

102-A Woodwinds Industrial Court, Cary, NC 27511

(919) 467-3090 – Phone (919) 467-3515 - Fax

CHAIN OF COUSTODY

☐ SHADED AREAS FOR LABORATORY USE

CLIENT NAME: Chemical and Environmental Technology

ADDRESS: 102-A Woodwinds Industrial Court, Cary, NC 27511

Turnaround Time:
- ☐ ~~10 Business Days~~
- ☒ Rush 5 Business Days*
- ☐ ~~Rush 48 Hours*~~
- ☐ Rush 24 Hours*

ATTENTION: Link Thrower

PHONE: 919.467.3090
FAX: 919.467.3515

PROJECT #:

PROJECT NAME: 59943

COLLECTED BY (Signatures):

PRINTED NAME(s): Tom Augsparger

CHECK HERE IF RECEIVED ON ICE ☐

COOLER TEMPS #1: #2: #3: #4: #5: #6:

INITIALS:

BILL TO: Chemical and Environmental Technology

BILLING ADDRESS: PO Box 12298, RTP, NC 27709

Purchase Order#: S-1778

BILLING CONT.:

SAMPLE CONTAINERS INCLUDED PRESERVATIVES PRIOR TO SAMPLING ■

SAMPLES PRESERVED AFTER SAMPLING UPON RETURN TO LAB ☐

MATRIX CODE DW= Drinking Water, WW = Wastewater, GW = Groundwater, S= Soil/Solids

FRACTIONS AND PRESERVATION

Sample Receiving: Verify proper fractions are received and initial below.

ANALYSES REQUIRED

CET LIMS SAMPLE #	DATE	TIME	SAMPLE TYPE COMP	SAMPLE TYPE GRAB	SAMPLE IDENTIFIER	SAMPLE MATRIX	# OF CONTAINERS	Grain Size						SAMPLE REMARKS/COMMENTS	FRACTIONS AND PRESERVATION	Sample Receiving
	10/10/05	1205		X	Carbonton 1	S	1	X								
	10/10/05	1300		X	Carbonton 2	S	1	X								
	10/11/05	0940		X	Carbonton 3	S	1	X								
	10/10/05	1515		X	Carbonton 4	S	1	X								
	10/11/05	1030		X	Carbonton 5	S	1	X								
	10/11/05	1230		X	Carbonton 6	S	1	X								
	10/11/05	1300		X	Carbonton 7	S	1	X								

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)	RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)
[signature]	10/13/05	1220	[signature]				

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY	DATE	TIME

ADDITIONAL INFO/INSTRUCTIONS

*RUSH WORK REQUIRES LABORATORY APPROVAL PRIOR TO SAMPLE SUBMISSION. ADDITIONAL CHARGES MAY APPLY

Sampled for: Randy Turner / Restoration Systems 856-4520 x21

DEPARTMENT OF THE INTERIOR
U. S. FISH AND WILDLIFE SERVICE
DIVISION OF LAW ENFORCEMENT

CHAIN OF CUSTODY RECORD

FILE NO.
INV.

DATE AND TIME OF ~~SEIZURE~~ Collection:	DISTRICT:	EVIDENCE/PROPERTY SEIZED BY:
10/10/05 and 10/11/05		Tom Augspurger, USFWS, Raleigh, NC

SOURCE OF EVIDENCE/PROPERTY (person and/or location):
☒ TAKEN FROM: Deep River, upstream of Carbonton Dam
☐ RECEIVED FROM:
☐ FOUND AT:

CASE TITLE AND REMARKS: Deep River Sediments

ITEM NO.	DESCRIPTION OF EVIDENCE/PROPERTY (include Seizure Tag Numbers and any serial numbers):
Carbonton 1	Sediment sample; see attached list of descriptions
Carbonton 2	" " " " " " "
Carbonton 3	" " " " " " "
Carbonton 4	" " " " " " "
Carbonton 5	" " " " " " "
Carbonton 6	" " " " " " "
Carbonton 7	" " " " " " "
	Samples frozen solid on receipt. Several jars broken. 10/12/05

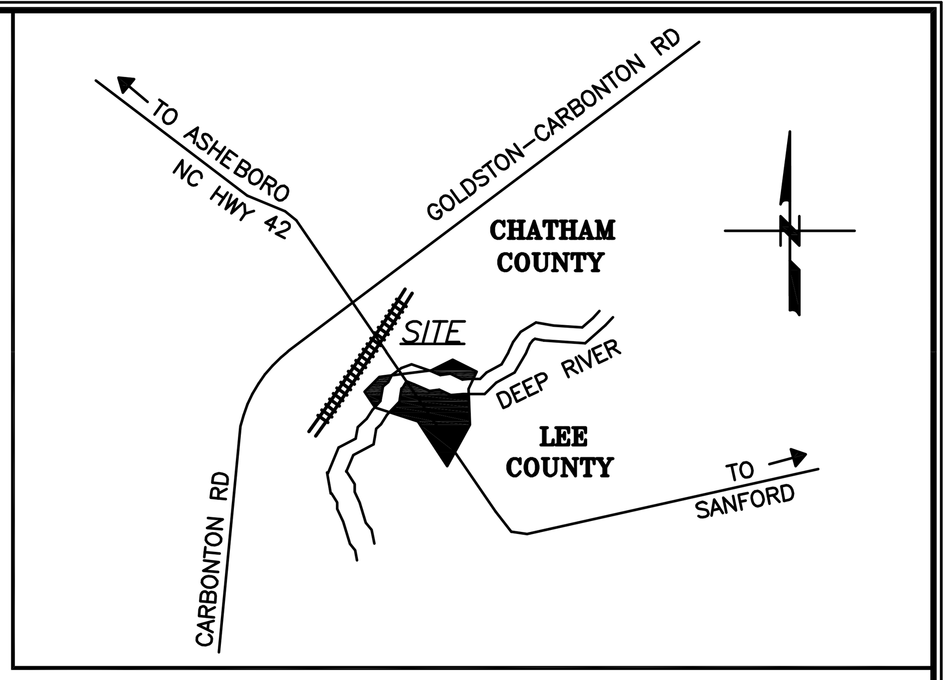
ITEM NO.	FROM: (PRINT NAME, AGENCY)	RELEASE SIGNATURE:	RELEASE DATE	DELIVERED VIA:
1 through 7	Tom Augspurger USFWS	TAugspurger	10/12/05	☐ U.S. MAIL ☒ IN PERSON ☐ OTHER:
	TO: (PRINT NAME, AGENCY)	RECEIPT SIGNATURE:	RECEIPT DATE	
	Milton Hobgood	Milton Hobgood	10-12-05 1330	
ITEM NO.	FROM: (PRINT NAME, AGENCY)	RELEASE SIGNATURE:	RELEASE DATE	DELIVERED VIA:
				☐ U.S. MAIL ☐ IN PERSON ☐ OTHER:
	TO: (PRINT NAME, AGENCY)	RECEIPT SIGNATURE:	RECEIPT DATE	
ITEM NO.	FROM: (PRINT NAME, AGENCY)	RELEASE SIGNATURE:	RELEASE DATE	DELIVERED VIA:
				☐ U.S. MAIL ☐ IN PERSON ☐ OTHER:
	TO: (PRINT NAME, AGENCY)	RECEIPT SIGNATURE:	RECEIPT DATE	

☐ ADDITIONAL TRANSFERS ON REVERSE SIDE

FORM 3-2063 (9/81)

APPENDIX D: AS-BUILT DRAWINGS

DEEP RIVER
CARBONTON DAM RESTORATION SITE



LOCATION MAP
N.T.S.

LEE & CHATHAM COUNTIES, NORTH CAROLINA
2005

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

SHEET INDEX:

AS BUILT DRAWING
Issued 5 / 19 / 06
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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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.
9. THE CONTRACTOR SHALL PLACE "NO PARKING" SIGNS ON THE NC–HWY 42 BRIDGE AND APPROACHING ROADWAYS.

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 NDICATING 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.
4. CONTRACTOR SHALL TAKE WEEKLY SOUNDINGS AT THE NC–42 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 CONCTRACTOR SHALL FOLLOW THIS GENERAL SEQUENCE TO DEMOLISH THE SPILLWAYS. ANY SUBSTANTIVE DEVIATION SHALL BE DISCUSSED WITH THE ENGINEER BEFOREHAND.

PRE–DEMOLITION ACTIVITIES

1. REPAIR POWERHOUSE HEAD GATES, MUD GATES, AND OPERATORS (COMPLETE)
2. DREDGE SEDIMENT FROM AHEAD OF INLET WORKS (COMPLETE)
3. LOWER IMPOUNDMENT THROUGH POWERHOUSE DRAFT TUBES AND MUD GATES (COMPLETE)
4. REMOVE GENERATING AND ALL OTHER EQUIPMENT (ONGOING)
5. ESTABLISH EQUIPMENT ACCESS POINTS (ONGOING)
6. INSTALL SEDIMENT AND EROSION CONTROLS (ONGOING)
7. IMPLEMENT SUBSTRATE REMOVAL AND MANAGEMENT PLAN (CONTINUING)
8. REMOVE UNCONSOLIDATED SEDIMENT BEHIND SPILLWAY GATES (COMPLETE)
9. CHANNELIZE RIVER TO DIRECT FLOW THROUGH SPILLWAY GATES (ONGOING)
10. OPEN SPILLWAY GATES IN CELLS 1, 3, & 5 (COMPLETE)
11. BREACH SPILLWAY BY REMOVING RIGHT–MOST BUTTRESS CELLS (COMPLETE)
12. REMOVE WOODY/SOIL SUBSTRATE "ISLAND" (ONGOING)
13. CONSTRUCT SAND–SILT–GRAVEL SEDIMENT "ISLAND" WITH SPILLWAY SEDIMENT WEDGE MATERIAL (ONGOING)

DEMOLITION ACTIVITIES (REMOVE PROJECT FEATURES)

14. DEMOLISH BUTTRESS SPILLWAY
15. DEMOLISH OGEE SPILLWAY
16. ROUGH GRADE RIVERBANKS AND STABILIZE SITE

POST–DEMOLITION/DECOMMISSIONING/LICENSE SURREDER ACTIVITIES

17. FINAL GRADE AND TOPSOIL FUTURE PARK AREA
18. STABILIZE ALL DISTURBED AREAS PER EROSION AND SEDIMENT CONTROL PLAN
    DEVELOP POWERHOUSE RENOVATION PLANS (TO BE USED AS CONFERENCE CENTER)
19. CONSTRUCT PARK ROAD AND PARKING (PLANS TO BE DEVELOPED)
20. RENOVATE POWERHOUSE
20. INSTALL PARK AMENITIES

AS BUILT DRAWING

Issued 5 / 19 / 06

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REVISIONS

LEGEND AND GENERAL NOTES

DEEP RIVER
CARBONTON DAM RESTORATION SITE

LEE & CHATHAM COUNTIES, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
KWK	PFM	JGM

SCALE NTS

DATE NOV. 30, 2005

PROJECT NO. 2691-01

DWG NAME notes.dwg

AS BUILT DRAWING

Issued 5 / 19 / 06

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REVISIONS

EXISTING CONDITIONS

DEEP RIVER
CARBONTON DAM RESTORATION SITE

LEE AND CHATHAM COUNTIES, NORTH CAROLINA

KWK	PBS	JGM
DESIGNED	DRAWN	CHECKED

SCALE AS SHOWN

DATE DEC 13, 2005

PROJECT NO. 2691-01

DWG NAME existing.dwg

AS BUILT DRAWING

Issued 5 / 19 / 06

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REVISIONS

EQUIPMENT ACCESS AND WORK ZONES

DEEP RIVER
CARBONTON DAM RESTORATION SITE

LEE AND CHATHAM COUNTIES, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
KWK	PBS	JGM

SCALE AS SHOWN

DATE DEC 13, 2005

PROJECT NO. 2691-01

DWG NAME workzone.DWG

NOTES:

1. STABILIZED EQUIPMENT ACCESS LOCATION IS SHOWN SCHEMATICALLY. CONTRACTOR SHALL LOCATE AT POINT WHERE ACCESS TO THE RIVERBED IS ANTICIPATED. STABILIZED ACCESS SHALL ALSO BE RELOCATED AS NECESSARY AS SUBSTRATE REMOVAL AND SPILLWAY DEMOLITION PROGRESS.

2. SILT FENCE LOCATION IS SHOWN SCHEMATICALLY. CONTRACTOR SHALL INSTALL SILT FENCE AT ADDITIONAL LOCATIONS AND RELOCATE AS NECESSARY AS SUBSTRATE REMOVAL AND SPILLWAY DEMOLITION PROGRESS.

3. EROSION CONTROL MATTING LOCATION IS SHOWN SCHEMATICALLY. CONTRACTOR SHALL INSTALL MATTING AT ADDITIONAL LOCATIONS AND RELOCATE AS NECESSARY AS SUBSTRATE REMOVAL AND SPILLWAY DEMOLITION PROGRESS.

4. NO EROSION CONTROL DEVICES ARE TO BE PLACED ON NEW CREATED FROM SAND-SILT-CLAY MATERIAL FROM SEDIMENT WEDGE BEHIND SPILLWAY. THIS CREATED ISLAND WILL BE ALLOWED TO ERODE NATURALLY TO PROVIDE BEDLOAD MATERIAL TO THE DEEP RIVER PER USFWS RECOMMENDATIONS.

5. SLOPES WHICH EXCEED EIGHT (8) VERTICAL FEET SHALL BE STABILIZED WITH SYNTHETIC OR VEGETATIVE MATS, 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.

6. SILT FENCE SHOWN AROUND NORTHERN WOODY DEBRIS DISPOSAL AREA IS TO BE INSTALLED IF ANY SOIL DISTURBANCE OCCURS, OR IF STOCKPILED AREA CONTAINS SOIL OR OTHER ERODIBLE MATERIAL.

AS BUILT DRAWING

Issued 5 / 19 / 06

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REVISIONS

EROSION & SEDIMENT CONTROL PLAN

DEEP RIVER
CARBONTON DAM RESTORATION SITE

LEE & CHATHAM COUNTIES, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
--	PFM	KWK

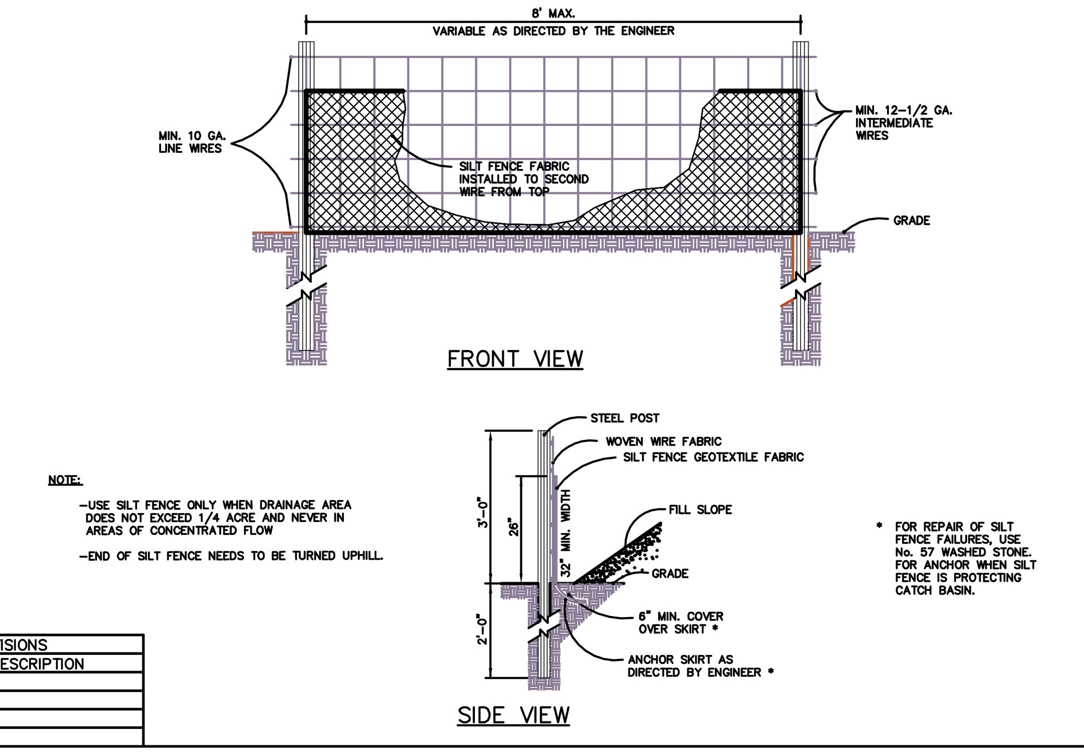
SCALE AS SHOWN

DATE DEC 13, 2005

PROJECT NO. 2691-01

DWG NAME erosion.dwg

SHEET NO. 4 of 11

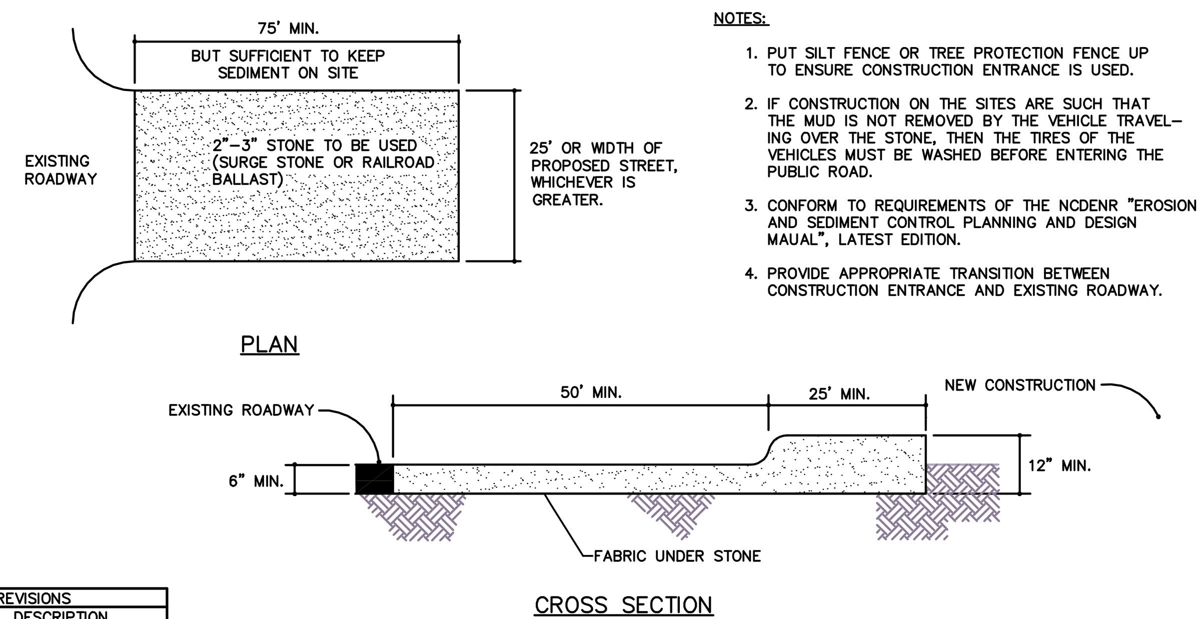


NOTE:
- USE SILT FENCE ONLY WHEN DRAINAGE AREA DOES NOT EXCEED 1/4 ACRE AND NEVER IN AREAS OF CONCENTRATED FLOW
- END OF SILT FENCE NEEDS TO BE TURNED UPHILL.

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

REVISIONS	
DATE	DESCRIPTION

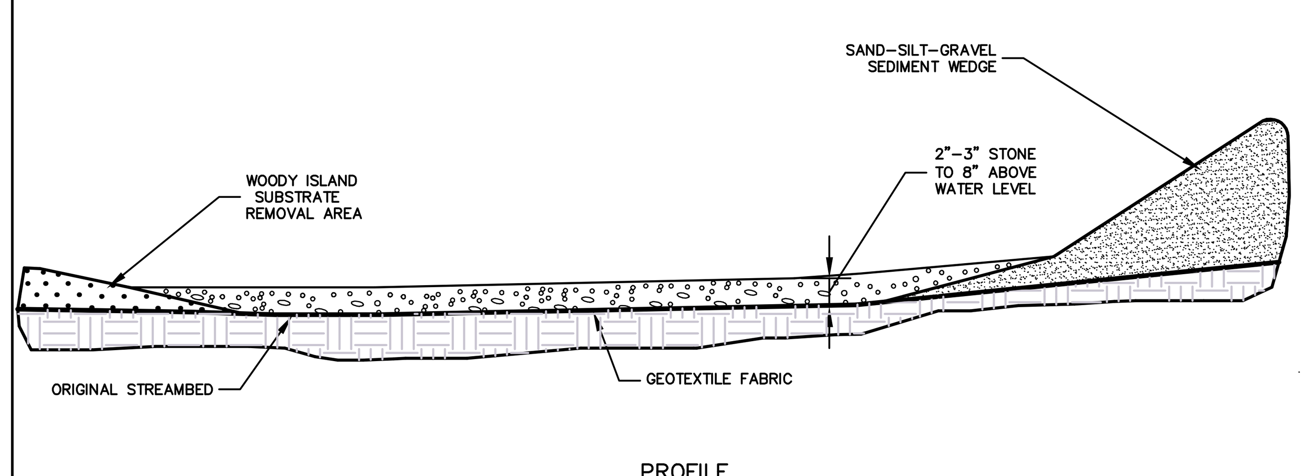
STANDARD TEMPORARY SILT FENCE | 1



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.

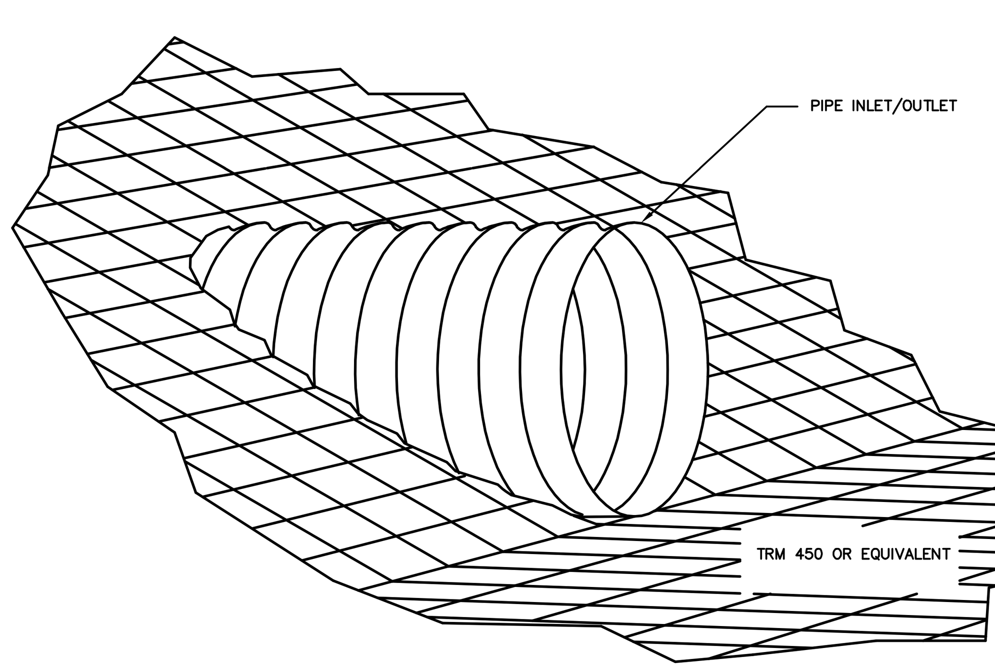
REVISIONS	
DATE	DESCRIPTION

CONSTRUCTION ENTRANCE | 7



REVISIONS	
DATE	DESCRIPTION

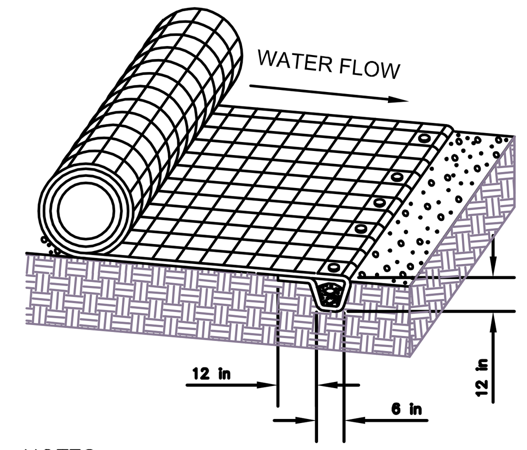
TEMPORARY DIVERSON DAM



NOTES:
1. TRM 450 PLACED OVER PIPE INLET/OUTLET FOR SCOUR PROTECTION

PIPE INLET / OUTLET PROTECTION

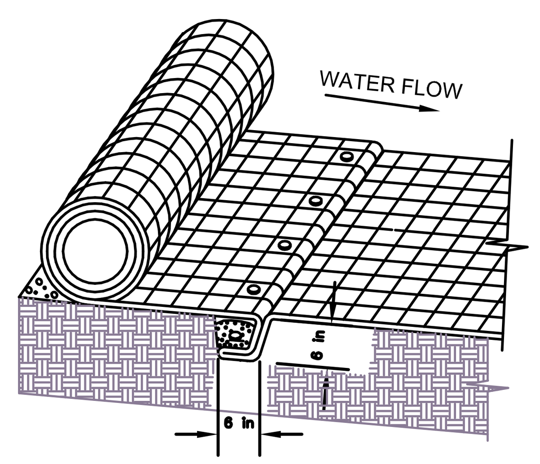
N.T.S.



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. 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.

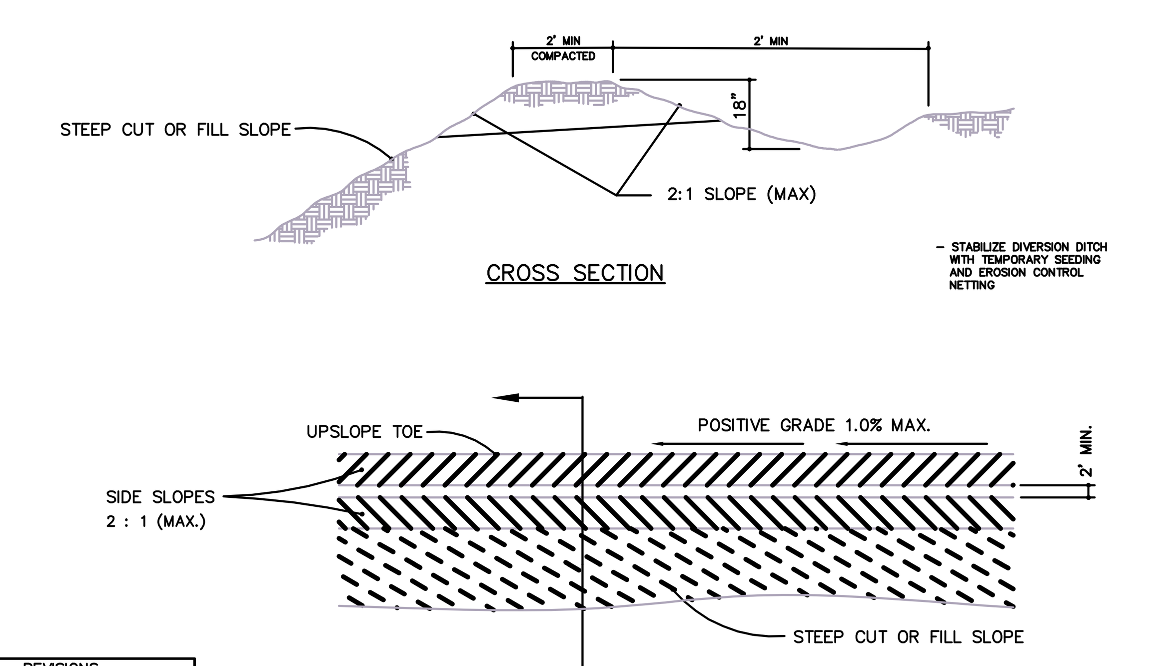
INTERMITTANT MATTING CHECK SLOT

N.T.S.

CONSTRUCTION SEQUENCE / SEDIMENT & EROSION CONTROL NOTES

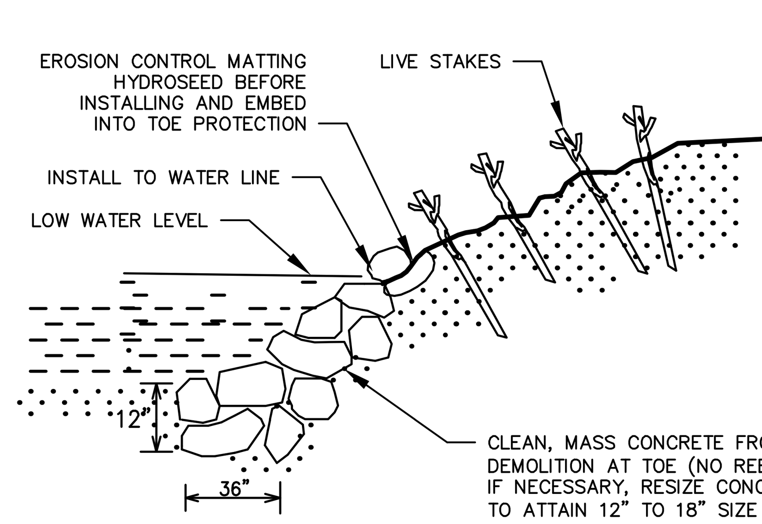
EROSION AND SEDIMENT CONTROL SHALL PROCEED IN THE FOLLOWING MANNER:

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 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.



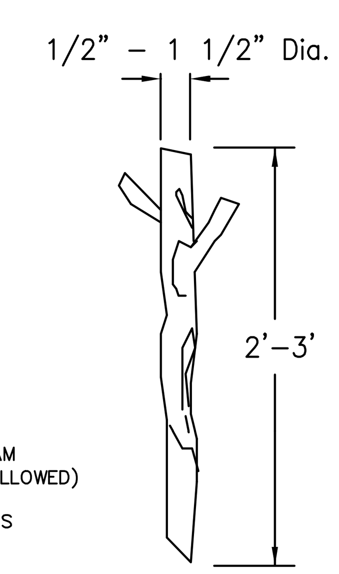
REVISIONS	
DATE	DESCRIPTION

DIVERSION DITCH | 9



TOE BANK PROTECTION ON SOUTH BANK

NOT TO SCALE



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

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:

PERMANENT GRASS: "RIPARIAN BUFFER SEED MIX" AT 20LBS/ACRE FROM MELLOW MARSH FARM, SILER CITY, NORTH CAROLIINA OR APPROVED EQUAL.

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.).

AS BUILT DRAWING

Issued 5 / 19 / 06

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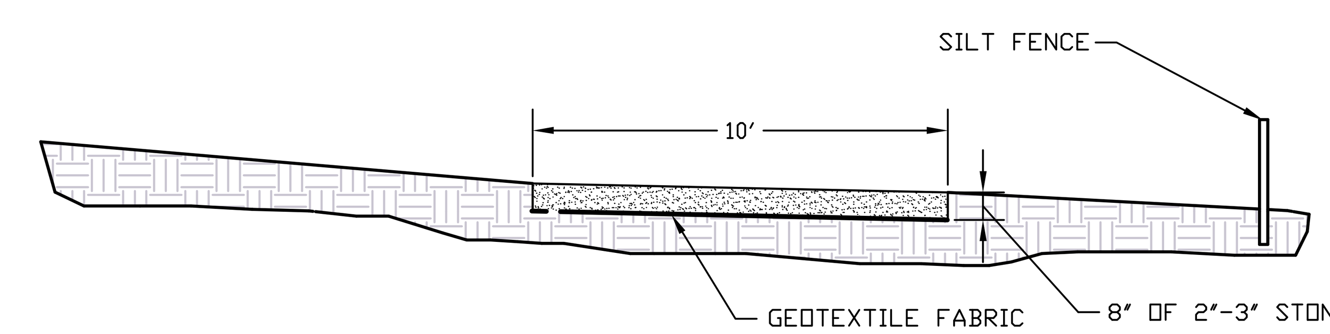

NOTES:
1. TEMPORARY ACCESS ROAD TO BE CONSTRUCTED AS NEEDED.

ACCESS ROUTE

NOT TO SCALE

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REVISIONS

EROSION & SEDIMENTATION CONTROL DETAILS

DEEP RIVER
CARBONTON DAM RESTORATION SITE

LEE & CHATHAM COUNTIES, NORTH CAROLINA

KWK	PFM	JGM
DESIGNED	DRAWN	CHECKED

SCALE N.T.S.

DATE DEC 13, 2005

PROJECT NO. 2691-01

DWG NAME erosion.dwg

SUBSTRATE REMOVAL

SEDIMENT WEDGE CONSISTS OF SAND, SILT, GRAVEL, TIMBERS AND STONE COBBLE FROM FORMER CRIB DAM, PARTIALLY OVERLYING BEDROCK. TO THE EXTENT PRACTICAL, SEPARATE AND STOCKPILE STONE COBBLE FOR USE IN PARK OR ELSEWHERE. USE SAND–SILT–GRAVEL SEDIMENT WEDGE MATERIAL TO CONSTRUCT DIVERSION DAM TO ISOLATE RIVER WATER ON NORTH SIDE OF SUBSTRATE "ISLAND."

MAINTAIN 20' DISTANCE TO OVERHEAD POWER. NOTIFY CP&L OF WORK IN VICINITY OF ITS LINES.

WITHIN THE WORK LIMITS, EXCAVATE TIMBER, WOODY MATERIAL, AND DEBRIS THAT EXISTS ON "ISLAND," AND REMOVE TO STAGING AREA ON KELLY PROPERTY CONSTRUCT EQUIPMENT ACCESSWAY AT LOW WATER LEVEL TO CREATE WORK PLATFORM TO REMOVE WOODY "ISLAND" MATERIAL. IF "ISLAND" SUPPORTS HEAVY EQUIPMENT, PREFERABLY CONSTRUCT EQUIPMENT ACCESSWAY FROM EAST TO WEST ALONG CENTER OF "ISLAND," WHILE REMOVING WOODY MATERIAL AHEAD OF ACCESSWAY. IF NECESSARY, ACCESSWAY MAY ALTERNATELY BE CONSTRUCTED ALONG NORTH EDGE OF "ISLAND."

TO HELP CONTAIN TURBIDITY TO THE NORTH SIDE OF THE ISLAND, REMOVE "ISLAND" MATERIAL TO AT OR BELOW THE LOW WATER LEVEL BY WORKING FROM NORTH TO SOUTH ON THE "ISLAND." LEAVE A NARROW BERM ALONG THE SOUTH LIMIT OF THE "ISLAND" TO HELP CONTAIN AND FILTER TURBIDITY. IF PRESENT ON ISLAND, LEAVE UNDERLYING SAND–GRAVEL–SILT IN PLACE.

EQUIPMENT ACCESSWAY (SAND–SILT–GRAVEL SEDIMENT WEDGE MATERIAL) TO REMAIN IN RIVER AS A SEDIMENT BAR TO ERODE NATURALLY AND PROVIDE BEDLOAD MATERIAL. WASTE ALL SUITABLE SEDIMENT WEDGE MATERIAL ON SEDIMENT BAR.

REMOVE TEMPORARY DIVERSION DAM AND RESTORE TO ORIGINAL CHANNEL ONCE ISLAND WORK IS COMPLETE.

AS BUILT DRAWING
Issued 5 / 19 / 06
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0 20' 40' 80' 120'

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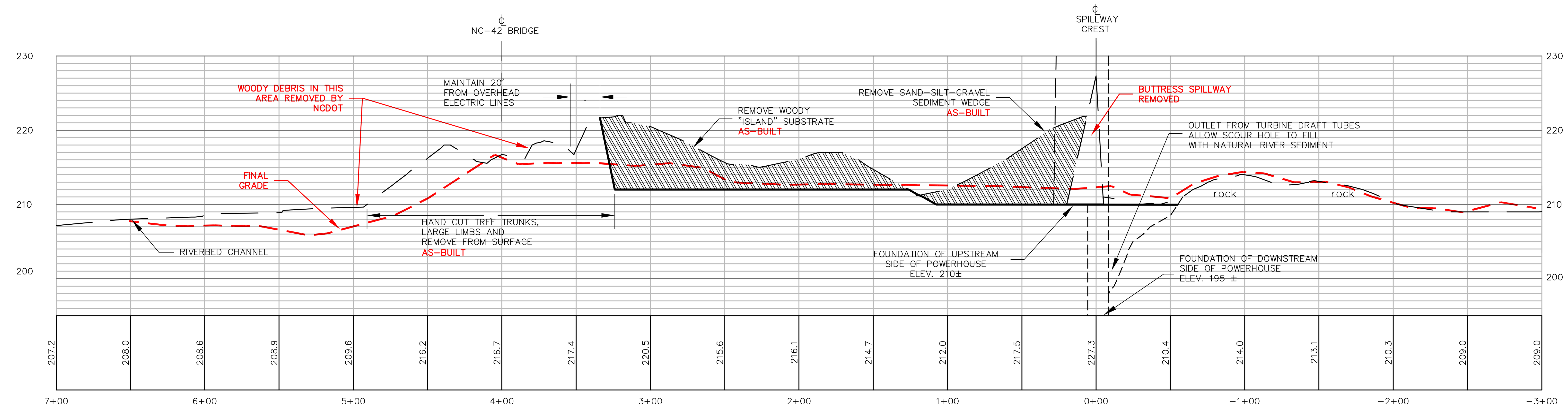
REVISIONS

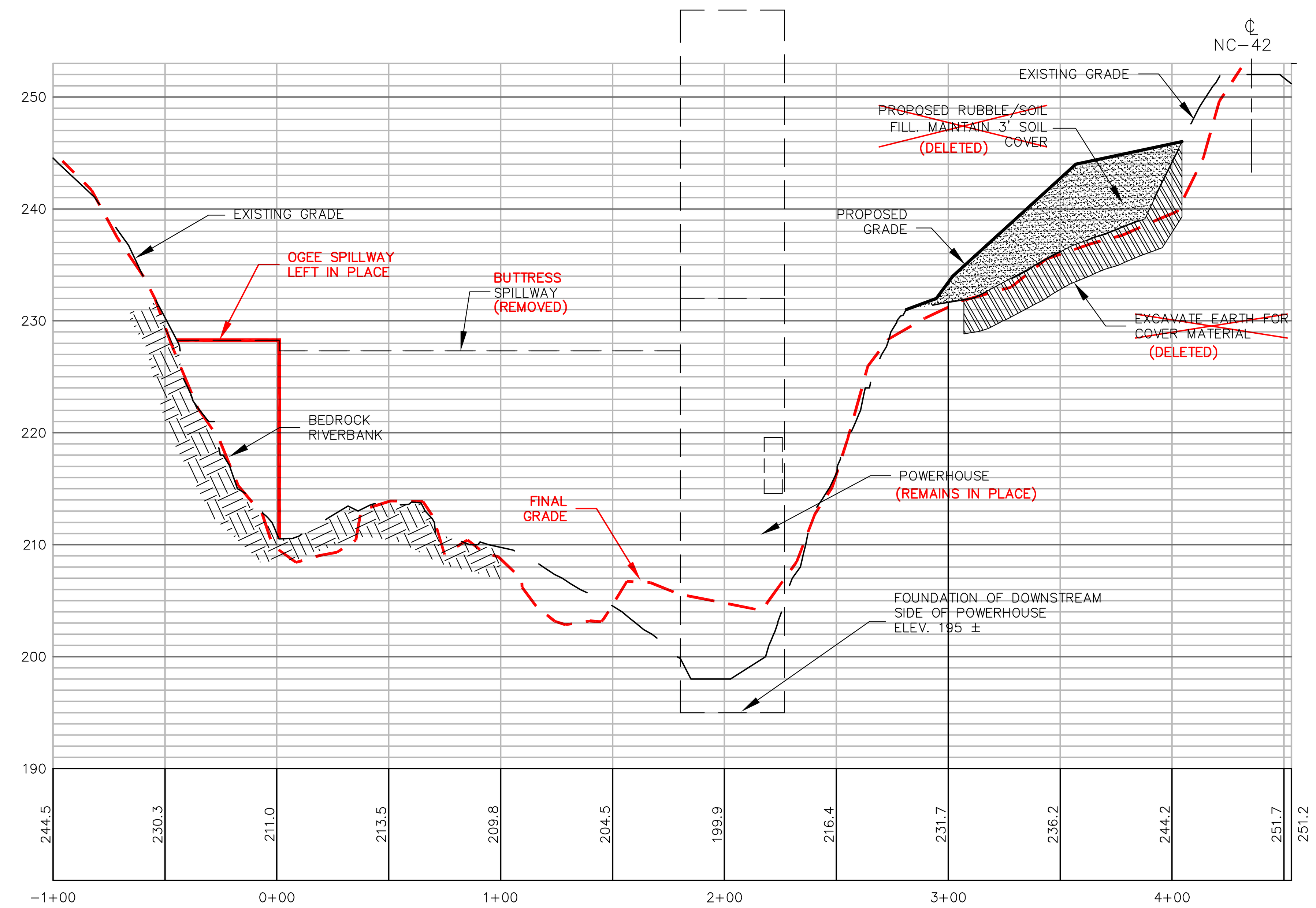
SUBSTRATE REMOVAL PLAN
DEEP RIVER
CARBONTON DAM RESTORATION SITE
LEE & CHATHAM COUNTIES, NORTH CAROLINA

KWK	JD	JGM
DESIGNED	DRAWN	CHECKED

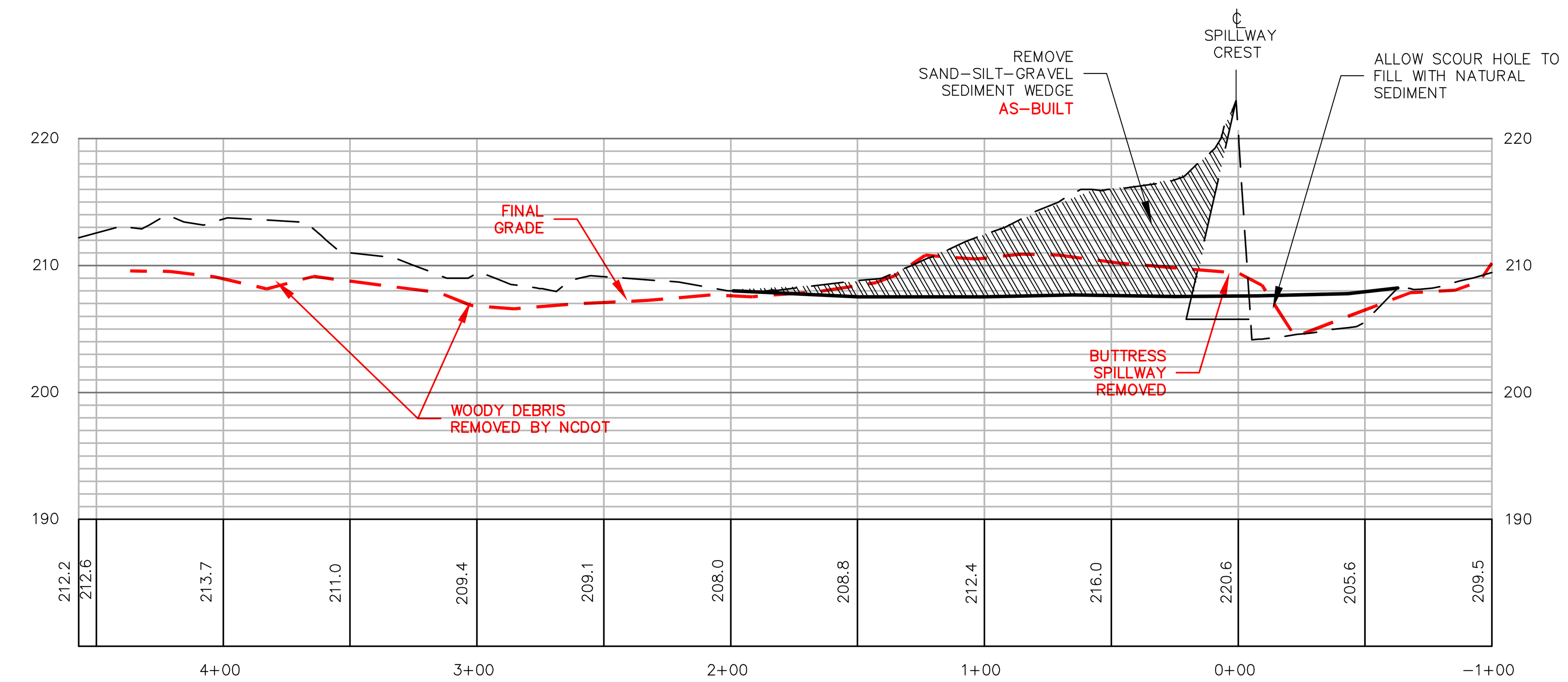
SCALE AS SHOWN
DATE DEC 13, 2005
PROJECT NO. 2691-01
DWG NAME substrate plan.dwg



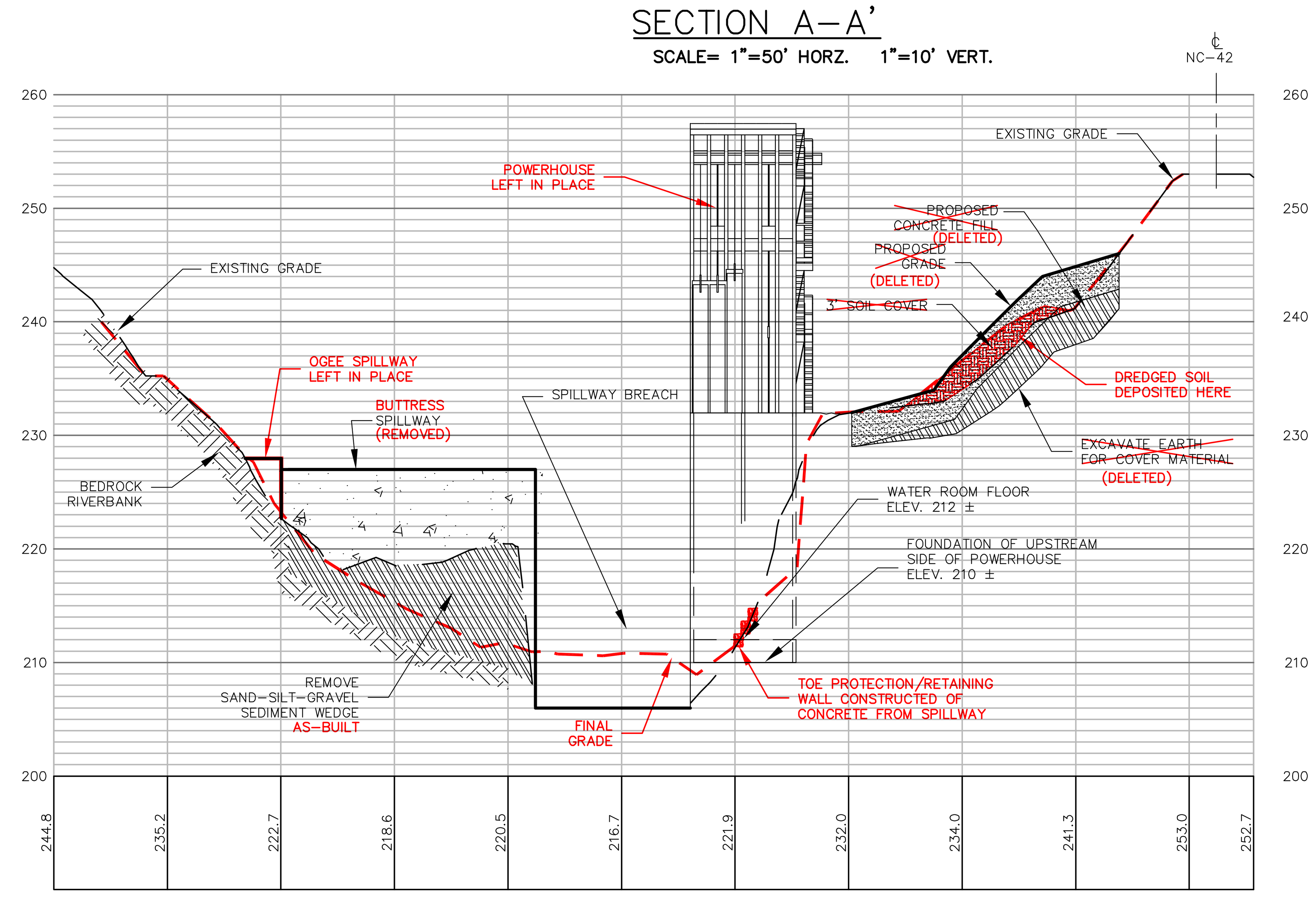
RIVER PROFILE A–A'
SCALE= 1"=50' HORZ.
1"=10' VERT.



SECTION A–A'
SCALE= 1"=50' HORZ. 1"=10' VERT.



RIVER PROFILE B–B'
SCALE= 1"=50' HORZ.
1"=10' VERT.



SECTION B–B'
SCALE= 1"=50' HORZ. 1"=10' VERT.

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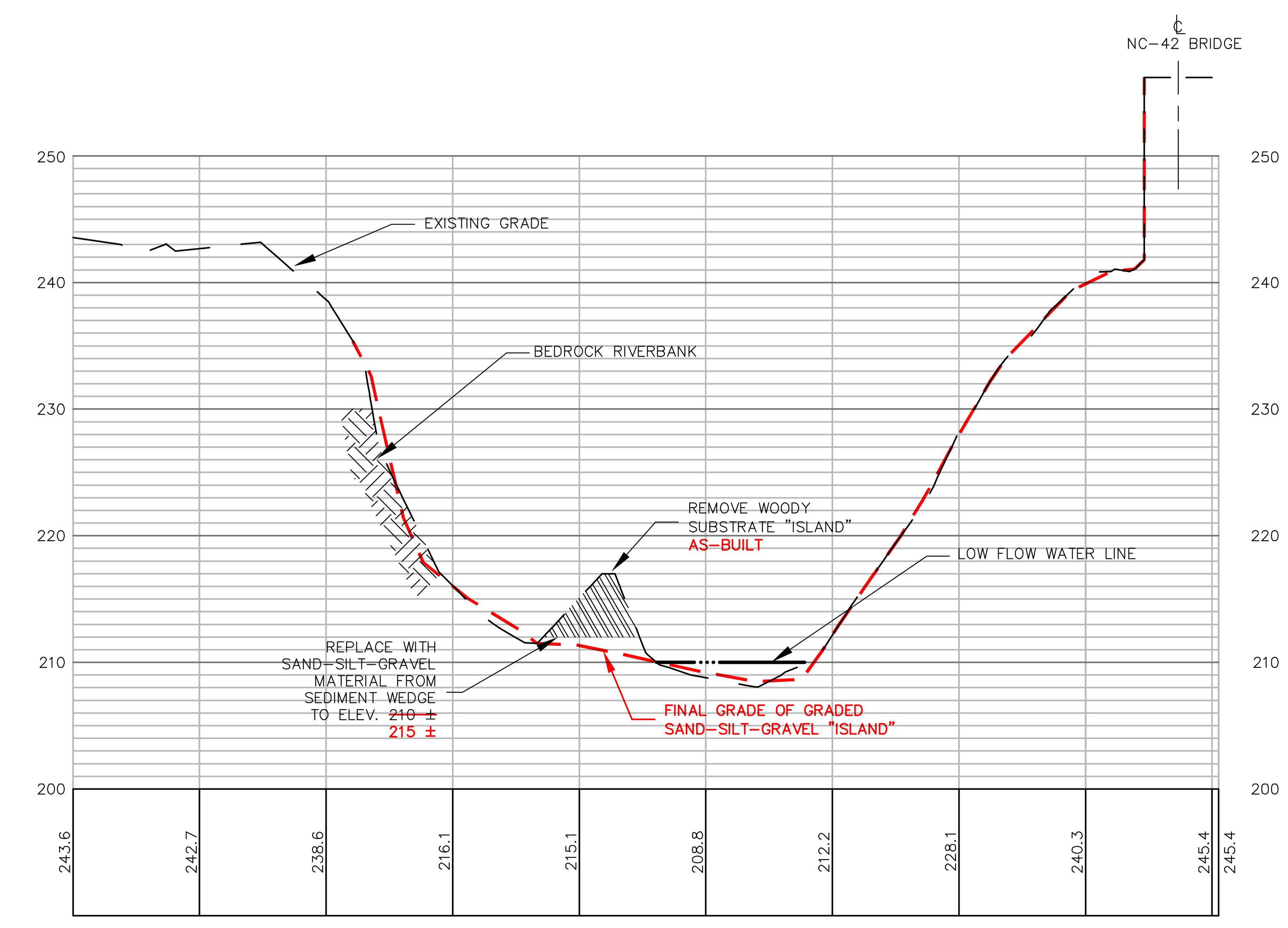

SECTION C–C'
SCALE= 1"=50' HORZ.
1"=10' VERT.

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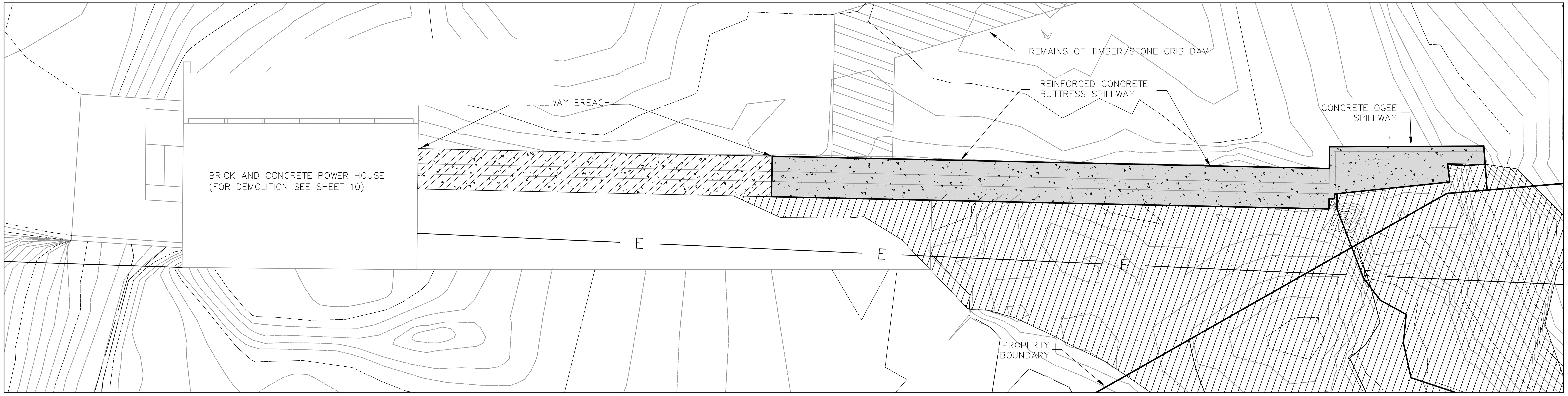
REVISIONS
5/19/06 ADDED ASBUILT INFORMATION

RIVER SECTIONS AND PROFILES
DEEP RIVER
CARBONTON DAM RESTORATION SITE
LEE & CHATHAM, NORTH CAROLINA

KWK DESIGNED	JD DRAWN	JGM CHECKED

SCALE AS SHOWN
DATE DEC 13, 2005
PROJECT NO. 2691-01
DWG NAME substrate.dwg



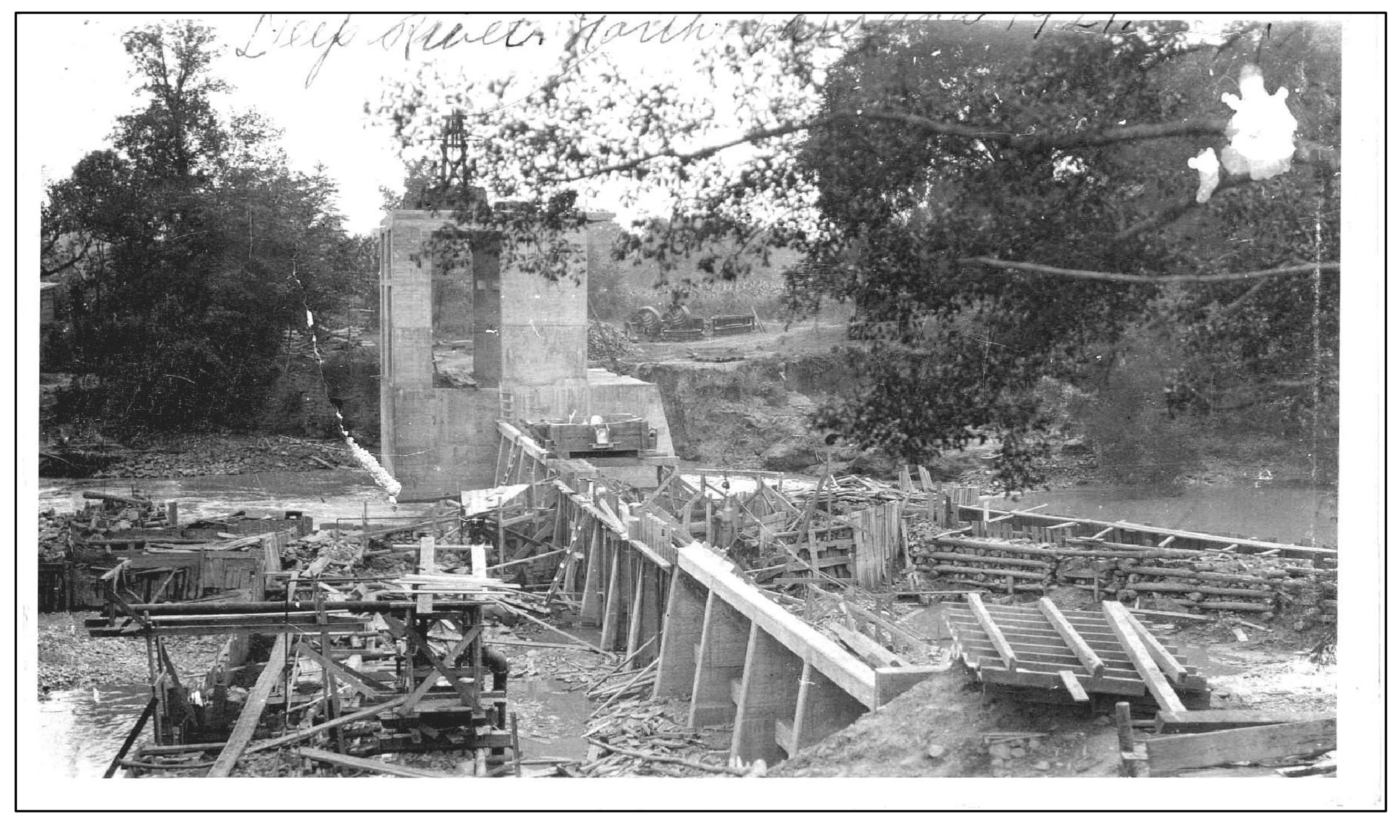
NOTE:

CONTRACTOR SHALL, TO THE MAXIMUM EXTENT POSSIBLE, WORK FROM ABOVE THE SPILLWAY BEFORE, DURING, AND AFTER SPILLWAY AND POWERHOUSE DEMOLITION ACTIVITIES.

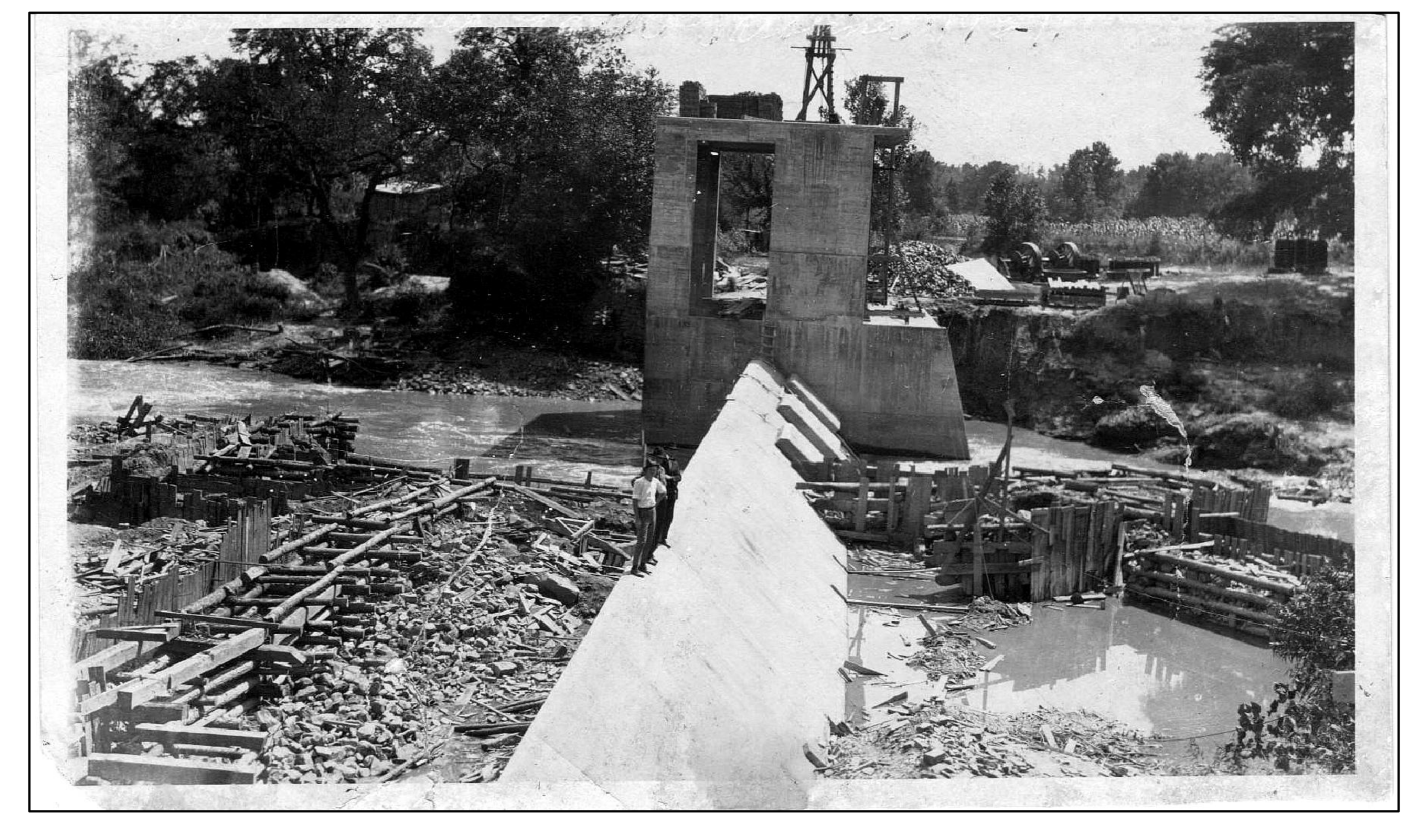
DUE TO THE PRESENCE OF CAPE FEAR SHINER, CONTRACTOR SHALL LIMIT WORK BELOW THE SPILLWAY TO ONLY ESSENTIAL OPERATIONS.

"ESSENTIAL OPERATIONS" SHALL BE REMOVING CONCRETE RUBBLE FROM THE RIVERBED THAT CANNOT BE RETRIEVED BY WORKING ABOVE THE SPILLWAY, REMOVING THE POWERHOUSE ONLY WHERE IT CANNOT BE ACCESSED FROM ABOVE THE SPILLWAY, AND TRAVERSING THE LOWER WORK ZONE ONLY WHERE NO OTHER EQUIPMENT ROUTE IS PRACTICAL.

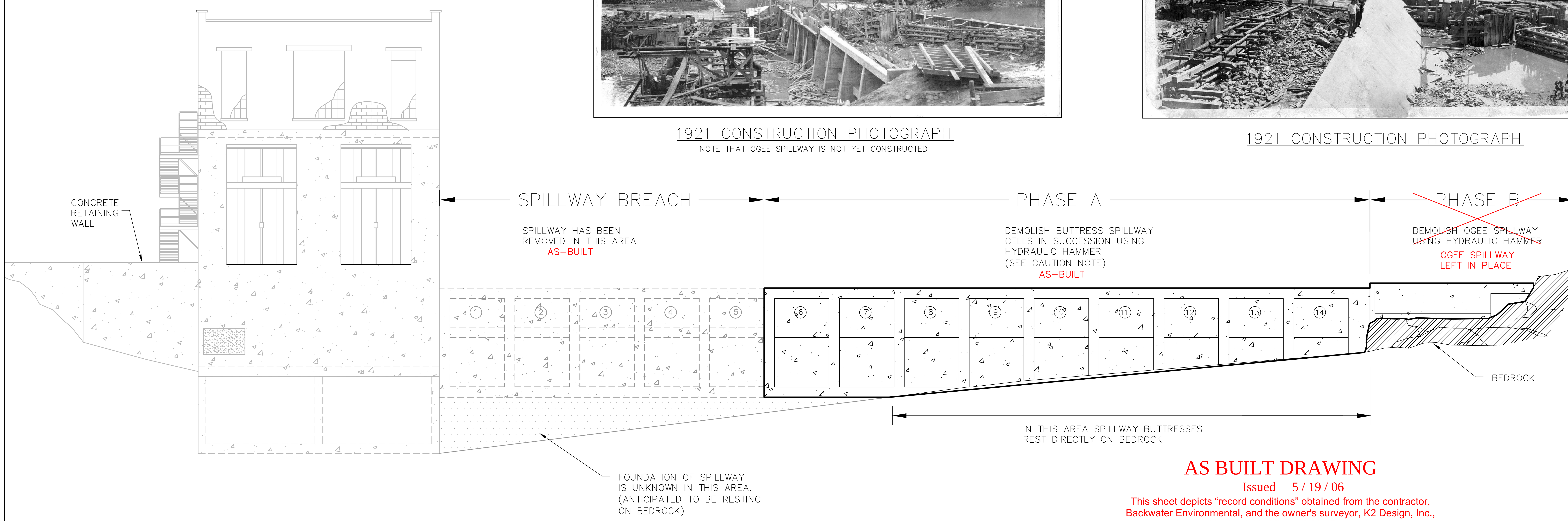
CONTRACTOR SHALL OPERATE HEAVY EQUIPMENT ON MATS WHERE POSSIBLE AND SHALL TAKE ALL OTHER PRACTICAL STEPS TO MINIMIZE EROSION, SILT/SOIL MOVEMENT, AND DISTURBANCE OF RIVERBED.



1921 CONSTRUCTION PHOTOGRAPH
NOTE THAT OGEE SPILLWAY IS NOT YET CONSTRUCTED



1921 CONSTRUCTION PHOTOGRAPH



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0 5' 10' 20' 30'

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REVISIONS

SPILLWAY DEMOLITION

DEEP RIVER
CARBONTON DAM RESTORATION SITE
LEE & CHATHAM COUNTIES, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
KWK	JD	JGM

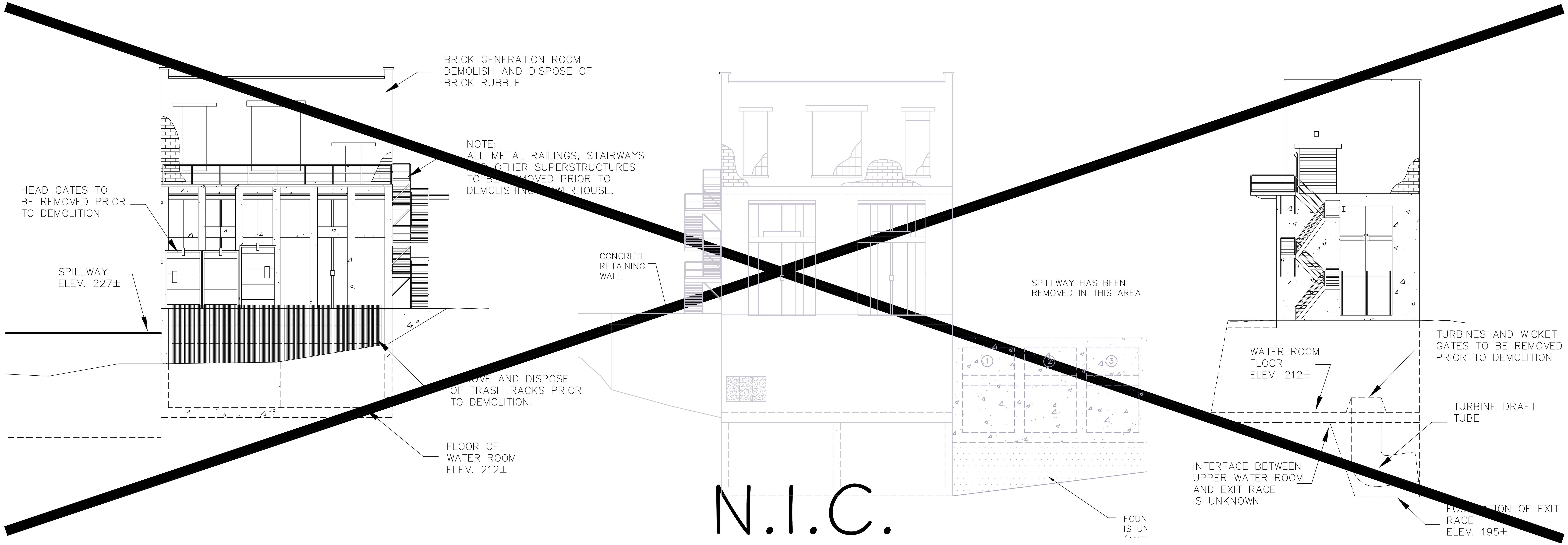
SCALE AS SHOWN

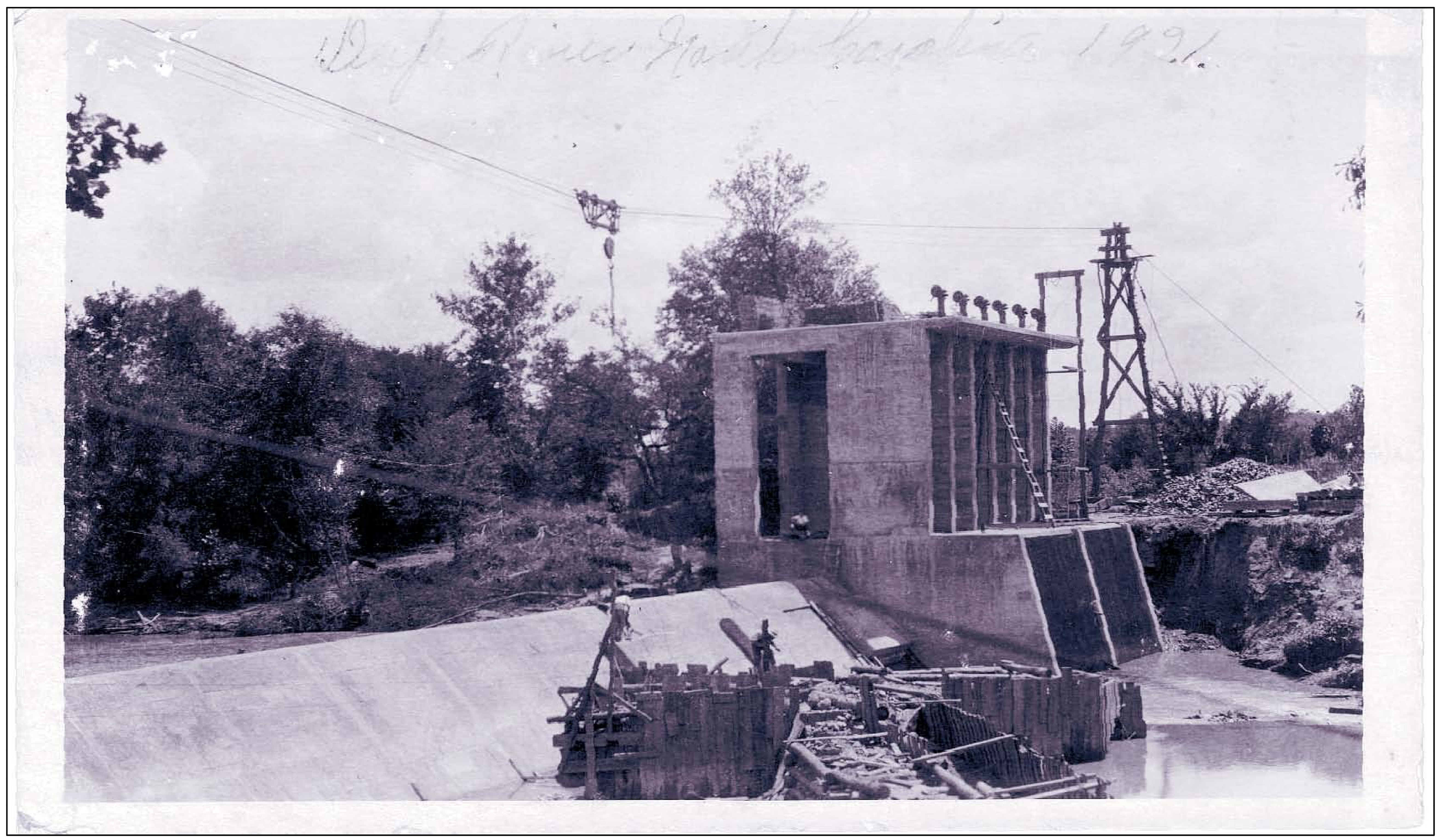
DATE DEC 13, 2005

PROJECT NO. 2691-01

DWG NAME demo.dwg

SHEET NO.





1921 CONSTRUCTION PHOTOGRAPH

(SHOWN APPROXIMATELY SAME SCALE AS ABOVE)
NOTE: BRICK GENERATION ROOM NOT YET CONSTRUCTED.

TES:
CONT OR SHALL, TO THE MAXIMUM EXTENT POSSIBLE, DEM SH STRUCTUR OM ABOVE THE POWERHOUSE. DUE TO THE PRESENCE OF CAPE FEAR INER, CONTRACTOR SHALL LIMIT W BELOW THE POWERHOUSE TO ESSENTIAL OPERATIONS.

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N.I.C.

AS BUILT DRAWING

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0 5' 10' 20' 30'

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REVISIONS

POWERHOUSE DEMOLITION

DEEP RIVER
CARBONTON DAM RESTORATION SITE

LEE & CHATHAM COUNTIES, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
KWK	JD	KWK

SCALE 1"=10'

DATE NOV 30, 2005

PROJECT NO. 2691-01

DWG NAME demo.dwg

SHEET NO. 9 of 11

AS BUILT DRAWING

Issued 5 / 19 / 06

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.

MILONE & MACBROOM®
Engineering, Landscape Architecture and Environmental Science
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Greenville, South Carolina 29601
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www.miloneandmacbroom.com

REVISIONS

5/19/06	ADDED ASBUILT INFORMATION

GRADING PLAN

DEEP RIVER
CARBONTON DAM RESTORATION SITE

LEE AND CHATHAM COUNTIES, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
PBS	PBS	JGM

SCALE AS SHOWN

DATE DEC 13, 2005

PROJECT NO. 2691-01

DWG NAME GRADING.DWG

SHEET NO. 10 of 11

S:\proj\2691 Restoration Systems\2691-01 Carbonton NC dam removal\dwg\ASBUILTS\grading.dwg, 5/17/2006 3:16:00 PM

PLANT LIST - TREES

Quan	Botanical Name	Common Name	Size
6	*Platanus occidentalis*	Sycamore	1 3/4 inch
6	*Liriodendron tulipifera*	Yellow Poplar	1 3/4 inch
6	*Amelanchier* sp.	Serviceberry	5 foot
6	*Acer rubrum*	Red Maple	10 gallon
6	*Cornus florida*	Flowering Dogwood	10 gallon

PLANT LIST - SHRUBS

Quan	Botanical Name	Common Name	Size
10	*Asimina triloba*	Paw-paw	bare root
10	*Callicarpa caroliniana*	Beautyberry	bare root

PLANT LIST - LIVE STAKES

Quan	Botanical Name	Common Name	Size
	Salix nigra	Black Willow	live stake
	Cornus amomum	Silky Dogwood	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

~~PLANT LIST - SHRUBS~~

Quan	Botanical Name	Common Name	Size
32	Itea virginica	Virginia Sweetspire	pints @ 2' o.c.

~~PLANT LIST - SHRUBS~~

Quan	Botanical Name	Common Name	Size
765	Phalaris arundinacea 'Strawberries and Cream'	Reed Grass	bare root @ 2' o.c.

AS BUILT DRAWING

Issued 5 / 19 / 06

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	5/10/06	ADDED AS-BUILT INFORMATION

LANDSCAPE PLAN

DEEP RIVER
CARBONTON DAM RESTORATION

LEE & CHATHAM COUNTIES, NORTH CAROLINA

DESIGNED	DRAWN	CHECKED
PBS	PBS	KWK

SCALE AS SHOWN

DATE NOV 30, 2005

PROJECT NO. 2691-01

DWG NAME 2691-01 Carbonton\dwg\landscape.dwg

SHEET NO. 11 of 11

APPENDIX E: SECTION 7 COORESPONDENCE

United States Department of the Interior

ORIGINAL

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

February 9, 2005

RECEIVED
FEB 15 2015
BY: DHS

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

Dear Mr. Schiller:

Thank you for your February 8, 2005 letter and attached Feasibility Study for the proposed removal of Carbonton Dam located on the Deep River in Lee, Chatham and Moore counties in central North Carolina. This letter provides the U.S. Fish and Wildlife Service's (Service) response pursuant to section 7 of the Endangered Species Act, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Based on the information provided and other information available, it appears that your project site does not contain any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act. We concur that this project will not affect the red cockaded woodpecker (*Picoides borealis*), Harperella (*Ptilimnium nodosum*) and Michaux's sumac (*Rhus michauxii*) and the project is not likely to adversely affect the bald eagle (*Haliaeetus leucocephalus*) and Cape Fear Shiner (*Notropis mekistocholas*). We believe that the requirements of section 7(a)(2) of the Act have been satisfied. We remind you that obligations under section 7 consultation must be reconsidered if: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

Thank you for the opportunity to review this project. If you have any questions or comments regarding our response, please contact Mr. Dale W. Suiter of this office at (919) 856-4520, Ext. 18 or Dale_Suiter@fws.gov.

Sincerely,

Dale Suiter

for Pete Benjamin
Ecological Services Supervisor

APPENDIX F: SECTION 106 COORESPONDENCE

MEMORANDUM OF AGREEMENT
BETWEEN
THE UNITED STATES ARMY CORPS OF ENGINEERS
AND
THE NORTH CAROLINA STATE HISTORIC PRESERVATION OFFICER
FOR
REMOVAL OF THE CARBONTON DAM, AND POWERHOUSE ON THE DEEP RIVER CHATHAM AND LEE COUNTIES, NORTH CAROLINA

WHEREAS, the US Army Corps of Engineers (USACE) is considering issuance of a permit to Restoration Systems, LLC for the demolition of the Carbonton Dam and Powerhouse (also known as the Sandhill Power Company); and

WHEREAS, the USACE has determined that the Undertaking will adversely affect the Carbonton Dam and Powerhouse, properties determined eligible for listing in the National Register of Historic Places; and

WHEREAS, the USACE has consulted with the North Carolina State Historic Preservation Officer (SHPO) pursuant to 36 CFR 800, regulations implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470f); and

WHEREAS, Restoration Systems, LLC was invited to participate in the consultation and concur in this Agreement;

NOW, THEREFORE, the USACE, and the North Carolina SHPO agree that the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effect of the Undertaking on historic properties.

STIPULATIONS

The USACE will include the following conditions in any permit issued for the Undertaking:

I. Photographic Recordation

Prior to the demolition of the Carbonton Dam and Powerhouse, Restoration Systems, LLC shall carry out the Recordation Plan attached to this Memorandum of Agreement as Appendix A. The documentation shall be submitted to the North Carolina SHPO for integration onto the permanent statewide inventory of historic properties.

II. Public Education/ Interpretive Display

Restoration Systems, LLC, in consultation with the North Carolina SHPO, will develop and install an interpretive display at the site of the Carbonton Dam and Powerhouse to provide for the public's education about the historical and architectural significance of the site and the environmental benefits of the removal of the dam and powerhouse.

III. Dispute Resolution

Should the North Carolina SHPO object within (30) days to any plans or documentation provided for review pursuant to this Agreement, the USACE shall consult with the North Carolina SHPO to resolve the objection. If the USACE or the North Carolina SHPO determines that the objection cannot be resolved, the USACE will forward all documentation relevant to the dispute to the Advisory Council on Historic Preservation (Council). Within thirty (30) days after receipt of all pertinent documentation, the Council will either:

A. Provide the USACE with recommendations which the USACE will take into account in reaching a final decision regarding the dispute, or
B. Notify the USACE that it will comment pursuant to 36 CFR Section 800.7(c) and proceed to comment. Any Council comment provided in response to such a request will be taken into account by the USACE, in accordance with 36 CFR Section 800.7 (c) (4) with reference to the subject of the dispute.

Execution of this Memorandum of Agreement by the USACE and the North Carolina SHPO, its subsequent acceptance by the Council and implementation of its terms, evidence that USACE has afforded the Council an opportunity to comment on the demolition of the Carbonton Dam and Powerhouse, and that the USACE, has taken into account the effects of the Undertaking on historic properties.

AGREED:

By: Charles R. Alexander Jr. Col USA Date: 5/26/05
U.S. Army Corps of Engineers, Wilmington District

By: Jeffrey J. Crow Date: 5/19/05
North Carolina State Historic Preservation Officer

CONCUR:

By: G A L W Date: May 16, 2005
Restoration Systems, LLC

FILED BY:

By: ______________________ Date: ______________
Advisory Council on Historic Preservation

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1890
WILMINGTON, NORTH CAROLINA 28402-1890
February 17, 2005

IN REPLY REFER TO
Regulatory Division

Action ID 200421183

Ms. Martha Catlin
Advisory Council on Historic Properties
Office of Federal Agency Programs, Eastern Office
1100 Pennsylvania Avenue NW, Suite 803
Washington, DC 20004

Dear Ms. Catlin:

Mr. George Howard with Restoration Systems, L.L.C., has been coordinating with our office and proposes to apply for a Department of the Army (DA) permit pursuant to Section 404 of the Clean Water Act to discharge fill material in the waters of the Deep River associated with the removal of the Carbonton Dam and Powerhouse (also known as the Sandhills Power Company). The purpose of the removal of the dam and powerhouse is to restore approximately 10 miles of impounded river to a naturally free-flowing system. Specifically, the project is located immediately upstream of N.C. Highway 42 on the Deep River, approximately 10 miles west of Sanford, in Lee, Chatham and Moore Counties.

Having applied the criteria of effect, we have determined that the proposed undertaking will adversely affect the Carbonton Dam, a property eligible for listing on the National Register of Historic Places. While we are presently considering issuance of the DA permit to the applicant for the proposed project, we have begun consultation with the North Carolina State Historic Preservation Office (SHPO) and the applicant to develop a Memorandum of Agreement (MOA) to address the adverse effect. Attached is a draft copy of the MOA for your review and comment. Accordingly, we would like to know whether or not the Advisory Council wishes to participate in the consultation process under Section 106 of the National Historic Preservation Act.

If you have any questions or need additional information, please contact me or Mr. Todd Tugwell Wade, Raleigh Regulatory Field Office, telephone (919) 876-8441, Ext. 24 and 26, respectively.

Sincerely,

Jean B. Manuele

Jean B. Manuele
Chief, Raleigh Field Office

Enclosure/as

Copy Furnished (without enclosure):

Mr. George Howard
Restoration Systems, L.L.C.
Pilot Mill
1101 Haynes Street, Suite 107
Raleigh, North Carolina 27604

Ms. Renee Gledhill-Earley
North Carolina Department of
Cultural Resources
State Historic Preservation Office
4617 Mail Service Center
Raleigh, North Carolina 27699-4617

North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

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

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

February 1, 2005

David H. Schiller,
Manager Contracts and Regulatory Affairs
Restoration Systems
Pilot Mill
1101 Haynes St., Suite 107
Raleigh, NC 27604

Re: Removal of Carbonton Dam and Powerhouse, Deep River Mitigation Bank, USACE Action ID # 200421183, Chatham and Lee Counties, ER 04-2232

Dear Mr. Schiller:

Thank you for your letter of December 16, 2004, transmitting the Sandhill (Carbonton) Power Company Dam and Powerhouse National Register of Historic Places Evaluation, prepared by Marvin Brown of URS.

For purposes of compliance with Section 106 of the National Historic Preservation Act, we concur that the Sandhill Power Company Dam and Powerhouse are eligible for listing in the National Register of Historic Places under the following criteria.

Criterion A for Industry and Criterion C for Architecture and Engineering

In addition to the recognition of significance by surveyors, the photo documentation and map of the area, reveal a great deal of integrity. While a number of changes have been made, in terms of *materials*, demolition of the Sandhill Power Company Dam and Powerhouse, will result in an adverse effect on these National Register-eligible resources. Therefore, any planned activities are subject to Section 106 of the National Historic Preservation Act and the regulations of the Advisory Council on Historic Preservation.

We have reviewed the mitigation proposed to address this adverse effect, and find this documentation will address our requirements with a few additional elements. We believe that the necessary recordation measures can be incorporated into a Memorandum of Agreement (MOA) between the United States Army Corps of Engineers (ACOE) and us for the undertaking. A draft MOA will be provided under separate cover for consideration by you and the ACOE.

	Location	Mailing Address	Telephone/Fax
ADMINISTRATION	507 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-4763/733-8653
RESTORATION	515 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6547/715-4801
SURVEY & PLANNING	515 N. Blount Street, Raleigh, NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6545/715-4801

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

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

Sincerely,

Peter Sandbeck

cc: ACOE Raleigh Office

North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

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

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

September 1, 2004

Todd J. Tugwell
Raleigh Regulatory Field Office
US Army Corps of Engineers
6508 Falls of the Neuse Road, Suite 120
Raleigh, NC 27615

Re: Removal of Carbonton Dam and Powerhouse, Deep River Mitigation Bank
USACE Action ID # 200421183, Multi-County, ER 04-2232

Dear Mr. Tugwell:

Thank you for including our staff in the review team for this project. We have reviewed the prospectus and participated in an on-site meeting, which included a tour of the dam, powerhouse and impoundment. Based on this information, we offer the following comments.

Development of the Deep River Mitigation Bank will require the removal of the Carbonton Dam and Powerhouse, which dates to the early 1900s. It is our understanding that Restoration Systems intends to have architectural drawings made of the dam and powerhouse prior to their removal. We recommend that two copies of the drawings be made available to our office and documentary photographs of both the dam and powerhouse be taken and provided to us. Research should be undertaken to determine the age and history of the facilities, as well as their eligibility for inclusion in the National Register of Historic Places.

The resulting materials would be suitable for use in an interpretive exhibit that could be placed on-site for the public benefit. It might also be appropriate to provide copies of the research report, drawings and photographs to the local libraries or historical societies.

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

	Location	Mailing Address	Telephone/Fax
ADMINISTRATION	507 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-4763/733-8653
RESTORATION	515 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6547/715-4801
SURVEY & PLANNING	515 N. Blount Street, Raleigh, NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6545/715-4801

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

Sincerely,

Renee Gledhill-Earley

for Peter Sandbeck
Deputy State Historic Preservation Officer

PS:w

cc: George Howard
Restoration Systems, LLC
1101 Haynes Street, Suite 107
Raleigh, NC 27604

MITIGATION PLAN - ADDENDUM

FULL DELIVERY PROJECT TO PROVIDE STREAM RESTORATION
CAPE FEAR RIVER BASIN CATALOGING UNIT 03030003

CARBONTON DAM – DEEP RIVER WATERSHED
RESTORATION SITE
Chatham, Lee, and Moore Counties, 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

CARBONTON DAM – DEEP 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 Carbonton Dam– Deep 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:

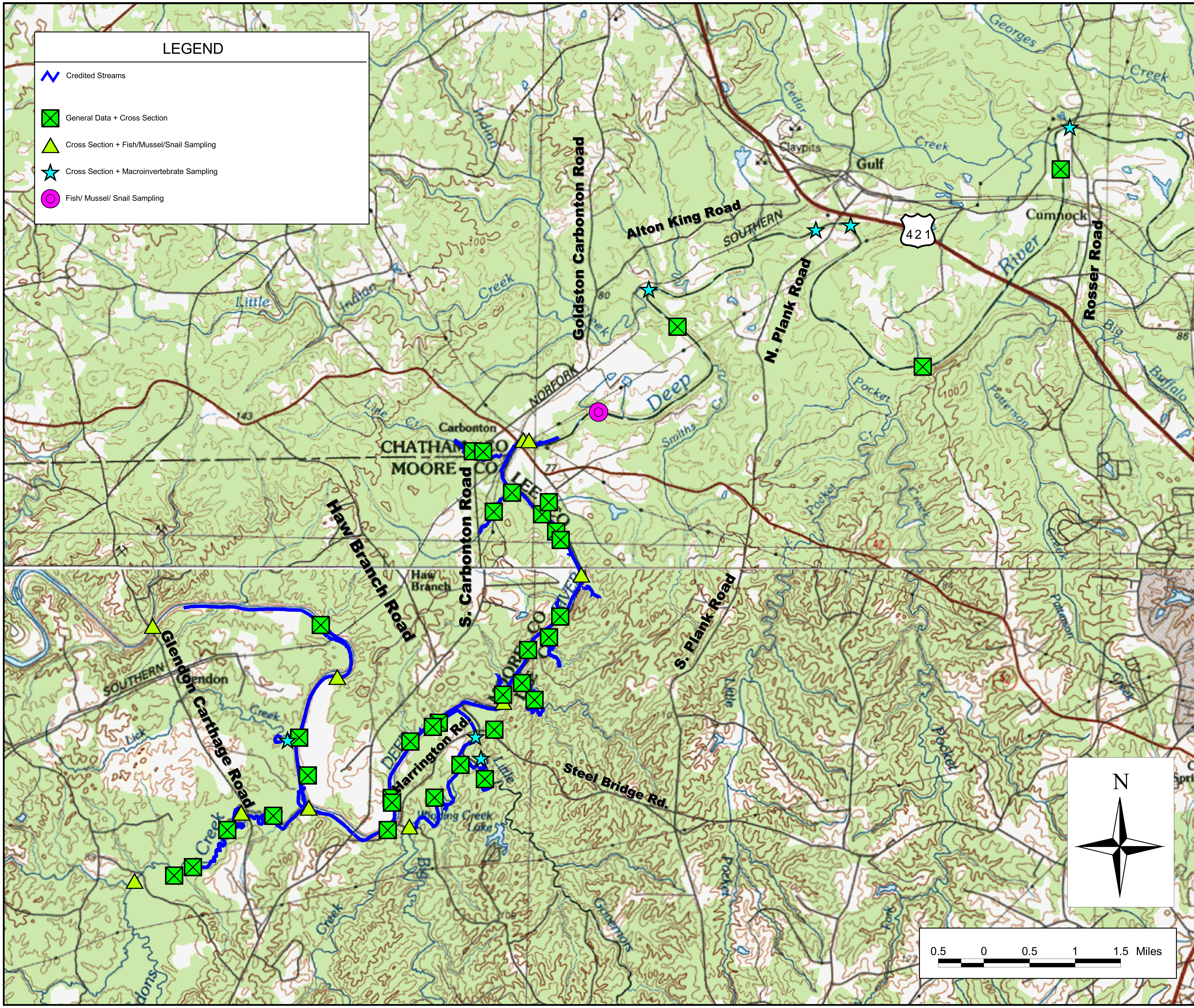
1. A table of habitat assessment results from pre-dam removal.
Habitat assessment data was collected at all monitoring stations prior to dam removal to evaluate aquatic habitat to support improvement in community populations. The North Carolina Division of Water Quality Habitat Assessment Field Data Sheet was completed to evaluate the quality and character of the sampled habitat niches and to provide a comparable score that describes the habitat available at each station. Habitat assessment data will be collected throughout the monitoring period at all monitoring stations to support success evaluation for the improved biotic community. Table A of this Addendum displays the habitat assessment results from pre-dam removal monitoring (Year 2005).

2. 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 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 ensuing text that includes tables of pre-dam removal sampling results for fish, mussels, and snails.

3. A map showing the locations for all of the above sample sites (pre-dam removal).
Monitoring activities described in the Mitigation Plan for pre-dam removal sampling stations are mapped on Figure 3 of the Mitigation Plan. Monitoring activities will be performed throughout the monitoring period at the same station locations shown in Figure 3. The field effort for all monitoring stations consists of one of the four following combinations as displayed in Figure 3: General data collection and Cross-section, Cross-section and Fish/Mussel/Snail Sampling, Cross-section and Macroinvertebrate sampling, and Fish/Mussel/Snail Sampling.

Table A. Habitat Assessment Results for Pre-Dam Removal Monitoring

Impounded Stations		Reference Stations	
Station	NCDWQ Habitat Assessment Field Data Sheet Score	Station	NCDWQ Habitat Assessment Field Data Sheet Score
1	28	12	75
2	38	14	39
3	45	15	58
4	45	16	59
5	43	17	48
6	37	18	55
7	36	19	61
8	47	25	54
9	39	26	58
10	59	33	76
11	53	35	42
20	28	37	65
21	18	39	53
22	23	44	63
23	30	45	61
24	37	52	76
27	47	53	76
29	43	54	53
30	53	**MEAN SCORE**	**59.56**
31	48		
32	38		
34	50		
36	31		
38	50		
40	51		
41	42		
42	49		
43	42		
47	56		
48	46		
49	46		
50	51		
51	50		
MEAN SCORE	**42.39**		



EcoScience Corporation
Raleigh, North Carolina

CLIENT:

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

Ecosystem Enhancement PROGRAM

PROJECT:

Deep River Carbonton Dam Restoration Site

Chatham, Lee and Moore Counties, North Carolina

TITLE:

Monitoring Station Locations

Dwn By:	Ckd By:
JDG	MTC
Date:	Scale:
MAY 2006	AS SHOWN

ESC Project No.: 06-288.02

FIGURE 3

Carbonton Dam –Deep River Watershed Restoration Site
Pre-Removal Aquatic Species Surveys

Prepared By: The Catena Group

1.0 INTRODUCTION

The impacts to aquatic fauna from artificial impoundments are well documented. Dams have been shown to result in declines in fish biodiversity and fisheries (Nehlsen et al. 1991, Martinez et al. 1994, Moyle and Leidy 1992, LaRoe et al. 1995, Quinn and Kwak 2003, Santucci et al. 2005; and others) and are identified as a major factor in the decline of freshwater mussels (Williams et al., 1993 Bogan 1993, Neves 1993). The construction of dams can indirectly impact freshwater mussel species, which require fish hosts to complete their life cycles, by posing a barrier to fish migration. The construction of the Petitcodiac River Causeway in 1968, resulted in the extirpation of the dwarf wedgemussel (*Alasmidonta heterodon*) from Canada, because the causeway restricted the migration of the diadromous Inner Bay of Fundy stock of Atlantic salmon (*Salmo salar*), which serves as the fish host for the dwarf wedgemussel in this region (Locke et al. 2003). Fish populations can also be greatly impacted by dam construction reducing both numbers and biodiversity (Nehlsen et al. 1991, Moyle and Leidy 1992 LaRoe et al. 1995, Santucci et al. 2005). Dam construction on the Cape Fear River system has been identified as the most significant factor causing the decline of the federally endangered Cape Fear shiner *(Notropis mekistocholas)* and has resulted in isolation of the remaining populations (USFWS 1988). Morita and Yokota (2002) showed that damming of waterways in Japan created population isolation of many fish species including the white-spotted char (*Salvelinus leucomaenis*) and that most of the small fragmented populations were not viable.

Restoration Systems, LLC (RS) is coordinating the demolition and removal of Carbonton Dam, a hydro facility located on the Deep River along the Chatham/Lee/Moore county line, with the goal of restoring the impounded stretch of the Deep River and its tributaries to pre-impoundment conditions. The existing dam currently separates two populations of the Cape Fear shiner. The removal of Carbonton dam is projected to result in the restoration of more than 9.5 river miles (RM) of the mainstem Deep River; significant portions of three major tributaries, McLendons Creek, Big and Little Governors Creeks; as well as fifteen smaller tributaries within the Cape Fear River Basin. The dam removal project is anticipated to restore significant additional, habitat for the federally endangered Cape Fear shiner, several species of rare mussels, and other riverine aquatic species. The project is expected to serve as a mitigation bank for future activities within the Cape Fear River Basin.

Based on the restoration success criteria recommended by the U.S. Fish and Wildlife Service (FWS), the expectations of the interagency dam removal task force, and the goals of RS, documenting the effectiveness of the restoration initiative requires that a baseline of existing aquatic fauna within the project area be established and then monitored for changes in composition after the dam is removed. Meeting this goal involves two phases:

Phase I. Pre-dam removal surveys in order to establish a baseline of fish, mussels, and macro-snails present in impounded and nearby free-flowing reaches.

Phase II. Post-dam removal surveys in the restored reaches to detect/document changes in fish, mussel, and macro-snail composition for a five-year period.

The Catena Group, Inc. (TCG) was contracted by RS to complete the Phase I aquatic fauna surveys for the project. This report provides a detailed summary of the survey efforts undertaken for this project.

2.0 TARGETED RARE AND PROTECTED SPECIES DESCRIPTIONS

Since rare and protected species restoration is one of the criteria that may be used to determine the success of dam removal, the following rare species with the potential to occur within the Cape Fear River Basin, were targeted for this study (Table 1). Descriptions of these federally protected, Federal Species of Concern (FSC), and North Carolina-state listed species are provided below.

Table 1. Rare Aquatic Species Documented from Upper Cape Fear River Basin

Scientific Name	Common Name	Taxa Group	Federal Status*	NC Status*
Alasmidonta undulata	triangle floater	Mussel	~	T
Alasmidonta varicosa	brook floater	Mussel	FSC	E
*Amboplites cavifrons***	Roanoke bass	Fish	FSC	SR
Elliptio roanokensis	Roanoke slabshell	Mussel	~	T
Etheostoma collis	Carolina darter	Fish	FSC	SC
Fusconaia masoni	Atlantic pigtoe	Mussel	FSC	E
Lampsilis cariosa	yellow lampmussel	Mussel	FSC	E
Lasmigona subviridis	green floater	Mussel	FSC	E
Moxostoma sp. 3	Carolina redhorse	Fish	FSC	PE
Strophitus undulatus	creeper	Mussel	~	T
Toxolasma pullus	Savannah liliput	Mussel	FSC	E
Villosa constricta	notched rainbow	Mussel	~	SC
Villosa delumbis	Eastern creekshell	Mussel	~	SR
Villosa vaughniana	Carolina creekshell	Mussel	FSC	E

* Federal and North Carolina status defined in Appendix A
** Not native to basin

2.1 Targeted Federally Protected Species

***Notropis mekistocholas* (Cape Fear shiner)**
Status: Endangered
Listed: September 26, 1987

Characteristics

The Cape Fear shiner is a small, moderately stocky Cyprinid described by Snelson (1971). The fish's body is flushed, pale, silvery, yellow, with a black band running along the side. The fins are yellowish and somewhat pointed. The upper lip is black and the lower lip bears a thin black bar along its margin.

The Cape Fear shiner is distinguished from all other *Notropis* by having an elongated alimentary tract with two convolutions crossing the intestinal bulb. This is believed to be an adaptation for herbivorous feeding (Snelson 1971, USFWS 1988).

Distribution and Habitat Requirements

Current distribution of the Cape Fear shiner is limited mainly to small stretches of the Deep, Haw, and Rocky rivers of the Cape Fear River basin. It is possible that it has always been rare and restricted in range; however a reduction in the historical range has been demonstrated (USFWS 1988). Approximately 17 RM of the Deep, Haw, and Rocky Rivers have been designated as federal Critical Habitat for the Cape Fear shiner (50 CFR Vol. 52 No. 186).

Typical habitat for the Cape Fear shiner has been described as slow pools, riffles, and slow runs over gravel, cobble, and boulder substrates (Snelson 1971, Pottern and Huish 1985). It has been suggested that essential spawning habitat for this species is associated with water willow (*Justicia americana*) beds, as Catch per Unit Effort (CPUE) were higher in water willow beds (NCWRC 1995), however recent micro-habitat studies did not support an association with water willow during the spawning season (Howard 2003). Water willow may still provide protection from predators as well as water velocity refugia for depositing eggs (Howard 2003).

Threats to the Species

The restricted range and small population sizes make this species vulnerable to catastrophic events, such as toxic chemical spills (USFWS 1988). Inundation of habitat and restriction of flow regimes, which have resulted from multiple dam construction projects in the Cape Fear system, is likely the most significant factor that contributed to the species decline (USFWS 1988). Sedimentation of habitat, particularly that of water willow beds, also threatens the species.

2.2 Targeted Federal Species of Concern

Federal Species of Concern (FSC) are defined as species that are under consideration for listing as Threatened and Endangered, but for which there is insufficient information to support the listing. FSCs are not afforded protection under the Endangered Species Act and are not subject to any of its provisions, including Section 7, until they are formally proposed or listed as Threatened or Endangered. However, since the status of these species is subject to change, FSCs should be included for consideration during the planning process of a project in the event that they become listed.

2.2.1 Alasmidonta varicosa **(brook floater)**
Federal Status: Federal Species of Concern
State Status: Endangered

Characteristics

Shells of the brook floater are long and rhomboid in outline with a yellowish to greenish, smooth perisotracum. Shell surfaces are partly to completely covered with dark, greenish rays which become obscured with age. The posterior slope of the shell is flattened and slightly concave with numerous, low corrugations or varicose ridges.

Distribution and Habitat Requirements

Described by Lamarck (1819) from the Schuylkill River in Philadelphia County, Pennsylvania, this species ranges from the lower St. Laurence River basin, south to the Atlantic drainages of South Carolina. It is found in riffle habitats in small streams to moderate-sized rivers, usually associated with gravel/cobble substrate in strong current.

Threats to Species

While still common in some areas, the species has experienced significant declines throughout its range. Like with many freshwater mussel species, the cumulative effects of several factors, including sedimentation, point and non-point discharge, and stream modifications (impoundments, channelization, etc.) have contributed to the decline of this species throughout its range. This species is listed as Endangered[1] in North Carolina

***2.2.2 Ambloplites cavifrons* (Roanoke bass) Cope 1868**
Federal Status: Federal Species of Concern
State Status: Significantly Rare

Characteristics

This member of the sunfish family (Centrachidae) was described from the head waters of the Roanoke River, in Virginia by Cope (1868). Along with the similar rock bass (*Ambloplites rupestris*), it is often referred to as "redeye bass, or "goggle eye", as it has a large red eye. The Roanoke bass has large terminal mouth with a short (150-235 SL), robust body, that is dark olive brown in color, with many dark spots and lateral stripes that are silvery to pale-green. It has five to six (usually six) anal spines (most centrachids have three), and a rounded pectoral fin. It is a popular "game" fish in some areas of its range.

Distribution and Habitat Requirements

This species has a relatively small native range, being known from the Chowan and Roanoke River Basins in Virginia south through the Tar-Pamlico and Neuse River Basin in North Carolina (Lee et al. 1980). This species was stocked into the upper Cape Fear River Basin between 1973, and 1975, by the NCWRC (Menhinick 1991). Although

[1] **North Carolina Listed Endangered (E)** defined as a species that is in danger of extinction throughout all or a significant portion of its range

stocking was discontinued, a reproducing population persists in the Deep River (Menhenick and Braswell 1997). It occurs in medium size streams to large rivers, but has experienced major declines throughout much of its range and has been extirpated from the upper Roanoke.

Threats to Species

The decrease in range and population numbers of this species has been attributed to impoundments, pollution, and siltation of habitats (Jenkins and Burkhead 1993). The extirpation from the upper Roanoke is suggested to be attributable to the introduction of the rock bass into this area (Jenkins and Burkhead 1993). It is considered Significantly Rare in North Carolina.

2.2.3 Etheostoma collis (Hubbs and Cannon 1935) pop 2 (Carolina darter-eastern Piedmont population)

Federal Status: Federal Species of Concern
State Status: Special Concern

Characteristics

The Carolina darter (a small fish) was described in South Carolina (Hubbs and Cannon 1935). Three allopatric taxa have been recognized in the *E. collis* group (Collette 1962): *E. collis lepidinion* in the Roanoke, Neuse, and Cape Fear drainages, *E. c. collis* in the Pee Dee drainage and the Catawba system of the Santee drainage; and *E. saludae* from the Saluda system of the Santee drainage. Jenkins and Burkhead (1993) noted that no populations from individual drainages exhibit distinctive taxonomic characters, and thus, use the name *E. collis* for the broadened species. In North Carolina, two populations are recognized (LeGrand et al. 2004): population 1 (central Piedmont population), which corresponds to *E. c. collis* and population 2 (eastern Piedmont population), which corresponds to *E. c. lepidinion*.

The Carolina darter is a small (31-60 mm) nondescript darter that has a yellow-brown body covered in eight to fourteen dark blotches along the midside, with a yellowish white venter. Its eyes are nearly on the top of its head and it has a rounded caudal fin with three dark blotches at the base.

Distribution and Habitat Requirements

This population of the Carolina darter (eastern Piedmont) ranges from the Roanoke River Basin south to the Cape Fear River Basin in North Carolina. It inhabits small to moderate size streams and small rivers, in areas of low current velocity. Preferred substrate is usually characterized as sand or mud, usually in or near aquatic vegetation (Rhode et al. 1994).

Threats to Species

Geographic isolation in addition to threats from development, water quality impacts, and habitat alterations (channelization, impoundments, etc.) has been identified as threats to this species (Warren et al. 2000). This species is of Special Concern in North Carolina.

***2.2.4 Fusconaia masoni* (Atlantic pigtoe)** Conrad 1834
Federal Status: Federal Species of Concern
State Status: Endangered

Characteristics

The Atlantic pigtoe (a mussel) was described by Conrad (1834) from the Savannah River in Augusta, Georgia. Shells of the Atlantic pigtoe are subrhomboidal in outline, with a parchment-like yellow to dark brown periostracum. The posterior ridge is very distinct, and the umbos extend well above the dorsal margin.

The Atlantic pigtoe is a tachytictic (short-term) breeder, brooding young and releasing glochidia in early summer. The bluegill (*Lepomis macrochirus*) and shield darter (*Percina peltata*) have been identified as potential fish hosts for this species (O'Dee and Waters 2000).

Distribution and Habitat Requirements

The Atlantic pigtoe ranges from the Ogeechee River Basin in Georgia north to the James River Basin in Virginia. It occurs in medium size streams to large rivers, but has experienced major declines throughout its entire range. The preferred habitat for this species is a substrate composed of gravel and coarse sand, usually at the base of riffles; however, it can be found in a variety of other substrates and habitat conditions (personal observations).

Threats to Species

Threats to this and many other freshwater mussel species are similar to those described above for the brook floater. Williams et al. (1993) list this species as Endangered. There appears to be sufficient data to warrant elevation of the Atlantic pigtoe to Candidate status in the very near future (John Fridell, Recovery Biologist USFWS, Personal Communication). It is listed as Endangered in North Carolina.

***2.2.5 Lampsilis cariosa* (yellow lampmussel)** Say 1817
Federal Status: Federal Species of Concern
State Status: Endangered

Characteristics

The yellow lampmussel (a mussel) was described by Say (1817) from the Schuykill River near Philadelphia, Pennsylvania (Say 1817). The waxy-yellow shell is obovate in outline, with a rounded anterior margin and slightly curved posterior margin and is rarely rayed. Like other members of this genus, this species is sexually dimorphic, with the shell of the male being more elongate and the female more rounded, particularly in the posterior margin.

Distribution and Habitat Requirements

The yellow lampmussel extends from the Ogeechee River in Georgia north to Nova Scotia, Canada, and westward in the St. Lawrence River Basin to the lower Ottawa River and Madawaska River drainages, Canada (Johnson 1970). It occurs in small size streams to large rivers, but has experienced major declines throughout its entire range. The preferred habitat for this species is a substrate composed of sand and gravel, but it may also occur in substrates of silt, cobble, and bedrock crevices.

Threats to Species

Threats to this and many other freshwater mussel species are similar to those described above for the brook floater. Williams et al. (1993) list this species as Endangered throughout its range. It is listed as Endangered in North Carolina.

***2.2.6 Lasmigona subviridis* (green floater)** Conrad 1835
Federal Status: Federal Species of Concern
State Status: Endangered

Characteristics

The green floater (a mussel) was described by Conrad (1835) from the Schuykill River in Lancaster County Pennsylvania. The small mussel species has a thin slightly inflated subovate shell that is narrower in front, higher behind. The dorsal margin forms a blunt angle with the posterior margin. The shell is dull yellow or tan to brownish green, usually with concentrations of dark green rays.

Distribution and Habitat Requirements

The green floater occurs along the Atlantic slope from the Savannah River in Georgia north to the Hudson River in New York, as well as in the "interior" basins (New, Kanawah, and Wataugua Rivers) of the Tennessee River basin. It occurs in small size streams to large rivers, in quiet waters or pools, or eddies, with gravel and sand substrates. It has experienced major declines throughout its entire range.

Threats to Species

Threats to this and many other freshwater mussel species are similar to those described above for the brook floater. Williams et al. (1993) list this species as Threatened. It is listed as Endangered in North Carolina.

2.2.7 Moxostoma sp 3 (Carolina redhorse)

Federal Status: Federal Species of Concern
State Status: Proposed Endangered

Characteristics

This undescribed species of sucker is most closely related to the golden redhorse (*Moxostoma erythrurum*). Like other members of the genus it has a large horizontal mouth with fleshy lips, with 12 rows of scales around the caudal peduncle. It has a long slender body, with light orange pectoral, anal and pelvic fins. The taxonomy and life history of this species is being studied by R.E. Jenkins of Roanoke College.

Distribution and Habitat Requirements

The Carolina redhorse appears to be restricted to a relatively short reach of the Great Pee Dee River in North Carolina and South Carolina and the Deep River of the Cape Fear River Basin in North Carolina. Very little is known of its habitat requirements other than it is found in medium-sized rivers with moderate gradient, usually in deep pools.

Threats to Species

Given its limited natural distribution, and the degree of habitat modification that has taken place in the Pee Dee and Cape Fear River basins, the Carolina redhorse is highly vulnerable to extinction (Wayne Starnes NCSM, personal communication). This species is considered a G1 species (Globally Imperiled) and warrants federal protection (NatureServe 2006).

The undescribed Carolina redhorse is known from the Yadkin-Pee Dee and Cape Fear River basins in North Carolina. Comparative studies are being conducted by Robert Jenkins of Roanoke College and Wayne Starnes of the North Carolina State Museum of Natural Sciences (NCSM) in order to formally describe this species (R.E. Jenkins and Wayne Starnes, personal communication). Currently, the best known population is from the Deep River near the project area. Based on its apparent restricted range and current threats, the Carolina redhorse merits endangered status (John Fridell USFWS personal communication). The Carolina redhorse is currently considered State Rare (Proposed Endangered) in North Carolina.

2.2.8 Toxolasma pullus (Savannah liliput)

Federal Status: Federal Species of Concern
State Status: Endangered

Characteristics

This species was described by Conrad (1838) from the Watree River, South Carolina (Johnson 1970). This very small mussel reaches a maximum size of 35 mm TL. Like other members of this genus, this species is sexually dimorphic, with the shell of the male being more elongate and pointed, and the female more rounded and truncate in the posterior margin. The ventral margin is generally straight in males, and rounded in females. The periostracum is usually blackish, or olivish with obscure fine green rays. The nacre of the shell is bluish white with a purplish iridescence.

Distribution and Habitat Requirements

The Savannah liliput ranges from the Altamaha River Basin in Georgia to the Neuse River Basin in North Carolina. It may be extirpated from the Neuse River Basin (Bogan 2002). This species is typically found near the banks of streams and ponds in mud or sandy substrate.

Threats to Species

Threats to this and many other freshwater mussel species are similar to those described above for the brook floater. Williams et al. (1993) lists this species as Threatened. It is considered Endangered in North Carolina.

2.2.9 Villosa vaughniana (Carolina creekshell)

Federal Status: Federal Species of Concern
State Status: Endangered

Characteristics

This species was described from Swaney's Creek near Camden, South Carolina (Lea 1838). Like other members of this genus, this species is sexually dimorphic, with the shell of the male being more elongate, and the female more inflated and rounded in the posterior margin. The periostracum is usually dark yellow brown with many green, unbroken rays. The shell of this species is generally thicker, with more prominent pseudocardinal teeth than the similar eastern creekshell.

Distribution and Habitat Requirements

The Carolina creekshell ranges from the Santee River Basin in South Carolina north to the Cape Fear River Basin in North Carolina. This species is typically found near the banks in shaded shallow pools of small streams and in muddy or silty gravel (Bogan and Alderman 2004).

Threats to Species

Threats to this and many other freshwater mussel species are similar to those described above for the brook floater. Williams et al. (1993) lists this species as Special Concern. It is considered Endangered in North Carolina.

2.3 Targeted State Listed and Rare Species

North Carolina Endangered, Threatened and Special Concern species have legal protection status in North Carolina under the State Endangered Species Act administered and enforced by the North Carolina Wildlife Resources Commission. Species listed as Significantly Rare and Watch List species are not afforded any protection.

Alasmidonta undulata (triangle floater)-This mussel species was described from the Schuylkill River near Philadelphia (Say 1817). Its range extends from the Catawba River in North Carolina north to the lower St. Lawrence River. The shell shape is subtriangular to ovate and inflated. The anterior and ventral shell margins are rounded. The periostracum is yellowish green with broad green or black rays. This species is considered Special Concern throughout its range (Williams et al. 1993). It is considered Threatened in North Carolina.

Elliptio roanokensis (Roanoke slabshell)-The Roanoke slabshell was described from the Roanoke River (exact location unknown) by Lea (1838). The reported range of this mussel species extends from the Connecticut River in Massachusetts south to the Savannah River in Georgia (Walter 1954). Based on shell morphologies, Johnson (1970) synonimized this and 100 other species into the *Elliptio complanata* complex, however it is now widely recognized as being a valid species. The periostracum is generally very smooth, often with placations (furrows), and reddish yellow in color. Shells of this species reach lengths exceeding 150 mm. This species is listed as Threatened in North Carolina. Williams et al. (1993) list this species as Special Concern.

Strophitus undulatus (creeper)-This mussel species was described from the Schuylkill River near Philadelphia (Say 1817). Its range extends from throughout much of the Interior River Basin and Atlantic Slope regions. The shell is elliptical to rhomboid in outlined and somewhat inflated. The anterior end is rounded and the posterior end is bluntly pointed. The periostracum is yellowish green to brown, with dark green rays. Williams et al. (1993) consider this species to be Stable; however it is considered Threatened in North Carolina.

Villosa constricta (notched rainbow)-This mussel species was described by Conrad (1838) from the North River in Rockbridge County Virginia. It is reported to occur from the James River Basin in Virginia south to the Catawba River Basin in North Carolina (Johnson 1970). The shell is fairly small and short, and sub elliptical in outline. The beaks are generally not elevated. The periostracum is shiny yellowish green to black occasionally having dark green rays. Like other members of the genus, the notched rainbow is sexually dimorphic, however the marsupial swelling of the females is generally small compared to other species. Williams et al. (1993) lists this species as special concern. It is also considered Special Concern in North Carolina.

Villosa delumbis (eastern creekshell)- This mussel species, described by Conrad (1834) from small streams near the Cooper River, South Carolina, ranges from Ocmulgee River, Georgia north to the Cape Fear River in North Carolina. It has a generally thin shell that is ovate in outline. Like other members of this genus, this species is sexually dimorphic, with the shell of the male being more elongate, and the female more rounded and swollen, particularly in the posterior margin. The periostracum is yellow with numerous green rays that are broken along the prominent growth lines. Williams et al. (1993) consider this species to be stable; however it is considered Significantly Rare in North Carolina.

3.0 SURVEY EFFORTS

Pre Survey Investigation

Prior to conducting field surveys, a review was conducted of previous surveys in the project area. The North Carolina Natural Heritage Program (NCNHP) systematic inventory (database) of rare plant and animal species, NCWRC database of North Carolina fauna, and other available biological inventories conducted within the project area were consulted.

The pre-survey database search revealed records of Cape Fear shiner, Carolina redhorse, yellow lampmussel, and notched rainbow in the Deep River both upstream and downstream of the Carbonton dam. The Carolina redhorse has also been documented within the impounded portion of the Deep River, and the Atlantic pigtoe has been recorded upstream of the impoundment.

Aquatic Surveys

Surveys for freshwater mussels, fish, and snails were conducted April-October, 2005, by the following personnel from The Catena Group on the listed dates:

Tom Dickinson – 4-20, 4-22, 5-5, 5-25, 6-1, 8-25, 8-26
Tim Savidge – 4-20, 4-22, 5-5, 5-25, 10-20, 10-22
Shay Garriock – 5-5, 6-1, 8-25, 8-26
Michael Wood – 6-1
Sharon Snider – 4-20
Kate Montieth – 4-22, 8-25, 8-26
Steve Melin – 5-25, 10-20
Alex Adams – 10-20
Chris Sheats -10-22

The surveys were conducted at 18 sampling locations (listed in Table 2 by general site location, survey date, survey type, and GPS location). Figure 1 shows the approximate midpoints of each survey location listed in Table 2.

Table 2. Pre Dam Removal Survey Locations

TCG Site #	Site Location	Survey Type*	Survey Date(s)	GPS Location
1	Deep River-upstream-1 (Howard Mill Rd)	M, F, S	8/25/2005, 10/20/2005	35.50311ºN, -79.58303ºW
2	Deep River-upstream-2 (Island Channel/Howard Mill Rd)	F	10/20/2005	35.50162ºN, -79.58331ºW
3	Deep River-upstream-3 (NC 22)	M, F, S	8/25/2005, 10/20/2005	35.47842ºN, -79.52077ºW
4	Deep River-upstream-4 (Tyson's Creek)	M, F, S	8/25/2005, 10/20/2005	35.49417ºN, -79.44673ºW
5	Deep River-upstream-5 (Glendon-Carthage Rd)	M, F, S	4/20/2005	35.49102ºN, -79.41919ºW
6	Deep River-impoundment-1	M, S	4/22/2005	35.48269ºN, -79.38307ºW
7	Deep River-impoundment-2	M, S	4/22/2005	35.46126ºN, -79.38965ºW
8	Deep River-impoundment-3	M, S	4/22/2005	35.47855ºN, -79.35072ºW
9	Deep River-impoundment-4	M, S	4/22/2005	35.49891ºN, -79.33601ºW
10	Deep River-downstream-1 (Tailrace)	F	5/25/2005	35.5198ºN, -79.34719ºW
11	Deep River-downstream-2	M, F, S	5/25/2005	35.52488ºN, -79.33158ºW
12	Deep River-downstream 3 (Plank Road)	M,F,S	8/26/2005, 10/22/2005	35.55487ºN, -79.28666ºW
13	Deep River-downstream 4 (US 421)	M,F,S	8/26/2005, 10/22/2005	35.54573ºN, -79.25275ºW
14	Deep River-downstream 5 (Rosser/Cummock Rd)	M,F,S	8/26/2005, 10/22/2005	35.56945ºN, -79.24425ºW
15	McLendons Creek-upstream (Cool Springs Rd)	M, F, S	5/5/2005	35.44977ºN, -79.42318ºW
16	McLendons Creek-impoundment	M, S	6/1/2005	35.45894ºN, -79.39803ºW
17	Big Governors Creek-upstream (Underwood Rd)	M, F, S	5/5/2005	35.4583ºN, -79.36951ºW
18	Big Governors Creek-impoundment	M, S	6/1/2005	35.47434ºN, -79.3564ºW

*M (mussel survey), F (Qualitative fish assessment), S (snail survey)

Survey site locations were correlated with pre-selected data collection sites identified by RS, when possible, although time and accessibility constraints influenced survey locations in some instances. Most importantly, survey site locations were chosen in the field in areas with physical characteristics that represented the best available habitat for the target fauna. In impounded reaches, site selection was based on the presence of rock outcrops or other indicators suggesting good habitat conditions for the target species prior to impoundment. These sites will be established as post-removal monitoring stations.

4.0 METHODOLOGY

Aquatic species surveys were conducted at 18 sites:

- Four sites within the current reservoir pool in the Deep River created by Carbonton Dam (Sites 6-9)
- Four sites upstream of the reservoir pool in the Deep River (Sites 1-4)
- Five sites downstream of the dam in the Deep River (Sites 10-14)
- One site within the current reservoir pool in McLendons Creek
- One site above the reservoir pool in McLendons Creek
- One site within the current reservoir pool in Big Governors Creek
- One site above the reservoir pool in Big Governors Creek (Figure 1).

Power boat and canoe were used to access many of the sites, while the other sites were accessed via bridge crossings or other access points (e.g. public park access, dam site). Typically a three-person survey team was used to perform the aquatic inventories at each site. The visual survey component (primarily mussel/snails) of the inventory surveys was conducted first at each site, followed by the active capture (fishes) component.

The length of each survey site was approximately 200-300 feet, with the exception of Site 10, which occurred in a 30 feet length of the tailrace immediately below the dam, in very swift current. Due to the high water velocity only active capture (fish) surveys were conducted at this site. The midpoints of each survey site were recorded using a hand-held Garmin etrex Vista GPS unit.

4.1 Visual (SCUBA, Mask/Snorkle and Bathyscope) Methods

Specific visual searches were conducted for freshwater mussels, fish, and freshwater snails. The survey team spread out across the stream into survey lanes to provide total width coverage as they ascended the stream. All appropriate habitat types within a given survey reach were searched thoroughly via visual surveys using primarily mask/snorkel, and occasionally glass bottom buckets (bathyscopes) in the shallow water habitats and SCUBA at the sites in the impounded reach (Sites 6-9, 16,18). Tactile methods were also employed when appropriate. Where SCUBA was used, one of the three person survey team members provided surface support to the divers.

All species of freshwater bivalves were recorded and returned to the substrate. Searches were also conducted for relict shells. 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 hour of search time. All species that are monitored by the NC Natural Heritage Program (NCNHP) were measured (total length). Snails were hand picked 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 survey site.

Active searches for mussels and snails were also 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.

4.2 Active Capture (Seine Netting/Dip Netting/Hook and Line) Methods

After visual surveys were completed, a combination of seine netting and hand-held dip netting was used to capture fish. These methods were used at each of the upstream and downstream survey sites (Sites 1-5, 10-15, 17). Active capture fish surveys were not conducted within the impounded locations, as water depths were too deep to employ similar methodologies as those used at the other sites. Additionally, it was determined in conjunction with USFWS that these lentic areas contain a predictable suite of impoundment-adapted species and therefore would not require an initial inventory. Fish species observed while conducting visual surveys within the impounded sites were recorded and assigned a relative abundance based on the number of individuals seen at the site.

As with the visual surveys, the survey team began at the downstream point of the survey site and proceeded upstream. Seine netting was the primary method used to sample fish, as it is the most effective survey method for the targeted Cape Fear shiner. Seine netting is an effective method in shallow riffles and runs, as well as shallow pools; generally the preferred habitat of the Cape Fear shiner. This method is not as effective in deeper pools or riffles with a very strong current, therefore fish species preferring these habitats were not effectively sampled. Other sample methods included capturing fish in hand held dip nets against shoreline or bottom structure as well as visual census surveys. Visual survey census methods using mask/snorkel were also employed. These methods often provide more accurate estimates on abundance of some species than more traditional methods, such as mark recapture and depletion (Hankin and Reeves 1988, personal observations).

All habitat types present in each survey reach were sampled using the following method, surveyors moving upstream at 3-4 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. 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 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 upon the number of fish in the bucket and their condition. Any fish that did not recover from the sampling 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.

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

5.0 RESULTS

A total of 32 fish species, at least 16 freshwater mussel species, 4 aquatic snail species, and 2 freshwater clam species were located during the combined survey efforts (Table 3). Mussels were found at all sites that were surveyed for mussels except the impounded section of Big Governors Creek (Site 18). Mussel surveys were not conducted at the Tailrace site (Site 10) or the Deep River Island Channel-upstream (Site 2); however, relict shells of mussels were observed at these two sites. The Cape Fear shiner, was located at two upstream sites in the Deep River (Sites 1 and 3) and two sites in the Deep River downstream of the dam (Sites, 10 and 13).

Table 3. Aquatic Species Found in Carbonton Dam Pre-Removal Surveys

Scientific Name	Common Name	Sites
Freshwater Mussels	~	~
Alasmidonta undulata	triangle floater	3,5,7,12
Alasmidonta varicosa	brook floater	1,3,5,
Elliptio angustata	Carolina lance	14
*Elliptio complanata**	Eastern elliptio	1-17
*Elliptio icterina**	variable spike	3,5,11,14,15,17
Elliptio producta	Atlantic spike	5,6,11,15
Elliptio roanokensis	Roanoke slabshell	6,11,12
Elliptio sp.	lanceolate elliptio	6,11,12
Elliptio spp.*	elliptio mussels	14
Lampsilis cariosa	yellow lampmussel	1,4,5,6,11,14
Pyganadon cataracta	Eastern floater	7,9
Strophitus undulatus	Creeper	1,3,4,5,
Toxolasma pullus	Savannah liliput	3
Uniomerus carolinianus	Florida pondhorn	3,6,7,8,9,11,14,15
Utterbackia imbecillis	paper pondshell	9
Villosa delumbis	Eastern creekshell	1,2,3,11,12,13,14,15
Villosa vaughniana	Carolina creekshell	12
Freshwater Snails and clams	~	**Sites**
Campeloma decisum	pointed campeloma	1,3,4,6,7,8,11,13,17
Corbicula fluminea	Asian clam	All
Elimia catenaria	gravel elimia	1,3,4,5,14
Helisoma anceps	Two-ridge rams-horn	3,4
Hydrobidae	Hydrobiade snail	4,17
Psidium sp.	A fingernail clam	15
Freshwater Fish	~	**Sites**
Ameiurus natalis	yellow bullhead	3
Amboplites cavifrons	Roanoke bass	1
Cyprinella analostanus	satinfin shiner	1,10
Cyprinella nivea	whitefin shiner	1,10,11,12

Dorosoma cepedianum	gizzard shad	10
Erimyzon oblongus	creek chubsucker	2
Esox americanus	redfin pickerel	17
Etheostoma flabellare	fantail darter	3,4,
Etheostoma olmstedi	tesseslated darter	1,2,3,4,6,11,12,13,14,15,17
Etheostoma serriferum	sawcheek darter	17
Fundulus rathbuni	speckled killifish	12,13,14
Gambusia holbrookii	eastern mosquitofish	1,2,3,4,5,12,13,14
Ictaluridae	Catfish	6,7
Lepomis auritus	redbreast sunfish	2,4,5
Lepomis cyanellus	green sunfish	2,3,4
Lepomis macrochirus	Bluegill	1,2,3,4,5,6,7,8,11,13,15,17
Luxilus albeolus	white shiner	1,2,15
Micropterus salmoides	largemouth bass	5,6,8,9,11,13,17
Minytrema melanops	spotted sucker	2,3,4
Moxostoma pappillosum	V-lip redhorse	2,3,4
Nocomis leptocephalus	bluehead chub	2,3,10,11,15,17
Notemigonus crysoleucas	golden shiner	10
Notropis alborus	whitemouth shiner	3,4,5,10,11,12,13,14,15
Notropis altipinnis	highfin shiner	1,3,4,10,11,15
Notropis amoenus	comely shiner	10
Notropis hudsonius	spottail shiner	1,2,3,4,5,10,11,12,13,14,15
Notropis mekistocholas	Cape Fear shiner	1,3,10,13
Notropis procne	swallowtail shiner	1,2,3,4,5,10,11,12,13,14,15
Notropis scepticus	sandbar shiner	1,2,3,4,5,10,11,12,13,14
Noturus insignis	margined madtom	3,5,
Percina crassa	Piedmont darter	1,3,5,6,11,12,15
Scartomyzon sp. nov.	brassy jumprock	2,3
Semotilus atromaculatus	creek chub	2

* Referred to collectively as *Elliptio* spp. at Site 14

Relative abundance for fish, freshwater snails, and freshwater clam 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
- Patchy: indicates an uneven distribution of the species within the sampled site.

CPUE was calculated for each freshwater mussel species located per site and refers to the number of individuals of that species found per one person hour of survey time. Survey results for each site are further described below.

Site 1 (Deep River-upstream-1):
This site occurs upstream of Howard Mill Road (SR 1456) in a series of boulder and cobble dominated riffles and runs, with small pools formed on the upstream of large boulders. Moderate sized beds of water willow (*Justichia americana*) occur in much of the surveyed site. Timed mussel searches were conducted for 5 person hours and fish

were sampled until no new species were collected (approximately 1.5 hours). The targeted Cape Fear shiner (1 individual) and Roanoke bass (1 individual) were collected at this site.

Table 4. Site 1: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels *	~	**#/CPUE**
Alasmidonta undulata	triangle floater	1 shell
Alasmidonta varicosa	brook floater	1 (0.20/hr)
Elliptio complanata	eastern elliptio	210 (42.0/hr)
Elliptio icterina	variable spike	Shells
Lampsilis cariosa	yellow lampmussel	7 (1.40/hr)
Strophitus undulatus	Creeper	2 (0.40/hr)
Villosa delumbis	Eastern creekshell	4 (0.80/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Campeloma decisum	pointed campeloma	patchy uncommon
Corbicula fluminea	Asian clam	Abundant
Elimia catenaria	gravel elimia	Abundant
Helisoma anceps	two-ridge rams horn	Common
Hydrobiidae	Hydrobiide snail	Uncommon
Freshwater Fish	~	**Relative Abundance**
Amboplites cavifrons	Roanoke bass	rare (2)
Cyprinella analostanus	satinfin shiner	Uncommon
Cyprinella nivea	whitefin shiner	Uncommon
Etheostoma olmstedi	tesseslated darter	Common
Gambusia holbrookii	Eastern mosquitofish	Uncommon
Lepomis macrochirus	Bluegill	Common
Luxilus albeolus	white shiner	Common
Notropis altipinnis	highfin shiner	Common
Notropis hudsonius	spottail shiner	Common
Notropis mekistocholas	Cape Fear shiner	rare (1)
Notropis procne	swallowtail shiner	Abundant
Notropis scepticus	sandbar shiner	Common
Percina crassa	Piedmont darter	Common

* The notched rainbow *(Villosa constricta)* recorded at this site in 1997 (Personal observations)

Site 2 (Deep River-upstream-2-(Island Channel/Howard Mill Road):
This site occurs within an overflow channel formed along the right descending bank of the Deep River just upstream of Howard Mill Road (SR 1456) at approximately 35.5051°N, 79.5847°W. The site is connected with Site 1; however, it was treated as a separate site due to the different characteristics than the main river channel. The island channel receives significant flows during high water periods, but also appears to receive a small amount of flow from the river during low flow. In addition, a small intermittent stream joins the channel in mid course. Habitat in the channel consists of shallow riffles and small pools of moderate (3 feet) depth. Gravel, sand, and cobble dominate the substrate, and multiple sand/gravel bars occur throughout the channel. This is the only location that the creek chubsucker and the creek chub were found during this survey effort. Live freshwater mussels were not observed in this channel, however shells of the

eastern elliptio and the eastern creekshell were found. The Asian clam is fairly common in the channel.

Table 5. Site 2: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels	~	**#/CPUE**
Elliptio complanata	Eastern elliptio	Shells
Villosa delumbis	Eastern creekshell	1 shell
Freshwater Snails and Clams	~	**Relative Abundance**
Campeloma decisum	pointed campeloma	Uncommon
Corbicula fluminea	Asian clam	Common
Freshwater Fish	~	**Relative Abundance**
Erimyzon oblongus	creek chubsucker	rare (2)
Etheostoma olmstedi	tesseslated darter	Common
Gambusia holbrookii	Eastern mosquitofish	Common
Lepomis auritus	redbreast sunfish	rare (1)
Lepomis cyanellus	green sunfish	rare (1)
Lepomis macrochirus	bluegill	rare (2)
Luxilus albeolus	white shiner	Common
Minytrema melanops	spotted sucker	Common
Moxostoma pappillosum	V-lip redhorse	rare (1)
Nocomis leptocephalus	bluehead chub	Uncommon
Notropis hudsonius	spottail shiner	Common
Notropis procne	swallowtail shiner	Common
Notropis scepticus	sandbar shiner	Uncommon
Scartomyzon sp. nov.	brassy jumprock	Common
Semotilus atromaculatus	creek chub	very abundant

Site 3 (Deep River-upstream-3):

This site occurs in the vicinity of the NC 22 crossing of the Deep River and is characterized by a series of small vegetated islands with multiple channels. Substrate consists of boulders and cobble, with accumulations of gravel in the shallow runs. Large water willow beds are present throughout the site. Timed mussel searches were conducted for 3 person hours and fish were sampled using seine netting and dipnetting for approximately 1 hour. The targeted Cape Fear shiner was abundant in every seine haul and the decision was made to cease survey activities at this site, to limit disturbance to this species.

Table 6. Site 3: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels	~	**#/CPUE**
Alasmidonta undulata	triangle floater	1 (0.33/hr)
Alasmidonta varicosa	brook floater	4 (2/hr)
Elliptio complanata	eastern elliptio	358 (119.33/hr)
Strophitus undulatus	creeper	2 (0.67/hr)
Toxolasma pullus	Savannah liliput	1 (0.33/hr)
Unimoerus carolinianus	Florida pondhorn	7 (2.33/hr)
Villosa delumbis	Eastern creekshell	18 (6.0/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Campeloma decisum	pointed campeloma	Uncommon
Corbicula fluminea	Asian clam	Abundant
Elimia catenaria	gravel elimia	Abundant
Helisoma anceps	Two-ridge rams horn	patchy uncommon
Freshwater Fish	~	**Relative Abundance**
Ameiurus natalis	yellow bullhead	rare (2)
Etheostoma flabellare	fantail darter	Common
Etheostoma olmstedi	tesseslated darter	Uncommon
Gambusia holbrookii	Eastern mosquitofish	Common
Lepomis cyanellus	green sunfish	Uncommon
Lepomis macrochirus	Bluegill	Common
Minytrema melanops	spotted sucker	very abundant
Moxostoma pappillosum	V-lip redhorse	rare (1)
Nocomis leptocephalus	bluehead chub	Common
Notropis alborus	whitemouth shiner	Common
Notropis altipinnis	highfin shiner	Uncommon
Notropis hudsonius	spottail shiner	Common
Notropis mekistocholas	Cape Fear shiner	very abundant (>100)
Notropis procne	swallowtail shiner	Common
Notropis scepticus	sandbar shiner	Common
Notorus insignis	margined madtom	Common
Percina crassa	Piedmont darter	Common
Scartomyzon sp. nov.	brassy jumprock	rare (1)

Site 4 (Deep River-upstream-4):

This site occurs below the mouth of Tyson's Creek and is characterized as a swift, gravel/cobble dominated, run of moderate depth on the left descending side of the river, with a small depositional island creating a shallow sand dominated run/riffle and pool channel along the right descending bank. A large amount of coarse sand was being carried through the site during the site visits. Timed mussel searches were conducted for 2.5 person hours and fish were sampled until no new species were collected (approximately 1.5 hours).

Table 7. Site 4: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels	**~**	**#/CPUE**
Elliptio complanata	eastern elliptio	63 (25.2/hr)
Lampsilis cariosa	yellow lampmussel	1 (0.5/hr)
Strophitus undulatus	creeper	2 (0.8/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Campeloma decisum	pointed campeloma	patchy uncommon
Corbicula fluminea	Asian clam	Abundant
Elimia catenaria	gravel elimia	Abundant
Helisoma anceps	two-ridge rams horn	patchy uncommon
Hydrobiidae	Hydrobiid snail	Abundant
Freshwater Fish	~	**Relative Abundance**
Etheostoma flabellare	fantail darter	Uncommon
Etheostoma olmstedi	tesseslated darter	Common
Gambusia holbrookii	Eastern mosquitofish	Common
Lepomis auritus	redbreast sunfish	rare (1)
Lepomis cyanellus	green sunfish	Uncommon
Lepomis macrochirus	bluegill	Common
Minytrema melanops	spotted sucker	Common
Moxostoma pappillosum	V-lip redhorse	rare (1)
Notropis alborus	whitemouth shiner	Common
Notropis altipinnis	highfin shiner	Uncommon
Notropis hudsonius	spottail shiner	Common
Notropis procne	swallowtail shiner	Common
Notropis scepticus	sandbar shiner	Uncommon

Site 5 (Deep River-upstream-5):

This site included one of the first riffles upstream of the impoundment effects of the Carbonton dam and is located in the vicinity of Glendon Carthage Road (SR 1006). The area searched consisted of a riffle and flows into a slow moving pool of moderate depth. Depths sampled ranged from less than one foot to approximately five feet in the pool, however SCUBA was not necessary to effectively survey for the target mussel species. Substrates were dominated by sand and gravel, although cobble areas were common in the riffle. Silt-clay banks overlain with gravel and cobble were vegetated and mostly stable, providing some of the best mussel habitat in the surveyed reach. A series of small vegetated sand bar islands occurred in the river at this site near the left descending side of the river. Timed mussel searches were conducted for 4.5 person hours and fish were sampled until no new species were collected (approximately 1.5 hours).

Table 8. Site 5: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels *	~	**#/CPUE**
Alasmidonta undulata	triangle floater	2 (0.44/hr)
Alasmidonta varicosa	brook floater	2 0.44/hr)
Elliptio complanata	eastern elliptio	153 (34.0/hr)
Elliptio icterina	variable spike	23 (5.1/hr)
Elliptio producta	Atlantic spike	5 (1.1/hr)
Lampsilis cariosa	Yellow lampmussel	1 (0.22/hr)
Strophitus undulatus	Creeper	2 (0.44/hr)
Freshwater Snails and clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	common
Elimia catenaria	gravel elimia	patchy common
Freshwater Fish	~	**Relative Abundance**
Etheostoma flabellare	fantail darter	common
Etheostoma olmstedi	tesseslated darter	common
Gambusia holbrookii	Eastern mosquitofish	rare
Lepomis auritus	redbreast sunfish	rare
Lepomis macrochirus	bluegill	common
Micropterus salmoides	largemouth bass	rare
Notropis alborus	whitemouth shiner	common
Notropis hudsonius	spottail shiner	common
Notropis procne	swallowtail shiner	abundant
Notropis scepticus	sandbar shiner	common
Noturus insignis	margined madtom	common
Percina crassa	Piedmont darter	common

* The Atlantic pigtoe (*Fusconaia masoni*) has been recorded at this general location (Site 5 - near Glendon Carthage Road) in the early 1990s (NCNHP database search).

Site 6 (Deep River, impoundment-1):
This was the furthest upstream site within the Carbonton impoundment. Mussel surveys were conducted near a large rock outcrop on the left descending side of the river. Substrates were dominated by gravel/cobble and were interspersed with large boulders. Visual surveys were conducted using SCUBA at depths averaging 6 feet (maximum 12 feet) for 1.17 person hours. This site had the highest mussel diversity and abundance of the impounded sites. Fish surveys were not conducted at this site; however, a number of fish species were observed and noted during the mussel surveys.

Table 9. Site 6: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater mussels	~	**#/CPUE**
Elliptio complanata	eastern elliptio	75 (64.0/hr)
Elliptio producta	Atlantic spike	5 (4.3/hr)
Elliptio sp.	lanceolate elliptio	5/ (4.3/hr)
Elliptio roanokensis	Roanoke slabshell	1/ (0.85/hr)
Uniomerus caroliniana	Florida pondhorn	8/ (4.4/hr)
Lampsilis cariosa	yellow lampmussel	1 shell
Freshwater Snails and Clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	common
Campeloma decisum	Pointed campeloma	common
Freshwater Fish	~	**Relative Abundance**
Etheostoma olmstedi	tesseslated darter	present*
Lepomis macrochirus	Bluegill	present*
Micropterus salmoides	largemouth bass	present*
Percina crassa	Piedmont darter	present*
Ictaluridae	Catfish	present*

* Species was observed at site, but relative abundance could not be estimated due to poor conditions for visual surveys

Site 7 (Deep River, impoundment-2):

This impoundment site was located downstream of an island that divided the channel, just below the confluence of McLendons Creek. The substrate consisted of a gravel/sand bar below the surface covered with scattered large cobbles and boulders. Depths searched averaged approximately 6 feet (maximum depth 11 feet). SCUBA surveys were conducted for 1.17 person hours. Fish surveys were not conducted at this site; however, a few fish species were observed and noted during the mussel surveys. The eastern elliptio was the most abundant mussel found with the Florida pondhorn next in abundance. An individual eastern floater, a species well adapted to lentic conditions, was also found.

Table 10. Site 7: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater mussels	~	**#/CPUE**
Alasmidonta undulata	Triangle floater	1 (0.44/hr)
Elliptio complanata	eastern elliptio	57 (46/hr)
Pyganadon cataracta	eastern floater	2 (0.88/hr)
Uniomerus caroliniana	Florida pondhorn	8 (4.40/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	Common
Campeloma decisum	pointed campeloma	Common
Freshwater Fish	~	**Relative Abundance**
Lepomis macrochirus	bluegill	present*
Ictaluridae	catfish	present*

* Species was observed at site, but relative abundance could not be estimated due to poor conditions for visual surveys

Site 8 (Deep River, impoundment-3):
This site was located just downstream of a large, nearly 180º bend in the river near a significant rock outcrop. Average search depths were approximately 10 feet (maximum depth 20 feet). Substrates were dominated by sand and gravel with some cobble and silty areas present. Only two mussel species were found. SCUBA searches were conducted for 1 person hour. Fish surveys were not conducted at this site; and few fish were observed during the mussel survey, which was likely due to the poor water clarity.

Table 11. Site 8: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater mussels	~	**#/CPUE**
Elliptio complanata	eastern elliptio	24 (24/hr)
Uniomerus caroliniana	Florida pondhorn	10 (10/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Campeloma decisum	pointed campeloma	Rare
Corbicula fluminea	Asian clam	Common
Freshwater Fish	~	**Relative Abundance**
Lepomis macrochirus	bluegill	present*
Micropterus salmoides	largemouth bass	present*

* Species was observed at site, but relative abundance could not be estimated due to poor conditions for visual surveys

Site 9 (Deep River, impoundment-4):
This site is less than two RMs upstream of the Carbonton dam. Flow was virtually non-existent when compared to the other impoundment sites, and an accumulation of silt covered most substrates, including rock outcrops. Average search depth was approximately 11 feet (maximum depth 15 feet). Mussel searches were conducted for 0.83 person hours. Fish surveys were not conducted at this site; and few fish were observed during the mussel survey, which was likely due to the poor water clarity. Fairly large numbers of Florida pondhorn were located at this survey site along with the only occurrence of paper pondshell found during the survey effort. The majority of mussels found at this site occurred along the sloping clay banks just below the water's edge.

Table 12. Site 9: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels	~	**#/CPUE**
Elliptio complanata	eastern elliptio	2 (2.4/hr)
Pyganadon cataracta	eastern floater	3 (3.6/hr)
Uniomerus caroliniana	Florida pondhorn	20 (24.1/hr)
Utterbackia imbecillis	paper pondshell	1 (1.2/hr)
Freshwater Fish	~	**Relative Abundance**
Micropterus salmoides	largemouth bass	present*

* Species was observed at site, but relative abundance could not be estimated due to poor conditions for visual surveys

Site 10 (Deep River, downstream-1):
This site was located within the tailrace directly below the Carbonton dam. The area consists primarily of bedrock adjacent to the dam and shallow gravel shoals and bars, with sparse patches of water willow present. The site was seined for fish, but due to high water velocity, mussel surveys were not able to be conducted. Seine hauls were conducted up to the dam over the bedrock areas. This site contained several lotic-adapted shiner species, including eight Cape Fear shiner. These individuals were captured along a sand bar in moderate current.

Table 13. Site 10: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater mussels	~	**#/CPUE**
Elliptio complanata	eastern elliptio	Shells
Freshwater Snails and Clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	Common
Freshwater Fish	~	**Relative Abundance**
Cyprinella analostana	satinfin shiner	Uncommon
Cyprinella nivea	whitefin shiner	Uncommon
Dorosoma cepedianum	gizzard shad	Uncommon
Nocomis leptocephalus	bluehead chub	Uncommon
Notropis alborus	whitemouth shiner	Common
Notropis altipinnis	highfin shiner	Common
Notropis amoenus	comely shiner	Rare
Notropis hudsonius	spottail shiner	Uncommon
Notropis mekistocholas	Cape Fear shiner	common (8)
Notropis procne	swallowtail shiner	Abundant
Notropis scepticus	sandbar shiner	Common
Notemigonus crysoleucas	golden shiner	Common

Site 11 (Deep River, downstream-2):
This site represents the first major riffle/run habitat below Carbonton dam. Searches were concentrated within this relatively shallow riffle and run ranging from less than 1 foot to 3 feet deep. Substrate was dominated by cobble, gravel, and sand with silt-clay banks. Areas of exposed bedrock were also present. Fairly high accumulations of silt were observed on the substrate throughout much of the site. Timed mussel searches were conducted for 5.25 person hours and fish were sampled until no new species were collected (approximately 1.0 hours).

Table 14. Site 11: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels	~	**#/CPUE**
Elliptio complanata	eastern elliptio	109 (20.8/hr)
Elliptio icterina	variable spike	2 (0.38/hr)
Elliptio producta	Atlantic spike	5 (0.95/hr)
Elliptio roanokensis	Roanoke slabshell	5 (0.95/hr)
Lampsilis cariosa	yellow lampmussel	1 (0.2/hr)
Elliptio sp.	lanceolate elliptio	6 (1.14/hr)
Uniomerus caroliniana	Florida pondhorn	23 (4.4/hr)
Villosa delumbis	eastern creekshell	3 (0.57/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	Common
Campeloma decisum	pointed campeloma	Common
Freshwater Fish	~	**Relative Abundance**
Cyprinella nivea	whitefin shiner	Uncommon
Etheostoma olmstedi	tesseslated darter	Uncommon
Lepomis macrochirus	bluegill	Rare
Micropterus salmoides	largemouth bass	Rare
Nocomis leptocephalus	bluehead chub	Common
Notropis alborus	whitemouth shiner	Common
Notropis altipinnis	highfin shiner	Uncommon
Notropis hudsonius	spottail shiner	Uncommon
Notropis procne	swallowtail shiner	Abundant
Notropis scepticus	sandbar shiner	Common
Percina crassa	Piedmont darter	Common

Site 12 (Deep River-downstream-3):

This site occurs in the vicinity of the Plank Road (SR 1007) crossing of the Deep River, and was accessed via the Triangle Lands canoe access. A moderately deep (3 feet) run occurs along the left descending bank and a vegetated island forms a shallow riffle/run channel along the right bank. A large pooled area occurs at the head of the island. The substrate in the runs is predominately sand and gravel. Cobble and gravel, with deposits of silt, occur in the pooled areas. Timed mussel searches were conducted for 3.75 person hours and fish were sampled until no new species were collected (approximately 1.5 hours).

Table 15. Site 12: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels *	~	**#/CPUE**
Alasmidonta undulata	triangle floater	1 (0.27/hr)
Elliptio complanata	Eastern elliptio	152 (40.53/hr)
Elliptio roanokensis	Roanoke slabshell	1 shell
Lampsilis cariosa	yellow lampmussel	0.2
Elliptio sp.	lanceolate elliptio	1 shell
Villosa delumbis	eastern creekshell	2 (0.53/hr)
Villosa vaughniana	Carolina creekshell	1 (0.27/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	Common
Freshwater Fish	~	**Relative Abundance**
Cyprinella nivea	whitefin shiner	Common
Etheostoma olmstedi	tesseslated darter	Uncommon
Fundulus rathbuni	speckled killifish	rare (2)
Gambusia holbrookii	Eastern mosquitofish	Common
Notropis alborus	whitemouth shiner	Common
Notropis hudsonius	spottail shiner	Common
Notropis procne	swallowtail shiner	Common
Notropis scepticus	sandbar shiner	Uncommon
Percina crassa	Piedmont darter	Uncommon

*The notched rainbow (*Villosa constricta*) has also been reported from this site (Johnson 1970).

Site 13 (Deep River-downstream-4):

This site occurs in the vicinity of the US 421 crossing of the Deep River. Large amounts of woody debris have accumulated throughout the river in this location, creating numerous sand bars within the channel. The majority of the substrate in this area is dominated by unconsolidated sands; however, gravel troughs occur at the base of the clay banks on both sides of the river, which provide the most suitable habitat for mussels in this section of river. Timed mussel searches were conducted for 3.0 person hours and fish were sampled until no new species were collected (approximately 1 hour).
One well worn (frayed fins) Cape Fear shiner was captured at this location.

Table 16. Site 13: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels	~	**#/CPUE**
Elliptio complanata	Eastern elliptio	61 (20.33/hr)
Villosa delumbis	eastern creekshell	1 (0.33/hr)
Freshwater Snails and Clams	**~**	**Relative Abundance**
Campeloma decisum	pointed campeloma	patchy uncommon
Corbicula fluminea	Asian clam	Common
Freshwater Fish	~	**Relative Abundance**
Etheostoma olmstedi	tesseslated darter	Common
Fundulus rathbuni	speckled killifish	Common
Gambusia holbrookii	Eastern mosquitofish	Common
Lepomis macrochirus	bluegill	Common
Micropterus salmoides	largemouth bass	uncommon
Notropis alborus	whitemouth shiner	Abundant
Notropis hudsonius	spottail shiner	Abundant
Notropis mekistocholas	Cape Fear shiner	rare (1)
Notropis procne	swallowtail shiner	Abundant
Notropis scepticus	sandbar shiner	Common

Site 14 (Deep River-downstream-5):

This site occurs upstream of the Roser/Cummock Road (SR 2153/1400) crossing of the Deep River, and was accessed from the County park. The site is characterized by a long boulder/cobble dominated riffle with very swift flow, and a long gravel and sand run of moderate depth (2-3 feet). Small pools have formed upstream of woody debris accumulated along the clay banks. Timed mussel searches were conducted for 3.0 person hours and fish were sampled until no new species were collected (approximately 2 hours).

Table 17. Site 14: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater Mussels	~	**#/CPUE**
Elliptio angustata	Carolina lance	1 (0.33/hr)
Elliptio complanata	Eastern elliptio	140 (46.67/hr)
Lampsilis cariosa	yellow lampmussel	1 shell
Uniomerus carolinianus	Florida pondhorn	2 (0.67/hr)
Villosa delumbis	eastern creekshell	3 (1.0/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Campeloma decisum	pointed campeloma	patchy uncommon
Corbicula fluminea	Asian clam	Abundant
Elimia catenaria	gravel elimia	patchy uncommon
Freshwater Fish	~	**Relative Abundance**
Etheostoma olmstedi	tesseslated darter	Common
Fundulus rathbuni	speckled killifish	Uncommon
Gambusia holbrookii	Eastern mosquitofish	Common
Notropis alborus	whitemouth shiner	Abundant
Notropis hudsonius	spottail shiner	Abundant
Notropis procne	swallowtail shiner	Abundant
Notropis scepticus	sandbar shiner	Abundant

Site 15 (McLendons Creek, upstream):

This site was located on the largest of the Deep River tributaries impounded by the Carbonton dam. It was sampled for fish, mussels, and snails upstream of the impoundment effect (near the Cool Springs Road crossing). The wide floodplain surrounding the site is forested and natural. The stream is approximately 10-12 meters wide with very stable, vegetated banks. Substrate is dominated by sand and gravel with an occasional rock outcrop present. Gravel runs provided excellent mussel habitat. Mussel searches were conducted more than 200 meters below Cool Spring Road to a point just above the road crossing. Fish were collected in a riffle pool area above the road crossing. Survey depths averaged 1.5 feet deep with a maximum depth of 3 feet. Mussel searches were conducted for 3.5 person hours and fish were sampled until no new species were collected. Five species of mussels were collected, including the state rare eastern creekshell. Two freshwater clam species, the Asian clam, and a native pea clam (*Sphaerium sp.*) were common at this site. Fish species collected included six species of shiner.

Table 18. Site 15: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater mussels	~	**#/CPUE**
Elliptio complanata	eastern elliptio	286 (88.90/hr)
Elliptio icterina	variable spike	3 (0.85/hr)
Elliptio producta	Atlantic spike	2 (0.57/hr)
Uniomerus caroliniana	Florida pondhorn	1 (0.28/hr)
Villosa delumbis	Eastern creekshell	3 (0.85/hr)
Freshwater Snails and Clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	Common
Sphaerium sp.	a fingernail clam	Common
Freshwater Fish	~	**Relative Abundance**
Etheostoma olmstedi	tesseslated darter	Common
Lepomis macrochirus	bluegill	Rare
Luxilus albeolus	white shiner	Abundant
Nocomis leptocephalus	bluehead chub	Common
Notropis alborus	whitemouth shiner	Uncommon
Notropis altipinnis	highfin shiner	Rare
Notropis hudsonius	spottail shiner	Uncommon
Notropis procne	swallowtail shiner	Abundant
Percina crassa	Piedmont darter	Common

Site 16 (McLendons Creek, impoundment):
This site is impounded and was surveyed for mussels downstream of the Glendon-Carthage Road crossing. The channel is approximately 10 meters wide and has a wide, natural floodplain. Substrate in this portion of McLendons Creek is dominated by thick accumulations of silt and detritus with sloping clay banks, although some areas of gravel were searched. Woody debris was heavy throughout the surveyed reach. Depths averaged 4 feet, with 8 feet being the maximum depth reached. Mussel habitat was marginal. One eastern elliptio was located during 1.33 person hours of SCUBA search time. Fish surveys were not conducted at this site, and no fish species were observed during the visual (mussel) surveys. The Asian clam was observed to be rare at this site.

Table 19. Site 16: Aquatic Species Found

Scientific Name	Common Name	Abundance
Freshwater mussels	~	**#/CPUE**
Elliptio complanata	Eastern elliptio	1 (0.75/hr)
Freshwater Snails and clams	**~**	**Relative Abundance**
Corbicula fluminea	Asian clam	Rare

Site 17 (Big Governors Creek, upstream):
This section of Big Governors Creek occurs in a wide, low-lying floodplain near the Underwood Road crossing. While the site is outside of the recognized impoundment area, the stream appears as slow moving slackwater, with only one 'riffle' area observed downstream of the road crossing (likely result of construction rip-rap). Mussel surveys were conducted for more than 200 meters, starting downstream of the road and ending upstream near the confluence of Crawley Creek. Substrate was dominated by gravel and

mud, with a high concentration of detritus and woody debris. Mussel searches were conducted for 2.25 person hours, with two species being found. Fish surveys were conducted using seine netting and dip netting until no new species were collected (approximately 1 hour). No shiner species were located during the fish surveys; however, fish species typically associated with slow-moving swampy streams, such as the redfin pickerel and sawcheek darter, were found only at this site.

Table 20. Site 17: Aquatic Species Found

Scientific Name	Common Name	Abundance/CPUE
Freshwater mussels	~	**CPUE**
Elliptio complanata	eastern elliptio	40 (17.7/hr)
Elliptio icterina	variable spike	2 (0.89/hr)
Freshwater snails and clams	~	**Relative Abundance**
Corbicula fluminea	Asian clam	Uncommon
Campeloma decisum	pointed campeloma	Common
Hydrobiidae	Hydrobid snail	Rare
Freshwater fish	~	**Relative Abundance**
Esox americanus	redfin pickerel	Common
Etheostoma olmstedi	tesseslated darter	Common
Etheostoma serriferum	sawcheek darter	Uncommon
Lepomis macrochirus	Bluegill	Common
Micropterus salmoides	largemouth bass	Uncommon
Nocomis leptocephalus	bluehead chub	Common

Site 18 (Big Governors Creek, impoundment):
This impounded site was surveyed for mussels downstream of Steel Bridge Road (SR 1625) crossing. The approximately 8 meter wide channel is surrounded by a low lying, swampy floodplain. Substrate is dominated by silt and detritus and there are large accumulations of woody debris within the channel. Depths reached 12 feet, but averaged less than 5 feet. SCUBA searches were conducted for 1.5 person hours and no freshwater mussels were found. Fish surveys were not conducted at this site, and no fish species were observed during the visual (mussel) surveys. A few relict Asian clam shells were observed; however no live individuals were recorded.

6.0 DISCUSSION

Qualitative surveys for various targeted aquatic species were conducted to provide a baseline for the presence/absence of fish, freshwater bivalve and aquatic snail species at specific locations in the section of the Deep River (and its tributaries) impounded by Carbonton dam and those same water bodies in the immediate area above or below the impounded reaches. Changes in faunal community composition should be monitored over time following dam removal.

6.1 Freshwater Mussels

More species of freshwater mussels have been reported from the Cape Fear River Basin (29) than any other river basin in North Carolina (Bogan 2002). Although no federally protected mussel species are included in this fauna, as discussed above, several rare and state listed species are known from the basin. At least 16 species of freshwater mussels were found during this survey effort, including eight of the twelve targeted freshwater mussel species.

With the exception of Site 18 (Big Governors Creek, impoundment), freshwater mussels were found at all of the surveyed sites. The eastern elliptio was the most commonly encountered species at all of but one of the sites (Site 9 Deep River impoundment-4), where the Florida pondhorn was most common. Relative abundance (estimated by CPUE) for the eastern elliptio was highest at Site 3 (Deep River-upstream-3) with 119.33 individuals located per hour of survey time, followed by Site 15 (McLendons Creek, upstream) and Site 6 (Deep River impoundment-1), with 88.9 and 64.0 individuals located per hour of survey time, respectively.

Eight of the eleven targeted mussel species listed in Table 1 were found during this survey effort. The three targeted species not found are the Atlantic pigtoe, green floater and notched rainbow. However, in the past, the notched rainbow has been found in the vicinity of Site 1 and Site 12, and the Atlantic pigtoe has been found near Site 5. The fact that these species were not detected during this survey effort, confirms their rarity in the Deep River, and may even suggest possible extirpation from the river, as both species are usually easily detectable where they occur (personal observations). The green floater has never been reported in the Deep River, is known from only a few locations in the Cape Fear River Basin, and has not been reported in recent years.

The survey results indicate that the un-impounded reaches of the Deep River generally contained the highest species richness. Eight mussel species were found at Site 11 (Deep River-downstream-2), followed by seven species at Site 3 (Deep River-upstream-3), Site 5 (Deep River-upstream-5) and Site 12 (Deep River, downstream-3), respectively. The eight targeted "rare" mussel species were found primarily at un-impounded sites within the Deep River (Table 21).

Table 21. Relative Abundance and diversity of mussels per survey site

Site	CPUE all mussels	# mussels species*	# rare mussel species	# fish species
1: Deep River-upstream-1 (Howard Mill Rd)	44.8/hr	5	4	13
2: Deep River-upstream-2 (Island Channel/Howard Mill Rd) and Site 10 Deep River-downstream-1 (Tailrace)	not sampled for mussels			
3: Deep River-upstream-3 (NC 22)	130.33/hr	7	5	18
4: Deep River-upstream-4 (Tyson's Creek)	26.4/hr	3	2	13
5: Deep River-upstream-5 (Glendon-Carthage Rd)	41.77/hr	7	4	12
6: Deep River-impoundment-1	81.19/hr	6	2	5*
7: Deep River impoundment-2	58.12/hr	4	1	2*
8: Deep River impoundment-3	34.0/hr	2	0	2*
9: Deep River impoundment-4	31.32/hr	4	0	1*
10: Deep River downstream-1	not sampled for mussels			
11: Deep River downstream-2	29.33/hr	8	3	11
12: Deep River-downstream-3 (Plank Road)	41.86/hr	7	5	9
13: Deep River-downstream-4 (US 421)	20.67/hr	2	1	10
14: Deep River-downstream-5 (Rosser/Cummock Rd)	48.67/hr	5	2	7
15: McLendons Creek-upstream (Cool Springs Rd)	84.28/hr	5	1	9
16: McLendons Creek impoundment	0.75/hr	1	0	0*
17: Big Governors Creek-upstream (Underwood Rd)	18.67/hr	2	0	6
18: Big Governors Creek-impoundment	0.0/hr	0	0	0*

The brook floater and creeper were found at three and four sites, respectively, upstream of the reservoir pool (Sites 1, 3, and 5 and Sites 1, 3, 4 and 5). All of these sites are characterized as having a significant amount of habitat complexity. The absence of these species at the survey sites downstream of Carbonton Dam is most likely a reflection of the rarity of these species in the Deep River, and the limited amount of habitat complexity at some of the sampled downstream sites. Both of these species likely occur in low numbers at scattered locales in the Deep River below Carbonton Dam. The restoration of habitat within the reservoir pool may provide more potential habitat for these species in the river.

The eastern creekshell was found at the majority of the un-impounded sites (Sites 1-3, and 11-15) usually associated with shallow low velocity areas near the banks. Likewise, the yellow lampmussel was found at a number of upstream and downstream sites (Sites 1, 4, 5, 6, 11, and 14). The occurrence at Site 6, within the impoundment is represented by 1 very weathered relict shell, indicating that this species may occur in low numbers in the upper limits of the reservoir pool, where the lentic effect is diminished.

The state endangered Carolina creekshell and Savannah liliput were each represented by only one individual during the entire survey effort. The occurrence of the Carolina creekshell at Site 12 is somewhat of an oddity as this species is usually associated with smaller water bodies. This species likely occurs at various locales in the Deep River in low numbers, but is more likely to occur in larger numbers in tributaries to the river. The removal of Carbonton Dam may provide potential habitat for this species in the restored reaches of Big Governors Creek and McLendons Creek. The Savannah liliput was found at Site 3. This is only the second individual of this species reported from the entire Deep River subbasin. This species has only been reported at one other location in the Deep River (Art Bogan, personal communication). The Savannah liliput is more commonly associated with shallow water habitats with fine sediments and little to no current. Although Site 3 is characterized as a swift flowing riffle/run habitat, the numerous beds of water willow provide some hydraulic refugia and thus accumulate finer sediments, providing suitable habitat for this species. This species is likely very rare in the Deep River; however, it may be under sampled due to its diminutive size. If areas within the impounded reach develop similar characteristics as those present at Site 3 following dam removal, the Savannah liliput may be able to establish itself in these areas.

The impounded sites contain a less diverse, more lentic adapted mussel fauna than the un-impounded sites. The eastern floater and paper pondshell most often associated with lentic habitats were found only within the impounded portion of the Deep River. Species richness and mussel abundance within the impounded portion of the river increased with increasing distance upstream of the dam, suggesting a diminished lentic effect in the upstream limits of the impoundment. Mussels found within the lower limits of the impoundment Site 8 (Deep River, impoundment-3) and Site 9 (Deep River, impoundment-4) respectively were found primarily along the banks just below the waters edge, as the deeper habitats were heavily silted. In contrast the bottom substrates at the upstream sites within the impoundment, Site 6 (Deep River, impoundment-1), and Site 7 (Deep River, impoundment-2) were relatively free of fine sediments and supported comparatively high numbers of the eastern elliptio.

Noteworthy within the impoundment was the presence of a relatively old Roanoke slabshell individual at Site 6. This marks the furthest upstream occurrence of this species in the Cape Fear River Basin. The species was also found in low numbers downstream of the dam at Sites 11 and 12. The Roanoke slabshell, considered Threatened in North Carolina, is believed to have an anadromous fish host. The few individuals found during this survey effort may be senescent individuals that existed in this reach before construction of the many dams on the Cape Fear River, including the Carbonton dam, as many mussel species are long-lived organisms. It may also be possible that a population of this species is able to persist in very low numbers, by either using a less suitable fish species as a host (resulting in lower transformation), or by using direct transformation (bypassing the obligate fish host). Direct transformation has been reported in some mussel species, but never within the genus elliptio.

6.2 Aquatic Snails and Freshwater Clams

The pointed campeloma was the most common aquatic snail found during the survey efforts, being present at 9 of the 18 sites sampled. This species tolerates a wide range of habitat conditions, including lentic habitats. The gravel elimia, a lotic riffle adapted species was found exclusively in riffle habitats dominated by rocky substrates (Sites 1,3,4,5,14). Its apparent absence from the riffle habitat of Site 11 (Deep River, downstream-2) may be attributed to the relatively high silt loads observed at this site. The removal of the Carbonton dam will likely result in an increase of habitats occupied by this species within the Deep River as some areas revert to riffle conditions.

Two clam species were found during the pre-removal surveys, the invasive and ubiquitous Asian clam and a native fingernail clam. The Asian clam was found, usually in large numbers, at all of the sites surveyed with the exception of Site 18 (Big Governors Creek-impoundment), however, a few relict shells of this species were observed at this site. Native fingernail clams were found only at Site 15 (McLendons Creek-upstream). The apparent absence of fingernail clams at the other sites is more likely the result of not being detected rather than being absent, as fingernail clams are fairly difficult to detect without survey methods utilizing excavation of sediment.

6.3 Fish

At least 70 species of freshwater fish, including the federally endangered Cape Fear shiner have been reported from the Upper (above the fall line) Cape Fear River Basin (Menhenick 1991); at least ten of these are not native to the basin. The Carbonton dam currently separates two populations of the Cape Fear shiner in the Deep River. A stated goal of the dam removal project is to restore the habitat within the Deep River and its tributaries impounded by the Carbonton dam to lotic conditions, thus reconnecting the two isolated populations. Changes in fish community composition in response to dam removal will be evaluated as part of the proposed removal. The Cape Fear shiner is the main target species for this study. Other riffle adapted species will serve as surrogate species to demonstrate habitat restoration success.

The impounded portions of the Deep River and its tributaries contain a predictable suite of impoundment-adapted species and thus fish surveys were not conducted within the impounded reaches. Additionally, the target species, the Cape Fear shiner is not found in impounded reaches (Howard 2003).

As expected, shallow lotic species that exhibit affinities for rocky riffle/run habitats were located at the un-impounded survey stations. Survey sites that contained the greatest amount of habitat complexity (Sites 1-4) yielded the highest number of fish species (13, 15, 18 and 13 respectively. If Sites 1 and 2 are considered collectively as 1 site, fish species number is 21. The fish composition between the un-impounded upstream and downstream sites on the Deep River is fairly comparable, with the differences in species composition likely attributable to differences in habitat complexity between sites.

Although fish surveys were not conducted in the impounded reaches, many of the species found in the lotic habitats are not expected to occur, nor were they observed within the impounded sites. The one exception to this was the presence of the Piedmont darter within Site 6 (Deep River impoundment-1), the most upstream site within the impoundment. The presence of this species which is more often associated with lotic conditions, suggests a decreasing lentic effect at the upper limits of the impoundment. Results from the mussel surveys further support this theory.

The targeted Cape Fear shiner was found at two sites upstream of the dam (Sites 1 and 3) and two sites downstream of the dam (Sites 10 and 13). The two upstream sites are characterized as habitats typically associated with Cape Fear shiner. This species was found in great numbers at Site 3. Although the tailrace site (Site 10) differs from typical habitats supporting Cape Fear shiner, the high velocities over rocky substrate created by water being released from the dam mimic the rocky riffle habitats where this species is usually found. The occurrence of this species at Site 13 is unusual given the lack of flow and poor habitat conditions present at this site. The one individual found was in poor condition (worn fins) and was possibly a vagrant from a congregation occurring in more suitable habitat nearby.

The tailrace site (Site 10, Deep River downstream-1) contained the high numbers of shiner species (10), including the Cape Fear shiner. However, the bluehead chub and gizzard shad were the only other species captured at this site. Three individual gizzard shad were collected immediately below the dam. This species is more often found within impoundments, and its presence in the tailrace may be the result of individuals washing over the dam. The shiner species occupy similar niches (within the water column), and their large congregations below the dam may indicate that food resources (zooplankton) are suspended and concentrated by the action of water coming over the dam. The lack of other fish species at this site is consistent with reported reductions in species diversity below impoundments (Quinn and Kwak 2003) and may be a function of high velocities and scour. However, more demersal (having a close affinity to the bottom) species (sunfishes, catfish, bass etc.), likely occur in this habitat, but were not detected during this survey effort, as they are difficult to detect in these conditions exclusively using seine netting methodologies, because they are able to seek cover under boulders in the channel.

The differences in fish abundance between Site 15 McLendons Creek, upstream) and site 17 (Big Governors Creek, upstream), is likely attributable to a higher diversity of microhabitats in McLendons Creek. The habitat and fish fauna present in the surveyed portion of Big Governors Creek are more indicative of slow-moving swampy streams than faster flowing rocky streams of the Piedmont.

The Roanoke bass was captured in low numbers at Site 1. This species is fairly intolerant and has experienced declines throughout its natural range; however, the Deep River population is a result of introduction efforts by the NCWRC in the 1970's and carries no conservation status. Although established in the Deep River, little is known of the population in the Deep River, but it appears to be limited in numbers in the reach near Carbonton Dam (Wayne Starnes, personal communication).

The targeted Carolina darter and Carolina redhorse were not found during this survey effort. The Carolina darter is more commonly associated with smaller water bodies with sandy substrates and was not expected to be found during this effort. The capture methodologies used during this study are typically not conducive to capturing large redhorse species, as they tend to congregate in deeper habitats, and are able to avoid small seine nets. This species has been captured using boat-electrofishing at various locales throughout the Deep River, including the Carbonton Dam reservoir reach (Wayne Starnes, personal communication). Very little life history information is available for the Carolina redhorse, thus it is difficult to speculate how this species will respond to dam removal. Other similar redhorse species are known to be adversely affected by dam construction (R.E. Jenkins, personal communication). The NCWRC and NCSM are studying and monitoring the Carolina redhorse population in the Deep River.

As discussed earlier, electro-fishing was not used during this survey effort, in recognition of the "Collection sensitive waters" designation of the Deep River by the NCWRC. A more comprehensive survey effort conducted at various times throughout the year and using multiple sampling methodologies (boat-electrofishing, backpack electrofishing, seine netting etc.) is needed, particularly in the deeper habitats, to obtain a complete list of all fish species occurring in the Deep River and its tributaries. However, the methods used and the data collected is adequate for establishing fish fauna targeting the Cape Fear shiner. These methods will also allow for the monitoring of changes in community composition over time in response to dam removal.

7.0 ANTICIPATED IMPACTS FROM DAM REMOVAL

Potential beneficial and adverse impacts to the aquatic resources targeted in this study are briefly addressed here.

7.1 Freshwater mussels

Freshwater mussels are expected to re-colonize the restored habitats within the reservoir pool following removal of the Carbonton dam. However, re-colonization of freshwater mussels to restored habitats may take several years due to their life history characteristics: relatively immobile, slow growing and dependent on fish movement for dispersal. Sietman et al. (2001) reported that mussel population recovery took up to 80 years in the Illinois River following extirpation around the turn of the 20th century and recovery was dependent on the distance to source mussel populations as well as host fish and water quality parameters. Abundant mussel and fish populations were documented upstream and downstream of the existing dam, thus recruitment of many species into the restored habitats can come from both directions.

The survey results demonstrate that presence of the targeted “rare” mussel species was related to habitat complexity within a site. Restoration of the natural flow regime within the former impoundment will likely result in greater habitat complexity in this reach, which will in turn provide more available habitat for many of the targeted mussel species, including the NC state endangered brook floater, Savannah liliput and yellow lampmussel.

Mortality of mussels occurring within the impounded portion of the Deep River are expected to occur following dam removal as waters recede and mussels are stranded and are subject to desiccation and predation. Sethi et al. (2004) documented this following dam removal in Koshkonong Creek in Wisconsin and was also observed on the Little River in North Carolina following water draw down and partial dam removal (personal observations). The mussel species occurring within the impounded portion of the Deep River are widespread, common habitat generalists, or lentic-adapted species that would not naturally occur in as large of numbers without the impoundment. The loss of these individuals may be considered an acceptable impact, when considering the likely beneficial impact of restoring lotic mussel species in this reach.

Localized adverse impacts to mussel populations may also occur downstream of Carbonton dam. Sethi et al. (2004) documented significant mortality to mussels downstream of the dam on Koshkonong Creek following removal. The initial pulse of sediment that resulted from this dam removal, as well as continual deposition of fine sediment caused by head cutting and unstable banks within the formerly impounded section, were attributed to the loss of downstream mussel populations. Localized adverse impacts to mussel populations occurring downstream of Carbonton dam are likely to result from dam removal. The survey results indicate that the many of the mussel species found during the survey effort are widely distributed in the Deep River. Thus, long-term adverse impacts to mussel communities are less likely to occur as sufficient source mussel populations occur in close proximity to the impacted areas.

7.2 Aquatic Snails and Freshwater Clams

Like freshwater mussels, aquatic snails occurring within the impoundment (pointed campeloma, hydrobidae snails) may be subject to desiccation and predation following dam removal. However, these organisms are more mobile than freshwater mussels and may be able to retreat to deeper pools as the water levels recede.

The gravel elimia, a lotic riffle adapted species was found exclusively in riffle habitats dominated by rocky substrates (Sites 1, 3, 4, 5, and 14). Although this species may be adversely affected by downstream sedimentation to riffle habitats caused by dam removal, overall the removal of the Carbonton dam will likely result in an increase of available habitat for this species within the Deep River, as some areas revert to riffle conditions.

Population levels of the ubiquitous Asian clam will likely not be affected either way by dam removal, as it was found in high numbers in un-impounded as well as impounded habitats.

7.3 Fish Populations, Primarily Cape Fear shiner

One of the desired goals of dam removal is to restore existing lentic habitats to their natural lotic state and thus restore the appropriate, pre-impoundment aquatic faunal community. Studies have shown that highly mobile organisms such as fish and organisms with short life cycles (benthic macro-invertebrates) are able to quickly recolonize restored lotic habitats following dam removal in mid sized streams in southern Wisconsin (Kanehl et al. 1997, Stanley et al. 2002). In both of these instances, the return of the desired species, smallmouth bass (*Micropterus dolomieu*) and lotic benthic macro-invertebrate assemblages, respectively, occurred in short periods of time following the respective dam removals. Kanehl et al. (1997) demonstrated an increase in the desired smallmouth bass populations within the former impounded reach, as well as in habitats upstream of the former impoundment. These population increases were the result of recruitment rather than by permanent migration of fish from other areas. Additionally, populations of the undesired common carp (*Cyprinus carpio*) declined dramatically following dam removal.

The pre-dam removal surveys, as well as other survey data within the Deep River system, indicate that similar populations of lotic- adapted fish species occur within the un-impounded river reaches both upstream and downstream of Carbonton dam. Therefore ample source populations exist both upstream and downstream to facilitate recruitment into the restored reaches following dam removal. The removal of the dam is expected to increase the available habitat for the targeted Cape Fear shiner, and connect the two populations isolated by the dam. This increase in available habitat and the connection of populations should result in an increase in population numbers and viability (more genetic interchange, greater range, etc.) over time.

Although it is logical to assume recovery of lotic fish species into the restored reach, which is viewed as a long-term beneficial impact, various short-term adverse impacts to the fish community in the Deep River may also occur from dam removal. This is of particular concern when considering the impacts to the federally endangered Cape Fear shiner. In addition to impacts of conversion of lotic habitats to lentic habitats, sedimentation and water quality degradation have also been identified as factors adversely impacting the Cape Fear shiner (USFWS 1988, Howard 2003). The accumulation of sediments behind dams is well documented, and the removal of dams results in a release of sediment to downstream habitats. The fish fauna below the dam, including the Cape Fear shiner could be adversely impacted by the pulse of sediment released during water draw down and dam removal. Reductions in dissolved oxygen (DO) may also occur downstream during removal as oxygen depleting organic sediments are released. Additionally, concentrations of toxic substances which may have accumulated in the sediments behind the dam may be released downstream impacting aquatic organisms.

These potential impacts to the Cape Fear shiner were considered by the USFWS prior to dam removal. With measures that were incorporated into the removal project that avoid/minimize the potential for these impacts to occur, it was concluded that significant adverse impacts were unlikely to occur.

As with the impounded portions of the Deep River, beneficial impacts to the fish communities in the impounded portions of McLendons Creek and Big Governors Creek are also likely to result following dam removal. As discussed previously, the suite of fish species captured in the un-impounded portion of Big Governors Creek varies significantly from those that were found in the Deep River and McLendons Creek. It is not clear whether the fish community of the lower portion of Big Governors Creek will be more influenced by the Deep River fauna, or the fauna currently present in the stream above the reservoir pool. Although there is less habitat complexity in the un-impounded portions of McLendons Creek than the Deep River, the fish faunas are fairly similar. Colonization of the restored habitats in the lower portions of McLendons Creek will likely occur from both upstream as well as from the Deep River.

8.0 RECOMMENDATIONS/FURTHER STUDY

This project is expected to result in significant benefits to the aquatic fauna in the Deep River and its tributaries. Qualitative monitoring of the sites sampled during the pre-removal surveys should occur after removal to document general changes in faunal communities and demonstrate success. **Fish communities at the sampling sites should be monitored during the first year following removal. The results of the first-year monitoring should be factored into the decision for future monitoring. Due to their life histories, changes in mussel fauna associated with dam removal will likely not be evident for at least four years post removal. Thus, it is recommended that the freshwater mussel fauna be monitored at the pre-removal survey sites four years following removal. Aquatic snails and freshwater clams will also be sampled during this monitoring, as similar methodologies are used. The results of the 4-year monitoring will determine if future monitoring is warranted.**

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