RESTORATION PLAN

Glade Creek Stream Restoration
Alleghany County, North Carolina

Prepared for:
NCDENR-Ecosystem Enhancement Program
2728 Capital Blvd., Suite 1H 103
Raleigh, NC 27604

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By

Biohabitats
SOUTHEAST BIOREGION
Incorporated

8218 Creedmoor Road, Suite 200
Raleigh, NC 27613
Office 919-518-0311 Fax 919-518-0313

Project Manager: Kevin Nunnery

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Executive Summary

The project site and easement is located on the Steven Faw property (PIN # 3999252005), at 541 Dewitt Road, approximately 4 miles south of Sparta, North Carolina. The project reaches include the portion of Glade Creek that flows through the Faw property as well as an unnamed tributary that flows through the property and exits the property just before its confluence with Glade Creek. The total existing channel length on Glade Creek is 2,569 feet (thalweg) based on survey data and stationing. The unnamed tributary (UT) to Glade Creek is 1,088 feet long based on the survey. There is 0.17 acre of wetland that has been delineated beside the main channel of Glade Creek and 0.16 acre of wetland that has been delineated on the upper section of the UT, for a total of 0.33 acre of delineated wetland on the project site.

Glade Creek and the downstream portion of the UT channel are currently unstable, with an over-wide channel in many areas, mid-channel sediment bars, incised bed and steep, eroding, unvegetated banks throughout. Approximately 62% of the Glade Creek channel within the project boundary has a BEHI rating of High, 33% has a rating of Very High and 5% has a rating of Moderate. The estimated total sediment export per year for the Glade Creek reach is 619 tons, based on the Rosgen (2004) sediment export curves. The entire proposed restoration reach of the unnamed tributary has a BEHI rating of Very High, and the estimated total sediment export per year for the reach is 72 tons. The pervasive extent of high BEHI scores indicates that the channel is widening and migrating throughout most of the project reaches. Approximately 70% of the channel on Glade Creek had bank height ratios (BHR) of 2 or more and all of the channel proposed for restoration on the UT has a BHR of >2. A bank height ratio greater than two indicates a highly erosive condition for stream banks by definition, so field review of the channel indicates that it has experienced extensive incision and entrenchment. These conditions will become stabilized on their own only through the natural reconfiguration of the channel from bankfull flows, which takes place over many years and introduces very large amounts of sediment from the bed and banks into the stream flow and aquatic habitat as the channel readjusts its geometry and course.

The goals of the project are to:

- Rapidly stabilize the channel of Glade Creek relative to natural process,
- Rapidly stabilize and preserve the channel of the UT relative to natural process,
- Restore and rehabilitate channel features and aquatic habitat in Glade Creek and the UT,
- Rehabilitate the riparian buffer along both streams,
- Preserve the existing wetlands onsite.

These goals will be accomplished by designing and constructing a stable plan, profile and dimension for the stream channels and re-establishing continuous riparian buffers along the banks. Project implementation will greatly reduce bank erosion and consequently decrease the amount of sediment load in the stream at flows above baseflow. Restoration level (Rosgen Priority Level II) design is needed on all but 125 feet (which will be Enhancement I) of the channel on the project, due to unstable channel geometry, sinuosity and streambank steepness. Structures will be used to enhance holding and feeding areas for trout. Riparian buffer vegetation will be established to provide food and cover for terrestrial fauna and to provide a carbon source and shade for aquatic habitat.

Through its Local Watershed Planning initiative, EEP focuses resources in specific 14-digit hydrologic units - local watersheds - in order to address critical watershed issues. This process involves conducting a detailed assessment of the condition of the watershed, involving the local community in identifying solutions to water-quality, habitat and flooding problems, and working to get agreed-upon solutions implemented within priority sub-watersheds. Stream restoration on Glade Creek will help alleviate two problems identified in the Local Watershed Plan for the Little River (Phase I) as being sources of water quality degradation-inadequate riparian buffers and sediment. This project would address both of those

problems by stabilizing the severely eroding stream banks onsite and establishing a permanent riparian buffer on them.

To meet the goals listed above, the proposed objectives for Glade Creek are to perform Priority II Restoration on approximately 2,430 linear feet (LF) and stabilize 125 LF with Enhancement I design. Please note that a 25-foot section of channel underneath the existing bridge was excluded from the proposed restoration total, although channel profile and dimension will be reconfigured and stabilized there. The proposed objectives for the UT are to perform Restoration on approximately 275 LF and Preserve 788 LF. All the wetlands onsite will be preserved with the proposed project (see Table 1).

Reach	**Existing**	**Restoration (Priority II)**	**Enhancement I**	**Preservation**
Glade Creek	2,569	2,430	125*	
Un. Trib.	1,088	275**		788
Column Totals	3,657	2,705	125	788
Wetlands	~0.33 ac			~0.33 ac

*25 feet of channel underneath the bridge were excluded.
**The restoration on the UT will actually shorten the UT channel by 25 feet due to the unduly high existing sinuosity.

1.0 Project Site Identification and Location

The project site and easement is located on the Steven Faw property (PIN # 3999252005), at 541 Dewitt Road, approximately 4 miles south of Sparta, North Carolina. The project reaches include the portion of Glade Creek that flows through the Faw property as well as an unnamed tributary that flows through the property and exits the property just before its confluence with Glade Creek. The total existing channel length on Glade Creek is 2,550 feet (thalweg) based on survey data and stationing. The unnamed tributary to Glade Creek is 1,088 feet long based on the survey. The latitude and longitude of the midpoint of the restored mainstem is 1392171.90N, 995691.64E using the NAD83 coordinate system. For the tributary section the coordinates are 1392799.71N, 995076.13E. For the wetland on Glade Creek the coordinates for the approximate center are 1392253.65N, 995752.46E

1.1 Directions to Project Site

The project site is located in Alleghany County, North Carolina, approximately 4 miles southeast of the town of Sparta. From the south and east, the site can be accessed by exiting Interstate 77 North at the US 21 Bypass exit in Elkin and traveling 23.1 miles to Dewitt Road, turning left on Dewitt Road and traveling 0.7 miles to the site entrance on the left at 541 Dewitt Road. From the north and west, proceed south on US 21 4 miles to Dewitt Road, turn right and proceed 0.7 miles to 541 Dewitt Road on the left.

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

Glade Creek is located in the USGS 8-digit Hydrologic Unit Code 05050001, and in the 05050001030020 14-digit Code. The N.C. Division of Water Quality stream index number for Glade Creek is 10-9-9. This stream is classified as Class C trout water.

1.3 Project Vicinity Map

See Figure 1 (Section 10).

2.0 Watershed Characterization

The Glade Creek watershed is located in a rural area of a sparsely populated county. County land area is 235 square miles. The population of Alleghany County as of the 2000 Census was 10,677, rendering a population density of 45 persons per square mile, approximately 23 percent of the state average of 165 persons per square mile. The average temperature is 50.1 degrees Fahrenheit, the average annual rainfall is 46 inches and the average annual snowfall is 17 inches. (Alleghany County Demographics, http://ealleghany.net/main/demographics/)

2.1 Drainage Area

The drainage area of the main channel of Glade Creek at the downstream end of the project is ~2,922 acres (4.6 mi^2) and the drainage area of the unnamed tributary at the downstream end of the project is approximately 521 acres (0.8 mi^2), for a total watershed area of approximately 3,443 acres (5.4 mi^2). The area within the conservation easement or project area itself is approximately 12 acres.

2.2 Surface Water Classification / Water Quality

Glade Creek is located in the USGS 8-digit Hydrologic Unit Code 05050001, and in the 05050001030020 14-digit Code. The N.C. Division of Water Quality stream index number for Glade Creek is 10-9-9. This stream is classified as a Class C trout water.

2.3 Physiography, Geology and Soils

Alleghany County is located in northwestern North Carolina, and its northern border is with Virginia. The county is located entirely within the Appalachian Mountains region of western North Carolina. Most of the county is located atop a rolling plateau that ranges from 2,500 feet to 3,000 feet above sea level. The Glade Creek watershed is part of the area, and is underlain by sedimentary and metamorphic rock from the late Proterozoic Period, clastic metasedimentary rock, and mafic and felsic metavolcanic rock of the Ashe Metamorphic Suite, Tallulah Falls Formation and Alligator Back Formation, gneiss, schist, metagraywacke, amphibolite, and calc-silicate granofels (N.C. Geological Survey, 1985).

The NRCS is currently revising the soil survey of Alleghany County, and limited information is available on the Web Soil Survey 2.0 website. However, Biohabitats was able to get GIS soils information from the 1973 Soil Survey from the State NRCS office and analyze it (Figure 3). The results for the combined Glade Creek and unnamed tributary watersheds are listed below.

Series Name	**Acres**	**Percent**	**Series Name**	**Acres**	**Percent**
1. Watauga	1,512.0	43.9	8. Fannin	75.1	2.2
2. Chester	550.4	16.0	9. Cordurus	75.0	2.2
3. Porters	411.5	11.9	10. Clifton	73.0	2.1
4. Tusquitee	236.6	6.9	11. Ashe	44.3	1.3
5. Chandler	198.9	5.8	12. Stony Steep Land	22.9	0.7
6. Alluvial land	138.1	4.0	13. Rock Outcrop	1.7	0.1
7. Tate	103.5	3.0	14. Gullied Land	1.6	0.0
			15. Water	1.6	0.0
			TOTALS	**3,446.2**	**100**

By far the most prevalent soil series in the watershed is the Watauga series (44%, Typic Hapludults) followed by Chester (16%, Typic Hapludults) and Porters (12%, Typic Dystrudepts) soils. All these series are upland soils, and no hydric soil is included in the list, although it is assumed that the alluvial land category may contain hydric soils.

2.4 Historical Land Use and Development Trends

The main land use patterns for the Glade Creek watershed upstream of the project are approximately 44% (1,500 ac) Managed Herbaceous Cover (pasture), and 36% (1,226 ac) forested in Mixed Upland Forest (see Table 3 in Section 9). A major component of Alleghany County's economic history and present economy is dairy and livestock production. The high percentage of pasture in the watershed reflects this economic trend. A major cause of accelerated stream bank erosion can be related to land use change (Henderson, 1986). For decades livestock and dairy production has known to compact soils, increase stormwater runoff and increase sediment loading in stormwater. For example, overgrazing and soil compaction in the uplands often lead to rill erosion and elevated peak flows instream. Soil can become compacted by the repeated pressure of moving animals, especially if the soil is wet. The combination of soil exposure and compaction can decrease infiltration and increase surface runoff. If infiltration capacity is severely limited on a large fraction of a catchment, the extra runoff can quickly enter streams and generate higher peak flows (Davis, 1977.) The high percentage of land in the watershed converted to pasture indicates a high potential for non-point source runoff and pollution to be generated upstream of the site and transported downstream. Only 0.5% of the watershed is in cultivated land, the balance of the remaining land being in forest, shrub or herbaceous cover.

In addition to erosive impacts caused by livestock and dairy production, research has shown that stream erosion can be caused by logging done without following Best Management Practices. Rice et al. (1979) and Burwell (1970) showed that the quantity of sediment produced and delivered to a stream from a logging site is determined to a large extent by the care taken by the harvesting operator. Toews and Moore (1982) reported stream bank erosion was more than 250% greater after logging than before in clearcut areas where no buffer strips were left. After clearcutting an area where a buffer strip 5 meters or less was used, streambank erosion increased only 32% over the preharvest rate. Logging was historically common throughout the mountains of North Carolina, and based on the degree of incision of the restoration reach, the Glade Creek watershed was no exception. Best Management Practices were only developed and mandated for use in the past 20-30 years.

Projected population growth for the state of North Carolina from 2000 to 2006 was 10.1% while Alleghany County's population was projected to grow by 3%, indicating a suppressed population and development growth compared to the state as a whole (N.C. State Demographics, 2007). From the same data source, the projected growth rate from 2010-2020 was projected to be low, approximately 3%. The population growth for Sparta, NC from 2000-2007 was 2.3% (http://www.bestplaces.net/zip-code/Sparta_NC-72867500000.aspx).

2.5 Endangered / Threatened Species

A visual site assessment was conducted by traversing the entire project site. Biohabitats inspected the site for any indication of suitable habitat for any listed species. Based on the visual assessment results, Biohabitats determined if the project may affect one or more federally listed species or designated critical habitats. Prior to the site visit, we obtained an updated species list for Alleghany County from the US Fish and Wildlife Service web site (http://nc-es.fws.gov/es/countyfr.html).

The USFWS lists the following protected species for Alleghany County:

USFWS List of Protected Species in Alleghany County, N.C.

Common Name	Scientific name	Fed. Status	Record Status
Vertebrate:			
Allegheny woodrat	*Neotoma magister*	FSC	Probable/potential
Appalachian cottontail	*Sylvilagus obscurus*	FSC	Current
Bog turtle	*Clemmys muhlenbergii*	T (S/A)	Current
Eastern small-footed bat	*Myotis leibii*	FSC	Historic
Golden-winged warbler	*Vermivora chrysoptera*	FSC	Current
Hellbender	*Cryptobranchus alleganiensis*	FSC	Current
Kanawha minnow	*Phenacobius teretulus*	FSC	Current
Invertebrate:			
Diana fritillary (butterfly)	*Speyeria diana*	FSC	Current
Grayson crayfish ostracod	*Ascetocythere cosmeta*	FSC	Historic
Green floater	*Lasmigona subviridis*	FSC	Current
Grizzled skipper	*Pyrgus wyandot*	FSC	Current
Midget snaketail	*Ophiogomphus howei*	FSC	Current
Regal fritillary (butterfly)	*Speyeria idalia*	FSC	Historic
Vascular Plant:			
Butternut	*Juglans cinerea*	FSC	Current
Cuthbert turtlehead	*Chelone cuthbertii*	FSC	Current
Fen sedge	*Carex* sp. *2*	FSC	Current
Gray's lily	*Lilium grayi*	FSC	Current
Gray's saxifrage	*Saxifraga caroliniana*	FSC	Historic
Large-leaved Grass-of-Parnassus	*Parnassia grandifolia*	FSC	Current
Sweet pinesap	*Monotropsis odorata*	FSC	Obscure
Tall larkspur	*Delphinium exaltatum*	FSC	Historic

Note: T(S/A) = threatened due to similarity or appearance. A species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation. Federal Species of Concern (FSC) are defined as species under consideration for listing, for which there is insufficient information to support listing at this time (USFWS, May 2007).

Rare, threatened and endangered species listed by the N.C. Natural Heritage Program (NHP) for the U.S. Geological Survey Glade Valley 7.5-minute topographic quadrangle are presented in the list below.

N.C. Natural Heritage Program List of Rare, Threatened and Endangered Species				
Major Group	**Scientific Name**	**Common Name**	**State Status**	**Federal Status**
Invertebrate Animal	*Pyrgus wyandot*	Appalachian Checkered-Skipper	SR	FSC
Natural Community	*Southern Appalachian Bog (northern subtype)*	None	None	None
Nonvascular Plant	*Macrocoma sullivatii*	Sullivant's Maned-moss	SR-D	None
Nonvascular Plant	*Orthotrichum keeverae*	Keever's Bristle-moss	E	None
Vascular Plant	*Calamagrostis canadensis*	Canada Reed Grass	SR-P	None
Vascular Plant	*Carex leptonervia*	A Wood Sedge	SR-P	None
Vascular Plant	*Carex woodii*	Wood's Sedge	SR-P	None
Vascular Plant	*Chelone cuthbertii*	Cuthbert's Turtlehead	SR-L	FSC
Vascular Plant	*Coptis trifolia ssp. groenlandica*	Goldthread	SR-P	None
Vascular Plant	*Crocanthemum propinquum*	Creeping Sunrose	SR-P	None
Vascular Plant	*Dalibarda repens*	Robin Runaway	E	None
Vascular Plant	*Geum laciniatum var. trichocarpum*	Rough Avens	SR-P	None
Vascular Plant	*Glyceria laxa*	Lax Mannagrass	SR-P	None
Vascular Plant	*Hackelia virginiana*	Virginia Stickseed	SR-P	None
Vascular Plant	*Hexalectris spicata*	Crested Coralroot	SR-P	None
Vascular Plant	*Lillium grayi*	Gray's Lily	T-SC	FSC
Vascular Plant	*Platenthera grandiflora*	Large Purple-fringed Orchid	SR-P	None
Vascular Plant	*Rhynchospora alba*	Northern White Beaksedge	SR-P	None
Vascular Plant	*Robinia hispida var. fertilis*	Fruitcul Locust	SR-O	None
Vascular Plant	*Spirathes lucida*	Shining Ladies-tresses	SR-O	None
Vascular Plant	*Stenanthium roubustum*	Bog Featherbells	SR-P	None
Vascular Plant	*Vaccinium macrocarpon*	Cranberry	SR-P	None

N.C. Natural Heritage Program List of Rare, Threatened and Endangered Species (Continued)				
Major Group	**Scientific Name**	**Common Name**	**State Status**	**Federal Status**
Vertebrate Animal	*Ambystoma talpoideum*	Mole salamander	SC	None
Vertebrate Animal	*Crotalus horridus*	Timber Rattlesnake	SC	None
Vertebrate Animal	*Etheostoma kanawhae*	Kanawha Darter	SR	None
Vertebrate Animal	*Eumeces anthracinus*	Coal Skink	SR	None
Vertebrate Animal	*Exoglossum laurae*	Tonguetied Minnow	SR	None
Vertebrate Animal	*Glyptemys muhlenbergii*	Bog Turtle	T	T(S/A)
Vertebrate Animal	*Myotis leibee*	Eastern Small-footed Myotis	SC	FSC
Vertebrate Animal	*Myotis septentrionalis*	Northern Long-eared Myotis	SC	None
Vertebrate Animal	*Passerculus sandwichensis*	Savannah Sparrow	SR	None
Vertebrate Animal	*Phenacobius teretulus*	Kanawha's Minnow	SC	FSC
Vertebrate Animal	*Plethodon wehrlei*	Wehrle's Salamander	T	None
Vertebrate Animal	*Sylvilagus obscurus*	Appalachian Cottontail	SR	FSC

Plant statuses for the NHP list are determined by the Plant Conservation Program (NC Department of Agriculture) and the Natural Heritage Program (NC Department of Environment and Natural Resources). Endangered (E), Threatened (T), and Special Concern (SC) species are protected by state law (Plant Protection and Conservation Act, 1979). Candidate and Significantly Rare (SR) designations indicate rarity and the need for population monitoring and conservation action. The additional significantly rare designations "-P" and "-O" refer to species at the periphery of their range in North Carolina, and that the range of species is sporadic or cannot be described by other significantly rare designations, respectively. Note that plants can have a double status, e.g., E-SC, indicates that while the plant is endangered, it is collected or sold under regulation.

Animal statuses for the NHP list are determined by the Wildlife Resources Commission and the Natural Heritage Program. Endangered, Threatened, and Special Concern species of mammals, birds, reptiles, amphibians, freshwater fishes, and freshwater and terrestrial mollusks have legal protection status in North Carolina (Wildlife Resources Commission). The Significantly Rare designation indicates rarity and the need for population monitoring and conservation action.

There are no federally endangered species listed for Alleghany County. There is one federally threatened species listed for this county, the Bog turtle (*Clemmys muhlenbergii*). The Bog turtle has a shell length of approximately 4 inches with a distinctive red, orange, or yellow patch on each side of the head. The Bog turtle has a light brown to ebony shell.

Bog turtles inhabit slow, shallow, muck-bottomed rivulets of sphagnum bogs, calcareous fens, marshy/sedge-tussock meadows, spring seeps, wet cow pastures, and shrub swamps; the habitat usually contains an abundance of sedges or mossy cover. The turtles depend on a mosaic of microhabitats for foraging, nesting, basking, hibernation, and shelter (USFWS, 2000). "Unfragmented riparian systems that are sufficiently dynamic to allow the natural creation of open habitat are needed to compensate for ecological succession" (USFWS, 2000). Beaver, deer, and cattle may be instrumental in maintaining the essential open-canopy wetlands (USFWS, 2000).

Bog turtles rarely leave wetland habitats, although recent radio-telemetry evidence indicates that bog turtles sometimes venture into and across upland habitats (375 m, Carter *et al.*, 2000) and cross roads to reach adjacent wetlands (Morrow et al. 2001). Whitlock (unpublished data) also documented individuals regularly moving back and forth across 1 km of a typical wetland habitat to more suitable habitat patches. Successful movement across developed areas is probably negligible, due to susceptibility to collection, predation, and road mortality.

In North Carolina over somewhat less than 1 year, distances between relocations of radio-tagged turtles ranged from 0 to 87 m (mean= 24 m) for males, and 0 to 62 m (mean= 16 m) for females (Herman and Fahey, 1992).

There are 5 delineated wetlands on the project site, and they are all forested (refer to Section 5.1 and Figure 4), While these forested wetlands are not preferred habitat of the bog turtle, based on current scientific knowledge, they could be used by turtles as they travel between more suitable or preferred habitat. Based on personal communication with Dennis Herman of the N.C. Dept. of Transportation Office of the Natural Environment (July 20, 2007), a recognized bog turtle expert, bog turtles probably travel through the site on their way upstream or downstream to other sites, and may use the project site wetlands as stopping-over points. However, since all wetland areas within the project site will be undisturbed during project construction and will be permanently preserved, he stated that he believed that the short term disturbance of project construction would be offset by the long term preservation of the wetlands. Therefore, stream restoration activities associated with the Glade Creek Stream Mitigation site in Alleghany County will have no negative effect on the bog turtle species.

2.6 Cultural Resources

A visual on-site assessment was conducted by traversing the entire project site thoroughly, on both sides of the streams. No archeological artifacts were observed or noted during the site survey. The Environmental Data Resources, Inc. review for the project site revealed no record of mapped historic sites within the project area.

The State Historical Preservation Office (SHPO) was contacted and conducted a review of the site. In a response dated March 27, 2007 it was stated that SHPO was not aware of any historic resources that would be affected by the restoration project and that SHPO had no comment on the proposed undertaking.

A formal letter was sent to the Tribal Historic Preservation Office of the Eastern Band of Cherokee Indians on February 22, 2007. The project is still under review and when the letter is received, it will be submitted to EEP.

2.7 Potential Constraints

2.7.1 Property Ownership and Boundary

The project site and easement is located on the Steven Faw property (PIN # 39992520005), at 541 Dewitt Road, approximately 4 miles southeast of Sparta, North Carolina. The project reaches include the portion of Glade Creek that flows through the Faw property as well as an unnamed tributary that flows through the property and exits the property just before its confluence with Glade Creek (Figure 3).

2.7.2 Site Access

The easement is accessed from Dewitt Road by crossing the bridge over Glade Creek (the Faw's driveway) and accessing the easement from the side of the creek opposite from Dewitt Road. A temporary construction access road may need to be built from Dewitt Road to the creek if it is determined that the Faw's bridge over Glade Creek is not capable of safely supporting heavy equipment.

2.7.3 Utilities

An overhead power line services the property owner's house and passes over the easement. It is the only known utility that passes through the project site.

2.7.4 FEMA / Hydrologic Trespass

As of September 26, 2007, there is no FEMA mapping for the project area, based on a review of the N.C. Flood maps website. The proposed project is a Rosgen Priority II stream restoration project, with no wetland restoration component, only wetland preservation. The hydrology of the site will not be significantly altered by the project. The Faw's property and the adjoining properties will not be hydrologically trespassed upon by the stream restoration project.

2.7.5a. Beaver Pond and Design Approach

There is an existing beaver dam and pond along Glade Creek at station 17+75. Beavers built this feature during the fall of 2006 and then enlarged it in the winter of 2007. The proposed design will construct a stable channel directing flow beside and around the pond, preserving its present size and configuration. The mud and stick beaver dam will be removed and replaced with somewhat more permanent channel bed material. During higher flows the pond area will serve as additional floodplain capacity, and during low flows the stream thalweg will be adjacent to the pond area, flowing around it. This will allow the beaver impoundment area to persist, with a stable channel adjacent to it, thus providing stability while still allowing unimpeded sediment transport in the channel. The water table is expected to be high enough to maintain water in the adjacent pond area during periods of low flow.

This design provides a stable channel for stream flow and also maintains the small, ~ 0.1 ac impoundment that beavers have already constructed. According to the land owner, the beaver population is established both upstream and downstream from the project, and beaver are a natural part of the ecosystem. Eliminating them from a limited reach of stream when their population is established immediately upstream and downstream is generally not a reliable

control measure. There is no guarantee that the beavers wouldn't return and build a new dam near the present pond location if it is removed. This design approach, by retaining the impounded water in the existing pond, should allow the beavers to continue limited activity, while discouraging them from building new dams in the project area.

2.7.5b. Research on Beaver Activity and Stream/Riparian Zone Ecology

Much research has been published on the beneficial ecological effects of beaver activity. In the Rocky Mountain region, beaver have been shown to facilitate regeneration of long absent riparian vegetation (if cattle grazing was properly managed), and improve conditions for trout (Smith 1980; Munther 1981; Johnson 1984). Lack of beaver dams and imposition of grazing had led to channel incision and deterioration of trout habitat in the mountain valley creeks. Stocking beaver and initially providing them with aspen cuttings as food and dam-building material enabled them to impound water, which rejuvenated riparian zones. In such terrain, healing creeks with beaver proved to be more economical than traditional measures (Johnson 1984). Beaver help resist adverse perturbation of riparian areas, and their ponds improve chemical water quality (Parker 1986).

The reintroduction of beaver has demonstrated: 1) an elevated water table upstream of the dam, which in turn improves vegetation condition, reduces water velocities, reduces bank erosion, and improves fish habitat (increased water depth, better food production, higher dissolved oxygen, and various water temperatures), 2) reduced sedimentation downstream of the dam, 3) increased water storage, 4) improved water quality, and 5) more waterfowl nesting and brooding areas (McKinstry et al. 2001). In North Carolina beavers have naturally re-introduced themselves, but their effects on the environment are the same as if they were artificially re-introduced, as in much of the published research to date.

3.0 Project Site Streams (existing conditions)

3.1 Channel Classification

As part of the field reconnaissance, the Rosgen classification system (Rosgen, 1994) was used to determine channel type at each field cross section on the basis of existing morphological features of the stream channel. Two stable, representative riffle cross sections were surveyed on Glade Creek. The measured channel dimensions for the representative cross sections generate a C4 classification; except for width/depth ratio at the cross sections were 9.1 and 11.1, just under the classification minimum for a C channel, which is 12. A width/depth ration of less than 12 is characteristic of an E channel. For this reason, the existing channel is classified as a C_E4 channel, in deference to the low width/depth ratios at these representative riffles. However, in other sections of the Glade Creek channel, where downcutting and widening have occurred, decreasing the entrenchment ratio and increasing the width/depth ratio, the channel classification is F4 or G4. The F4 and G4 classifications are indicative of channel instability. Only one stable, representative cross section could be located on the unnamed tributary. Based on the measurements taken in the field, the unnamed tributary also was classified as a C4.

3.2 Discharge

In adjustable, alluvial, transport-limited rivers in temperate climates, flows of moderate frequency (e.g., the 1.5- to 2-year storm event) and magnitude perform most of the geomorphic work (Wolman and Miller, 1960). This concept of the “dominant discharge” provides a statistical index for the flow that corresponds with the peak volume of sediment transported. Dominant discharge is the maximum possible product of the frequency of a flow occurrence and the amount of sediment transported by that flow event. Channel morphology is ultimately a result of all flows above a sediment transport threshold that do some geomorphic work. However, the dominant discharge is commonly used as a single-value estimate for a flow that may be largely responsible for resulting geomorphic form.

It is thought that, in many cases, the morphological feature of a bankfull elevation corresponds fairly well to the flow stage of the dominant discharge. This has led to the concept of bankfull elevation as a tool in stream restoration design. However, the concept should be applied cautiously in stream restoration design. It should be noted that as channel boundaries are more resistant or less adjustable (i.e., bedrock, hillslope constraints, or large bed material) or in more arid environments, the majority of geomorphic work is more likely to be performed by larger and rarer flood events. For the purposes of this restoration plan, here the bankfull discharge is considered to be essentially equivalent to the dominant discharge, and serves a guiding value in many aspects of the restoration design.

As mentioned in Section 3.1, the bankfull elevation was identified in the field by Biohabitats personnel at surveyed cross sections. The bankfull elevation at each cross section was derived from all available indications including depositional features, changes in bank angle, vegetation, scour lines, and storm debris lines. Bankfull discharge was estimated by solving the Manning equation for discharge given the bankfull elevation, local channel geometry, slope, and roughness. Channel roughness, represented by Manning's "n", was approximated using the standard references Chow (1959) and Barnes (1967) based on field observations of bed material, channel geometry, and adjacent riparian vegetation.

For the purpose of comparison, a predicted bankfull discharge was also calculated for Glade Creek and the unnamed tributary using available North Carolina regression relationships for rural streams in

the Mountain physiographic province (Harman *et al.*, 1999). The rural regression relationships are expressed by the following equations:

$$A_{bkf} = 22.1\ A_w^{0.67}$$
$$Q_{bkf} = 115.7\ A_w^{0.73}$$
$$W_{bkf} = 19.9 A_w^{0.36}$$
$$D_{bkf} = 1.1 A_w^{0.31}$$

where A_w is watershed area in square miles (mi^2), A_{bkf} is the bankfull cross-sectional area in square feet (ft^2), Q_{bkf} is the bankfull discharge in cubic feet per second (cfs), W_{bkf} is the bankfull width in feet (ft), and D_{bkf} is the bankfull mean depth in feet (ft).

For the purpose of comparison, a predicted bankfull discharge was also calculated for Glade Creek and the unnamed tributary using available North Carolina regression relationships for rural streams in the Piedmont physiographic province (Harman *et al.*, 1999). The rural regression relationships are expressed by the following equations:

$$A_{bkf} = 21.43\ A_w^{0.68}$$
$$Q_{bkf} = 89.04\ A_w^{0.72}$$
$$W_{bkf} = 11.89 A_w^{0.42}$$
$$D_{bkf} = 1.50 A_w^{0.32}$$

The discharge was also estimated using the hydrologic model TR-20. The results of deriving Q_{bkf} from the different methods are listed below, along with the chosen design discharges.

Stream	**Bankfull Discharge**			**Peak Flow, TR-20**	**Design Discharge**
	Manning's Equation	**Mountain Regional Curve**	**Piedmont Regional Curve**		
Glade Creek					
Discharge (cfs)	X/S 1: 228	352	267	1-yr: 204	200
	X/S 2: 153			2-yr: 335	
Unnamed Tributary					
Discharge (cfs)	27	98	76	1-yr: 16	20
				2-yr: 23	

The existing channel cross section geometry data was used in the Manning's Equation and TR-20 estimates, making those estimates site specific. Bankfull indicators were more reliable at cross section 1 on Glade Creek. The Manning's Equation estimate at cross section 1 also falls within the bounds of the 1-year and 2-year discharge predictions from the TR-20 model output. The Regional Curve predictions are above the Manning's and TR-20 values, but the Manning's and TR-20 values fall reasonably within confidence intervals on the Piedmont curve, and within a reasonable range on the Mountain Curve. Therefore, the design discharges were determined using a combination of the Manning's Equation and TR-20 estimates.

3.3 Channel Morphology (pattern, dimension, profile)

The existing channel morphology exhibits several Rosgen Classifications over the project reaches of Glade Creek and the unnamed tributary (channel geometry is summarized in Table 4). The diagnostic classification, measured at stable riffle cross sections for both Glade Creek and the unnamed tributary is C4. C4 is what the entire channel would have been classified as before it experienced degradation.

However, the majority of the project channel reaches have experienced over-widening and incision, probably due to long-term increasing flows from forest conversion to pasture land upstream and from relatively short-lived increased runoff from clear-cutting in the watershed, and are classified as F4 and G4.

The existing C4 channel has a sinuosity of 1.2, a riffle cross sectional area of approximately 51 ft^2, and an average slope of 0.005.

3.4 Channel Stability Assessment

The entire Glade Creek reach and the downstream reach of the unnamed tributary that are proposed for restoration/enhancement were assessed in the field by Biohabitats using the Bank Erosion Hazard Index (BEHI) (Rosgen 2001). Approximately 62% of the Glade Creek channel within the project boundary has a BEHI rating of High, 33% has a rating of Very High and 5% has a rating of Moderate (see Table 5). The estimated total sediment export per year for the Glade Creek reach is 619 tons, based on the BEHI methodology and sediment export curves. The entire proposed restoration reach of the unnamed tributary has a BEHI rating of Very High, and the estimated total sediment export per year for the reach is 72 tons. The pervasive extent of high BEHI scores indicates that the channel is widening and migrating throughout most of the project reaches. Bank height ratios (BHR) were estimated while performing the BEHI analysis. Approximately 70% of the channel on Glade Creek had BHR's of 2 or more and all of the channel proposed for restoration on the UT has a BHR of >2. In the BEHI protocol, a bank height ratio greater than 1.5 is an indication of highly unstable banks.

Bedrock is present in a limited number of locations throughout the project reaches, but bank height ratios are greater than 1 throughout most of the project, and approach and exceed 2 in some places, indicating instability and downcutting of the channel.

3.5 Bankfull Verification

The 1- and 2-year water surface elevations predicted by HEC-RAS were compared with bankfull flows calculated based on field indicators using the Manning equation to help calibrate bankfull discharge estimates to be used in channel design. At both representative riffle cross sections on Glade Creek, the maximum depth predicted by the HEC-RAS program using the TR-20 discharge estimate coincided well with the maximum depth at the surveyed cross sections using the Manning's Equation discharge prediction, listed below.

Cross Section	Mannings Eq. Q (cfs)	TR-20 Q (cfs)	HEC-RAS d_{max} (ft)	Surveyed d_{max} (ft)
Glade 1	228	1-yr: 204	2.55	2.8
		2-yr: 335	3.33	
Glade 2	153	1-yr: 204	2.36	2.4
		2-yr: 335	3.14	
Unnamed Tributary	27	1-yr: 16	0.56	1.0
		2-yr: 23	0.71	

At the unnamed tributary cross section, the correlation was not as close, but it was within 0.4 ft of the midpoint between the two discharges. Therefore, the identified bankfull indicators in the field correlate well with the predictive estimates generated by Manning's Equation and HEC-RAS. In addition, the predicted discharges correlate well with the bankfull channel geometry identified in the field.

3.6 Vegetation

The riparian area along Glade Creek is in a relatively undisturbed, natural condition. The dominant canopy species there are white oak (*Quercus alba*), white pine (*Pinus strobus*) and red maple (*Acer rubrum*). The two dominant species in the understory/shrub layer are rhododendron (*Rhododendron maximum*) and mountain laurel (*Kalmia latifolia*). Other understory species included smooth alder (*Alnus serulata*), black cherry (*Prunus serotina*), multiflora rose (*Rosa multiflora*), and black willow (*Salix nigra*). The herbaceous layer, where the canopy is closed, is not present, but where there are openings it contains many grasses, including fescue (*Festuca* sp.), blackberry bushes (*Rubus* sp.) and various wild flowers, dominated by the Asteracae family.

4.0 Reference Stream

Basin Creek, located in Wilkes County in Doughton State Park, was used as the reference stream (Figure 5). It was surveyed by a team of NRCS and NCWRC personnel (Angela Jessup, Dick Everhart, Greg Goings, Jerry Pate and Joe Mickey) and by an NC SRI crew (Dan Clinton, Jan Patterson, Louise O'Hara and Jon Williams) in 1998. The original survey data from both surveys was acquired from the NC SRI. The data generated from those surveys was compared and used for design purposes. Biohabitats reviewed the stream in the field in May 2007 and determined from a walk of the stream from the downstream boundary of Doughton Park to above the confluence of Cove and Basin Creeks (approximately 2 miles of stream), that it was a stable, suitable reference reach.

4.1 Watershed Characterization

The Basin Creek watershed was delineated (see Figure 6) and the land uses within it are summarized below. The watershed is approximately 98% forested, and less than 1% developed.

Land Use In Basin Creek Watershed (Reference)

Land Use	Acreage	%
Deciduous Forest	3,963.2	91.3
Mixed Forest	139.2	3.2
Evergreen Forest	119.9	2.8
Pasture/Hay	59.2	1.4
Developed Open Space	20.7	0.5
Shrub Scrub	20.0	0.5
Woody Wetlands	13.6	0.3
Developed Low Intensity	6.2	0.1
Totals	4,342.0	100

4.2 Channel Classification

Based on the data collected in the field by both survey crews, the channel has a Rosgen Stream Type Classification of C4.

4.3 Discharge (bankfull, trends)

The reference bankfull discharge, estimated from the N.C. Mountain Regional Curve is approximately 425 cfs, and estimated from the N.C. Piedmont Regional Curve is approximately 300 cfs. The NRCS survey discharge estimate using Mannings Equation is approximately 375 cfs. The very high percentage of forest land cover in the watershed (98%) serves to stabilize and maintain bankfull discharge quantities, which in theory should remain unchanged unless the developed area within the watershed increases, generating more stormwater runoff that reaches the channel.

4.4 Channel Morphology (pattern, dimension, profile)

The reference channel has a sinuosity of 1.1, a riffle bankfull cross-sectional area of 57 square feet and an average slope of 0.014 (see Table 4).

4.5 Vegetation

The forest canopy is dominated by yellow poplar (*Liriodendron tulipifera*), white pine, red maple (*Acer rubrum*), hemlock (Tsuga canadensis) and sycamore (*Platanus occidentalis*). The understory is dominated by rhododendron and smooth alder along the stream. This community is most closely related to a Rich Cove Forest classification (Schafale and Weakley, 1990).

5.0 Project Site Wetlands (existing conditions)

5.1 Jurisdictional Wetlands

Wetlands on the site were evaluated based on the U.S. Army Corps of Engineers 1987 Wetland Delineation Manual. The presence or absence of three wetland parameters was documented (hydric soils, hydrophytic vegetation and wetland hydrology), following the guidance set forth in the Manual.

One jurisdictional wetland was delineated on Glade Creek and four jurisdictional wetlands were delineated on the unnamed tributary to Glade Creek (see Figure 4 for map and Appendix 2 for forms).

The areas of the individual wetlands are as follows:

Glade Creek wetlands:
Wetland 1-0.17 acres

Unnamed Tributary wetlands:
Wetland 1-0.009 acres
Wetland 2-0.034 acres
Wetland 3-0.033 acres
Wetland 4-0.087 acres

Total Wetland Area in Easement-0.33 acres

These wetland areas will not be disturbed, they will be preserved with the proposed project.

5.2 Soil Characterization

As previously noted, the mapping of soils in Alleghany County is currently under revision. The 1973 Soil Survey shows the area where the wetlands occur as Alluvial Land Wet, and does not include a detailed soil color description. However, based on field investigation and soil cores taken throughout the wetlands, the wetland soils present on the project site are Toxaway series soils (Cumulic Humaquepts). This conclusion is based on soil color and texture. The typical horizon description for the Toxaway series is 0-12 inches 10YR 3/1 loam, 12-25 inches 10YR 3/1 loam and 25-32 inches 10YR 4/1 loam. From the wetland delineation soil descriptions, the hydric soils found onsite are typically 7.5 YR or 10YR 2/1 sandy clay loams in the upper 18 inches of the profile, similar to the Toxaway series.

5.3 Plant Community Characterization

The wetland areas onsite are individually quite small, and the dominant woody vegetation occupying the wetlands is red maple. The herbaceous layer is often sparse, but where present, common rush (*Juncus effusus)* is dominant, along with various sedge species. These wetlands most closely resemble the High Elevation Seep community (Schafale and Weakley, 1990).

6.0 Project Site Restoration Plan

6.1 Restoration Project Goals and Objectives

The goals of the project are to:

- Rapidly stabilize the channel of Glade Creek relative to natural process,
- Rapidly stabilize and preserve the channel of the UT relative to natural process,
- Restore and rehabilitate channel features and aquatic habitat in Glade Creek and the UT,
- Rehabilitate the riparian buffer along both streams,
- Preserve the existing wetlands onsite.

These goals will be accomplished by designing and constructing a stable plan, profile and dimension for the stream channels and re-establishing continuous riparian buffers along the banks. Project implementation will greatly reduce bank erosion and consequently decrease the amount of sediment load in the stream at flows above baseflow. Restoration level (Rosgen Priority Level II) design is needed on all but 125 feet of the channel on the project, due to unstable channel geometry, sinuosity and streambank steepness. Structures will be used to enhance holding and feeding areas for trout. Riparian buffer vegetation will be established to provide food and cover for terrestrial fauna and to provide a carbon source and shade for aquatic habitat.

To meet the goals listed above, the proposed objectives for Glade Creek are to perform Restoration on approximately 2,430 linear feet (LF) and stabilize 125 LF with Enhancement I design. Please note that a 25-foot section of channel underneath the existing bridge was excluded from the proposed restoration total, although channel profile and dimension will be altered. The proposed objectives for the UT are to perform Restoration on approximately 275 LF and Preserve 570 LF. All the wetlands onsite will be preserved with the proposed project (see Table 1).

6.1.1 Designed Channel Classification

The designed channel classification, based on the existing channel substrate (D_{50}=12.5 mm) and the designed channel average slope (0.004), entrenchment ratio (>2.2), width/depth ratio (>12) and sinuosity (>1.2) is a Rosgen C4.

6.1.2 Designed Channel Structures

In order to provide stabilization to the newly graded channel, especially along outside meander banks, in-stream structures such as log vanes, rootwads, and large woody debris bundles will be utilized. The realignment of the channel will necessitate the removal of some trees (although the alignment was selected to minimize disturbance to mature trees) and this material will be utilized in these structures. Because this restoration is utilizing natural channel techniques and because there are very few man-made constraints on this project, we prefer to use wood structures rather than rock for bank stabilization. The logs used in these structures have a life expectancy of about 20 years which is plenty of time to establish native, riparian trees and shrubs to provide bank stabilization. Rock structures such as cross vanes and steps will be utilized to provide grade control and to quickly bring raised thalwegs down to meet existing elevations.

6.1.3 Target Buffer Communities

The site is located in a stream valley at an elevation of approximately 2,600 feet above mean sea level. This location can be characterized as transitional between relatively low elevation vegetation communities and high elevation communities. Accordingly, the stream buffer planting schedule (see Section 11, Table 6) incorporates species from several vegetation communities

described by Shafale and Weakley in the draft Fourth Approximation of the Classification of the Natural Communities of North Carolina. Those communities include Northern Hardwood Forest (Typic and Rich Subtype) and the Rich Cove Forest (Montane Intermediate Subtype). Two notable exceptions are the common occurrence of black willow and smooth alder along the existing channel, and their inclusion in the proposed planting schedule, and the absence of those two species from the Shafale and Weakley descriptions.

6.2 Sediment Transport Analysis

6.2.1 Methodology

For use as a guideline for sizing the substrate in the proposed restoration channel, a sediment competency analysis was undertaken, using shear stresses computed for the channel. The competency analysis provides an estimate of the local ability of the channel to move sediment for a given discharge and is embodied by estimating the local threshold grain size. For many engineering applications the threshold of sediment motion for an unisize or unimodal sediment can be characterized with the Shields criteria:

$$\tau_c^* = \frac{\tau'}{(s-1)\rho g D} \approx 0.045$$

where τ_c^* is the dimensionless critical Shields parameter (in this case assumed to be approximately 0.045), τ' is the grain stress (that component of the total boundary shear stress that acts upon the sediment grains populating the channel bed surface), *s* is the specific gravity of sediment (2.65), ρ is the density of water (1000 kg/m^3), *g* is the gravitational acceleration constant (9.81 m/s^2), and *D* is the median grain size of an unimodal sediment or the grain size of an unisize sediment (in meters when adopting the above values for the other parameters). When rearranged to solve for the critical grain size, the above equation is transformed to:

$$D = \frac{\tau'}{(s-1)\rho g \tau_c^*} \approx 1.37\tau'$$

where *D* is now in units of millimeters and τ' is expressed in Pascals (N/m^2). To estimate the threshold grain size for any location within the project reach, the total boundary shear stress acting on the channel was computed and then decomposed into the grain stress. For steady, uniform flow the local total boundary stress is provided by the depth-slope product:

$$\tau_o = \rho g R_h S$$

where τ_o is the total channel boundary shear stress, ρ and *g* are as defined before, R_h is the hydraulic radius, and *S* is the channel slope. In addition, the Manning's Equation holds for steady uniform flow:

$$U = \frac{C}{n} R_h^{2/3} S^{1/2}$$

where *U* is the mean channel velocity, C is a dimensioning coefficient (1.0 for SI units, 1.49 for Imperial units), and *n*, R_h, *S* and are as defined before. By using the Strickler Equation, a Manning's *n*-value attributable to the sediment roughness can be estimated:

$$n_D = 0.013 D^{1/6}$$

where n_D is the Manning's *n*-value and *D* is the sediment grain size in millimeters. When the above equations are combined, an equation for the stress decomposition can be developed:

$$\frac{\tau_o}{\tau'} = \left(\frac{n}{n_D} \right)^{3/2}$$

where all terms are as defined earlier. When this equation is folded into the Shields criteria, the following estimate for the threshold grain size is attained:

$$D = \left(\frac{0.00203 \tau_o}{n^{3/2}} \right)^{4/3}$$

where all terms are as defined earlier. This equation provides an estimate of the local threshold grain size at each cross-section for a given discharge (or shear stress).

6.2.2 Calculations and Discussion

The competency analysis provides an estimate of the local ability of the channel to move sediment for a given discharge and is embodied by estimating the local threshold grain size.

The local threshold grain size mobilized at bankfull discharge was computed for Glade Creek and the unnamed tributary for existing and proposed conditions. The list below summarizes the results of the computations.

	Computed Channel Shear (lbs/ft^2)	Threshold Diameter (mm)
Glade Creek		
Proposed (riffle)	0.39	10
Existing (riffle)	0.41	11
Unnamed Tributary		
Proposed (riffle)	0.17	3
Existing (riffle)	0.52	15

The reader will note that the Glade Creek proposed conditions are very similar to the existing conditions. This is because there was one riffle located on the restoration reach that, compared to the rest of the restoration reach, was stable, based on the data and field evidence. Data from this stable cross section were used to compute existing shear and particle threshold diameter. Shear stresses and particle threshold diameters in the remainder of the restoration reach are higher in the meanders and much lower in the F/G channel sections.

After numerous field reviews of the unnamed tributary channel, it was determined to be in a dynamic state and design parameters for restoration of the downstream end of the reach should allow for higher flows to access the floodplain more readily, thus reducing shear stress and particle sized threshold. Therefore, the shear stress and threshold diameter for the proposed channel are lower than existing.

6.3 HEC-RAS Analysis

6.3.1 No-rise, LOMR, CLOMR

As of July 2, 2007, there is no FEMA mapping for the project area, based on a review of the N.C. Flood maps website. The proposed project is a Rosgen Priority II stream restoration project, with no wetland restoration component, only wetland preservation. The hydrology of the site will not be significantly altered by the project. The Faw's property and the adjoining properties will not be hydrologically trespassed upon by the stream restoration project.

HEC-RAS (USACE, 2001) was used to model water surface elevations for existing conditions for a variety of discharges generated from TR-20. The peak 1-, 2-, 10-, and 100-year storm discharges were all modeled in HEC-RAS.

An existing conditions topographic basemap for the project reach was constructed in ArcGIS by merging the 1-foot contour interval channel survey conducted by Cavanaugh and Associates, PA with the 10-foot contour interval Alleghany County map. For existing conditions, topographic information from the Cavanaugh survey superceded that of the County basemap. These basemaps were then used in HEC-GeoRAS (version 3.1) to define and assemble the channel network topology, cross-sections, and reach lengths. Cross-sections were located at hydraulic control points (such as upstream and downstream of bridge culverts and at slope breaks), as well as at intermediate locations to capture changes to channel and overbank geometry. The cross-sections were oriented to be orthogonal to the local mean channel flow and anticipated overbank flow. Bridge and culvert geometry and hydraulic coefficients for the bridge were measured in the field during a site visit conducted in the Spring of 2007. The site visit also provided information on existing channel conditions and overbank vegetation so that the channel and overbank Manning's *n*-values could be estimated using a table of typical values found in Chow (1959).

In the absence of paired discharge-stage flow measurements on Glade Creek, model boundary conditions had to be assumed to be uniform flow with bed slopes estimated from the topographic basemaps. A subcritical flow regime was modeled, as there were no significant areas that would warrant calculations under mixed or supercritical conditions. Because of limited detailed survey data beyond the reach extents, boundary conditions were calculated by assuming that a local slope at the top and the slope from the downstream end of the bridge to the bottom of the reach extended beyond the reach.

6.4 Soil Restoration

6.6.1 Topsoil Salvage, Soil Testing and Nutrient Amendments

Where grading is performed for channel stabilization, the overlying 4-6 inches of topsoil will be stockpiled for redistribution over the site after grading is complete. Soil samples were collected onsite and were sent to the N.C. Department of Agriculture Soils Laboratory for analysis. The analysis report confirms the field assessment of the alluvial soils that occupy the project site, that they are loamy with a moderate to low bulk density and they will not require any more fertilization or lime application than is usually applied for tree seedling and live stake establishment.

6.5 Natural Plant Community Restoration

6.5.1 Narrative & Plant Community Restoration

The project site is approximately 2,600 feet above seal level, in the Blue Ridge Mountains. The planting schedule for riparian plantings (see Section 11, Table 6) reflects both the Piedmont/Mountain Levee Forest (Shafale and Weakley 1990) and the species already present on site. The trees, mid-story trees and shrubs species listed for Zone 1, Riparian Woodlands-Mesic are all common to the area and easily observed nearby. Many of the species are good food sources for wildlife and are adapted to the more well-drained areas of the site. The Zone 2-Floodplain Bench planting schedule lists a variety of willows, to be planted as live stakes to establish root systems quickly, stabilizing the soil in the active channel. Tag or smooth alder and river birch are listed as sub-canopy and canopy species, respectively. These species will grow taller than the willows and provide additional shading of the channel over the long term.

6.5.2 On-site Invasive Species Management

Multiflora rose is the only vegetative invasive species observed onsite, and it occurs mainly on the downstream end of the project. Mechanical control and herbicide will be used to control this species.

7.0 Performance Criteria

All performance criteria for this project are taken directly from the April 2003 Stream Mitigation Guidelines, as adopted by the USACE, EPA, NCWRC and NCDWQ, Monitoring Level 1.

7.1 Streams

Upon completion of the project, an as-built survey will be conducted, to document the dimension, pattern and profile of the restored channel. Permanent cross sections will be established with an approximate frequency of one per 20 bankfull-width lengths. The as-built survey will include photo documentation at all cross sections and structures, a plan view diagram, a longitudinal profile, vegetation information and a pebble count for at least 6 cross sections. The stream will be resurveyed each year and the survey data compared to the previous year. Success is defined as the documentation of no substantial aggradation or degradation of the channel or banks. Downcutting, deposition, bank erosion and an increase in sands or finer substrate material must be documented for assessment by the regulatory agencies.

7.2 Vegetation

Plant survival will be documented with survival plots and photographs. A minimum of 320 stems per acre must be surviving after year 3, 288 stems per acre after year 4 and 260 stems per acre after five years of monitoring.

7.3 Schedule / Reporting

Monitoring will be performed each year for 5 years with no less than 2 bankfull events documented throughout the period. If less than 2 bankfull events occur, then monitoring will continue until the second bankfull event is documented. The bankfull events must occur during separate years. In the event that the bankfull events do not occur during the five year period, the USACE and NCDWQ, in consultation with the resource agencies, may determine that further monitoring is not necessary.

The CVS-EEP Protocol for Recording Vegetation (Lee, 2007) will be used to document and track vegetation survival and growth.

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9.0 Tables

Table 1. Project Restoration Structure and Objectives

Restoration Segment / Reach ID	Station Range (Existing)	Restoration Type	Priority Approach	Existing Linear Footage or Acreage	Designed Linear Footage or Acreage
Glade Cr	0+00-22+15	Restoration	Rosgen II	2,215	2,210
Glade Cr	22+35-23+60	Enhancement I	Rosgen II	125	125
Glade Cr	23+60-25+69	Restoration	Rosgen II	219	220
UT to Glade Cr	0+00-3+00	Restoration	Rosgen II	300	275
UT to Glade Cr	3+00-10+88	Preservation		788	788

Table 2. Drainage Areas

Reach	Drainage Area (Acres)
Glade Mainstem	2,921.95
Unnamed Tributary	520.87
Total	3,442.82

Table 3. Land Use of Watershed

Land Use	Acreage	Percentage
Bottomland Forest / Hardwood Swamps	5	0.15%
Cultivated	16	0.46%
Deciduous Shrubland	3	0.10%
Evergreen Shrubland	16	0.45%
Mixed Hardwoods / Conifers	483	14.02%
Managed Herbaceous Cover	1,500	43.52%
Mixed Upland Hardwoods	1,226	35.57%
Mountain Conifers	165	4.79%
Southern Yellow Pine	27	0.77%
Unmanaged Herbaceous Cover-Upland	6	0.18%
Totals	3,446	100.00%

Table 4. Morphological Table

Table 4. Morphological Table					
Project Number X (Glade Creek Stream Restoration)					
Item	**Existing Conditions**	**Designed Conditions**	**Existing Conditions**	**Designed Conditions**	**Reference Reach**
LOCATION	Glade Creek	Glade Creek	Glade Creek Tributary	Glade Creek Tributary	Basin Creek
STREAM TYPE	C_E4/F4/G4	C4	C4	C4	C4
DRAINAGE AREA, Ac-Sq Mi	2,922 ac--4.6 sq mi	2,922 ac--4.6 sq mi	521 ac--0.8 sq mi	521 ac--0.8 sq mi	4,352 ac--6.8 sq mi
BANKFULL RIFFLE WIDTH, (W_{bkf}), ft	44.7	34	12.6	12	30.7
BANKFULL MEAN RIFFLE DEPTH (d_{bkf}), ft	1.41	1.56	0.8	0.7	1.9
MAXIMUM BANKFULL RIFFLE DEPTH (d_{max}), ft	2.3	2.2	1	1	2.5
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	31.7	22	16	18	16.4
BANKFULL RIFFLE X-SECTION AREA (A_{bkf}), ft^2	63	53	9.9	8.2	57.4
BANKFULL MEAN VELOCITY, fps	3.3	3.8	2	2.4	NA
BANKFULL DISCHARGE, cfs	200	200	20	20	NA
WIDTH FLOODPRONE AREA (W_{fpa}), ft	45	>76	13-25	>44	70
ENTRENCHMENT RATIO (ER)	6	>2.2	1.1-2	>2.2	2.3
MEANDER LENGTH (Lm), ft	66-403 (10)	136-261 (14)	66-93 (6)	75-84 (3)	350
RADIUS OF CURVATURE (R_c), ft	34-118 (8)	53-172 (17)	14-71 (10)	27-33 (6)	76-135 (NA)
BELT WIDTH (W_{blt}), ft	77-184 (8)	55-134 (15)	57-79 (7)	30-45 (5)	90-104 (NA)
MEANDER WIDTH RATIO	3.6-18.7	1.6-4.0	4.5-6.3	2.5-3.8	2.9-3.4
SINUOSITY	1.21	1.23	1.71	1.22	1.1
AVERAGE BANKFULL SLOPE (s), ft/ft	0.005	0.004	0.011	0.006	0.014
VALLEY SLOPE (s), ft/ft	0.0075	0.0075	0.019	0.019	0.017
POOL BANKFULL WIDTH (W_{pool}), ft	51	43	27	16	34-43
MAX. POOL DEPTH (D_{pool}), ft	5.7	4.4	3.5	2.2	3.1
POOL X-SECTION AREA (A_{pool}) ft^2	107	77.2	49	16	64.3
POOL TO POOL SPACING (P-P) ft	110-228 (7)	91-155 (15)	NA	31-56 (5)	224
BANK HT. RATIO	1.2-3	≤1	≥2	≤1	≤1
MATERIALS					
CHANNEL SIZE DISTRIBUTION					
D16, mm	0.136	NA	0.3	NA	0.17
D35, mm	0.87	NA	11	NA	29
D50, mm	12.5	NA	27	NA	58
D84, mm	114	NA	85	NA	180
D95, mm	2656	NA	115	NA	300

NOTE: Radius of curvature is measured along the bankfull elevation along the outside of the meander for the existing and proposed conditions For the reference reach, measurement protocol is not known.

NOTE: Sinuosity is the thalweg length/valley length for the existing and proposed conditions.

NOTE: Floodprone widths and entrenchment ratios are estimated for the proposed conditions. They will be defined at the next submittal.

NOTE: Number in parantheses indicates number of data points used to determine the ratio for the item.

Table 5. BEHI/NBS and Sediment Export Estimate for Project Site Streams

Time Point	Segment/ Reach	Linear Footage or Acreage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	Ton/y
Pre-Project	0+00-15+75	1,575						100							425
	15+75-22+00	625				100									144
	22+00-23+50	150								100					0
	23+50-25+69	219				100									50
Unnamed Tributary	0+00-3+15	315				100									72
TOTALS		3,545													691

Table 6. Designed Vegetative Communities (by zone)

PLANT COMPOSITION SCHEDULE[1]

NOTE: EACH TREE SPECIES SHOULD COMPRISE AT LEAST 10% AND NO MORE THAN 25% OF THE TOTAL STEMS PLANTED IN EACH VEGETATION STRATA-A MINIMUM OF 680 STEMS PER ACRE WILL BE OF PLANTED IN ZONE 1-A MINIMUM OF 1,210 STEMS PER ACRE WILL BE PLANTED IN ZONE 2. (The taxonomic standard follows Flora of the Carolinas, Virginia Georgia and Surrounding Areas by Alan S. Weakley)

Zone 1: Riparian Woodlands - Mesic **Size (acres): 3.6**

Overall Spacing (feet off center)	Quantity per acre	Maximum Frequency (%)	Maximum Stem Quantity	Vegetation Strata/ Species Name	Common Name	Unit Type[2]	Size[3]	Spacing Type	Individual Spacing (ft.)
14	226			**TREES: Minimum of 5 Species, Minimum # of Trees = 230**					
		N/A	N/A	*Quercus alba*	White Oak	c, bb	2" dbh min	Random	200
		N/A	N/A	*Pinus strobus*	White Pine	c, bb	2" dbh min	Random	200
		N/A	N/A	*Tsuga canadensis*	Eastern Hemlock	c, bb	2" dbh min	Random	200
		20	163	*Quercus rubra*	N. Red Oak	br, c, t	18-36"	Random	31
		20	163	*Betula alleghansiensis*	Yellow Birch	br, c, t	18-36"	Random	31
		20	163	*Liriodendron tulipifera*	Yellow Poplar	br, c, t	18-36"	Random	31
		20	163	*Tilia americana*	Basswood	br, c, t	18-36"	Random	31
		20	163	*Platanus occidentalis*	Sycamore	br, c, t	18-36"	Random	31
		20	163	*Betula nigra*	River Birch	br, c, t	18-36"	Random	31
		20	163	*Acer saccharum*	Sugar Maple	br, c, t	18-36"	Random	31
		20	163	*Acer rubrum*	Red Maple	br, c, t	18-36"	Random	31
		20	163	*Prunus serotina*	Black Cherry	br, c, t	18-36"	Random	31
			815	**TOTAL**					
14	226			**MIDSTORY TREES: Minimum of 5 Species, Minimum # of Trees = 230**					
		20	163	*Carpinus caroliniana*	Ironwood	br, c, t	18-36"	Random	31
		20	163	*Ostrya virginiana*	American Hophornbeam	br, c, t	18-36"	Random	31
		20	163	*Ilex opaca*	Holly	br, c, t	18-36"	Random	31
		20	163	*Oxydendron arboretum*	Sourwood	br, c, t	18-36"	Random	31
		20	163	*Amelanchier arborea*	Serviceberry	br, c, t	18-36"	Random	31
		20	163	*Chionanthus virginicus*	Fringetree	br, c, t	18-36"	Random	31
		20	163	*Cornus florida*	Flowering Dogwood	br, c, t	18-36"	Random	31
			815	**TOTAL**					
14	226			**SHRUBS: Minimum of 5 Species, Minimum # of Shrubs = 230***					
		20	163	*Lindera benzoin*	Spicebush	br, c, t	18-36"	Random	31
		20	163	*Sambucus canadensis*	Elderberry	br, c, t	18-36"	Random	31
		20	163	*Calycanthus florida*	Sweetshrub	br, c, t	18-36"	Random	31
		20	163	*Callicarpa americana*	American Beautyberry	br, c, t	18-36"	Random	31
		20	163	*Hydrangea arborescens*	Wild Hydrangea	br, c, t	18-36"	Random	31
		20	163	*Symplocos tinctoria*	Horse Sugar	br, c, t	18-36"	Random	31
		20	163	*Rhododendron maximum*	Rhododendron	br, c, t	18-36"	Random	31
		20	163	*Hamamelis virginiana*	Witchhazel	br, c, t	18-36"	Random	31
			815	**TOTAL**					
8			**2,445**	**GRAND TOTAL**					

Zone 2: Floodplain Bench **Size (acres): 2.2**

Overall Spacing (feet off center)	Quantity per acre	Maximum Frequency (%)	Stem Quantity	Vegetation Strata/ Species Name	Common Name	Unit Type	Size	Spacing Type	Individual Spacing (ft.)
7	870		**LIVE STAKES: Min. # of Stems = 870**						
		34	651	*Salix nigra*	Black Willow	live stake	2-3'	Random	12
		33	632	*Salix sericea*	Silky Willow	live stake	2-3'	Random	12
		33	632	*Cornus amomum*	Silky Dogwood	live stake	2-3'	Random	12
			1,915	**TOTAL**					
16	340		**SHRUB AND TREES: Minimum # = 340**						
		34	254	*Sambucus canadensis*	Elderberry	br, c, t	18-36"	Random	19
		33	247	*Alnus serrulata*	Tag Alder	br, c, t	18-36"	Random	20
		33	247	*Betula nigra*	River Birch	br, c, t	18-36"	Random	20
			748	**TOTAL**					
6			**2,663**	**GRAND TOTAL**					

[1]All planting stock provided shall be secured from a local producer located in the mountain physiographic province, not more than 200 miles from the site. Planting shall occur during the last full week of February through March. Bare root material must be stored in a refrigerated truck from nursery pick-up to no more than 30 minutes before planting. All planting stock must be stored properly before planting to avoid freezing or dessication, and must be approved by the Designer before it can be planted. Bare root seedlings that have been shipped by commercial carriers will not be accepted. If proper care of the material has not been taken, the material will be rejected for planting.

[2] unit type c, bb = container or balled in burlap, unit type br, c, t = bare root, container or tubling. NOTE-White Oak, White Pine and Eastern Hemlock minimum size is 2" dbh. At least 10 stems of each of these species must be planted if available. There should be at least 50 feet between 2" dbh stems and at least 200' between 2" dbh stems of the same species.

[3]Sizes listed are recommended, but are not meant to be a restriction in size.

Acres= 3.6

Lbs./Ac	Frequency (%)	Lbs per Species	Species Name	Common Name	Unit	Additional Amendment	Quantity LBS/AC
ZONE 1 RIPARIAN WOODLANDS-MESIC PERMANENT HERBACEOUS SEED							
40-rye	100	144.0	*Secale cereale*	Rye grain	LB of P.L.S. 76 %	Ground Limestone	4,000
30-other	20	21.6	*Panicum virgatum*	Switchgrass	LB of P.L.S. 76 %	Organic Fertilizer	320
species	20	21.6	*Dicanthelium clandestinium*	Deer tongue	LB of P.L.S. 76 %	Straw Mulch	4,000
combined	10	10.8	*Sorghastrum nutans*	Indian grass	LB of P.L.S. 76 %		
	10	10.8	*Elymus virginicus*	Virginia wild rye	LB of P.L.S. 76 %		
	10	10.8	*Tridens flavus*	Purpletop	LB of P.L.S. 76 %		
	5	5.4	*Andropogon glomeratus*	Bluestem	LB of P.L.S. 76 %		
	5	5.4	*Rudbeckia hirta*	Black-eyed susan	LB of P.L.S. 76 %		
	5	5.4	*Baptista australis*	Blue false indigo	LB of P.L.S. 76 %		
	5	5.4	*Daucus carota*	Queen Anne's lace	LB of P.L.S. 76 %		
	5	5.4	*Senna hebecarpa*	Wild senna	LB of P.L.S. 76 %		
	5	5.4	*Parthenium integrifolium*	Wild quinine	LB of P.L.S. 76 %		
	100	**252.0**	**= Total LBS**				

1. APPLY SOIL AMENDMENTS EVENLY AND INCORPORATE TO A DEPTH OF 4-6 INCHES. LOOSEN SURFACE JUST BEFORE BROADCASTING.
2. MULCH MUST COVER 75% OF THE GROUND SURFACE.

Acres= 2.2

Lbs./Ac	Frequency (%)	Lbs per Species	Species Name	Common Name	Unit	Additional Amendment	Quantity LBS/AC
ZONE 2 FLOODPLAIN BENCH PERMANENT HERBACEOUS SEED							
40-rye	100	88.0	*Secale cereale*	Rye grain	LB of P.L.S. 76 %	Ground Limestone	4,000
30-other	12.5	8.3	*Veronia noveboracensis*	New York ironweed	LB of P.L.S. 76 %	Organic Fertilizer	320
species	12.5	8.3	*Helianthus angustifolia*	Swamp sunflower	LB of P.L.S. 76 %	Straw Mulch	4,000
combined	10	6.6	*Chasmanthium latifolium*	River oats	LB of P.L.S. 76 %		
	60	39.6	*Panicum virgatum*	Switchgrass	LB of P.L.S. 76 %		
	5	3.3	*Coreopsis lanceolata*	Lance-leaf coreopsis	LB of P.L.S. 76 %		
	100	**154.1**	**= Total LBS**				

1. APPLY SOIL AMENDMENTS EVENLY AND INCORPORATE TO A DEPTH OF 4-6 INCHES. LOOSEN SURFACE JUST BEFORE BROADCASTING.
2. MULCH MUST COVER 75% OF THE GROUND SURFACE.

TEMPORARY HERBACEOUS SEED

Date	Species Name	Common Name	Unit	Additional Amendment	Quantity LBS/per acre
Jan.1-May 15	*Secale cereale*	Rye grain	LB of P.L.S. 76 %		35
				Ground Limestone	4,000
				Organic Fertilizer	320
				Straw Mulch	4,000
May 15-Aug.15	*Setaria italica*	German millet	LB of P.L.S. 76 %		40
				Ground Limestone	4,000
				Organic Fertilizer	320
				Straw Mulch	4,000
Aug. 15-Dec. 31	*Secale cereale*	Rye grain	LB of P.L.S. 76 %		35
				Ground Limestone	4,000
				Organic Fertilizer	320
				Straw Mulch	4,000

Notes:

1. SELECT AN APPROPRIATE TEMPORARY SPECIES BASED ON THE DATES GIVEN.
2. AVOID SEEDING IN DECEMBER OR JANUARY. IF NECESSARY TO SEED AT THESE TIMES, USE RYE GRAIN AND A SECURELY TACKED MULCH.
3. APPLY SOIL AMENDMENTS EVENLY AND INCORPORATE TO A DEPTH OF 4-6 INCHES. LOOSEN SURFACE JUST BEFORE BROADCASTING.
4. MULCH MUST COVER 75% OF THE GROUND SURFACE.

10.0 Figures

Figure 1. Project Site Vicinity Map

Glade Creek Stream Restoration

Alleghany County, North Carolina
December 2007

0 0.25 0.5 1 1.5 2 Miles

Legend

Project Boundary

USGS Quad Sheet Glade Valley

Ecosystem Enhancement Program

Biohabitats Southeast Bioregion

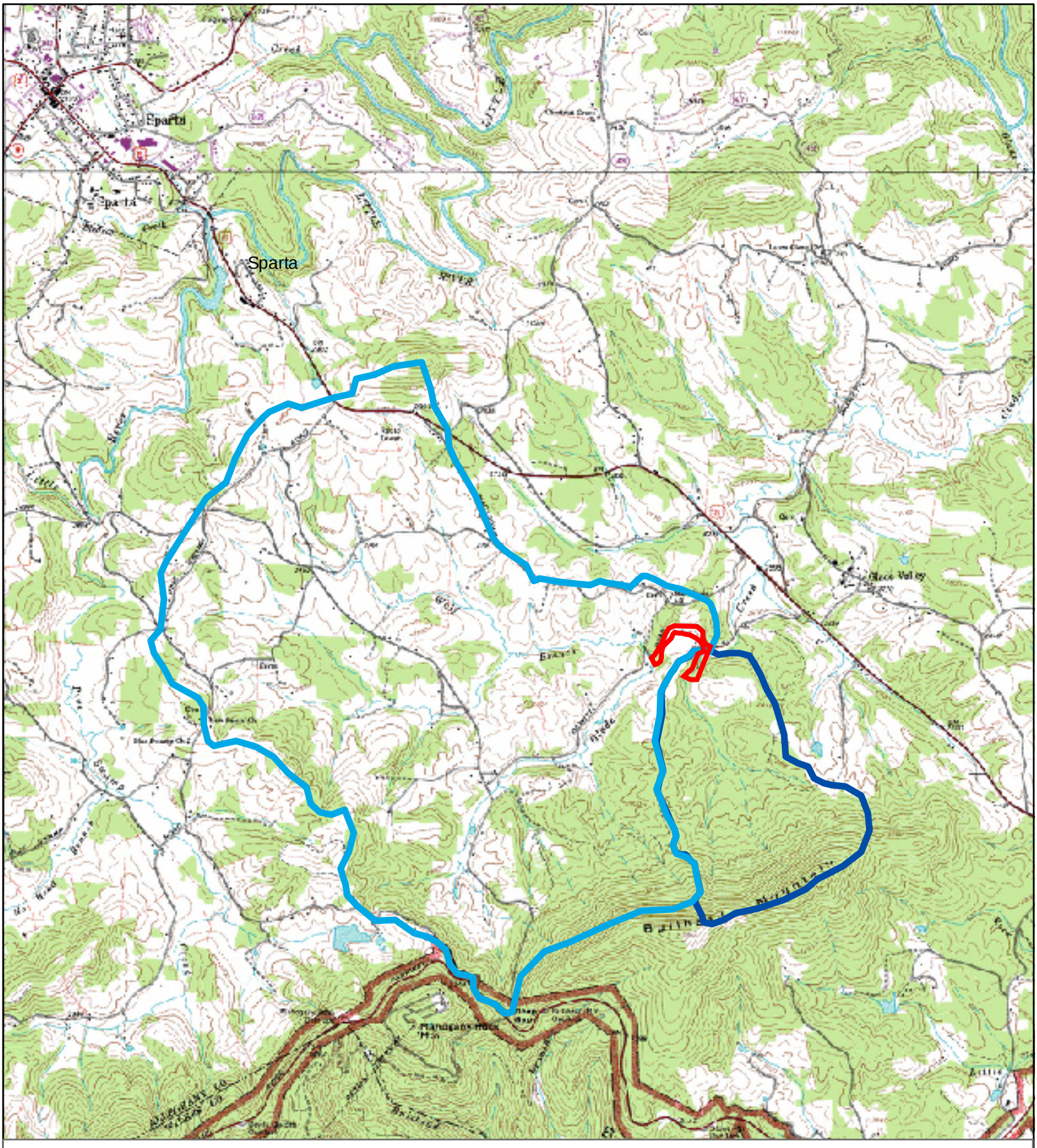

Figure 2. Project Site Watershed Map

Glade Creek Stream Restoration

Alleghany County, North Carolina

December 2007

Ecosystem Enhancement Program

Biohabitats
Southeast Bioregion

Figure 3. Project Site NRCS Soil Survey Map

Glade Creek Stream Restoration

Alleghany County, North Carolina

December 2007

0 62.5 125 250 375 500 Feet

Legend

Project Boundary

Streams

Soil Types

- Alluvial land, Ad
- Chandler silt loam, 25-45% slope, CaF
- Chandler stony silt loam, 25-45% slope, CdG
- Chester loam, 10-25% slopes, CeE
- Chester loam, 2-6% slope, CeB
- Chester loam, 6-10% slopes, CeC
- Tusquitee loam, 6-10% slopes, TIC
- Watauga loam, 10-25% slopes, WaE
- Watauga loam, 6-10% slopes, WaC
- Watauga stony loam, 15-45% slopes, WaF

Ecosystem Enhancement Program

Biohabitats Southeast Bioregion

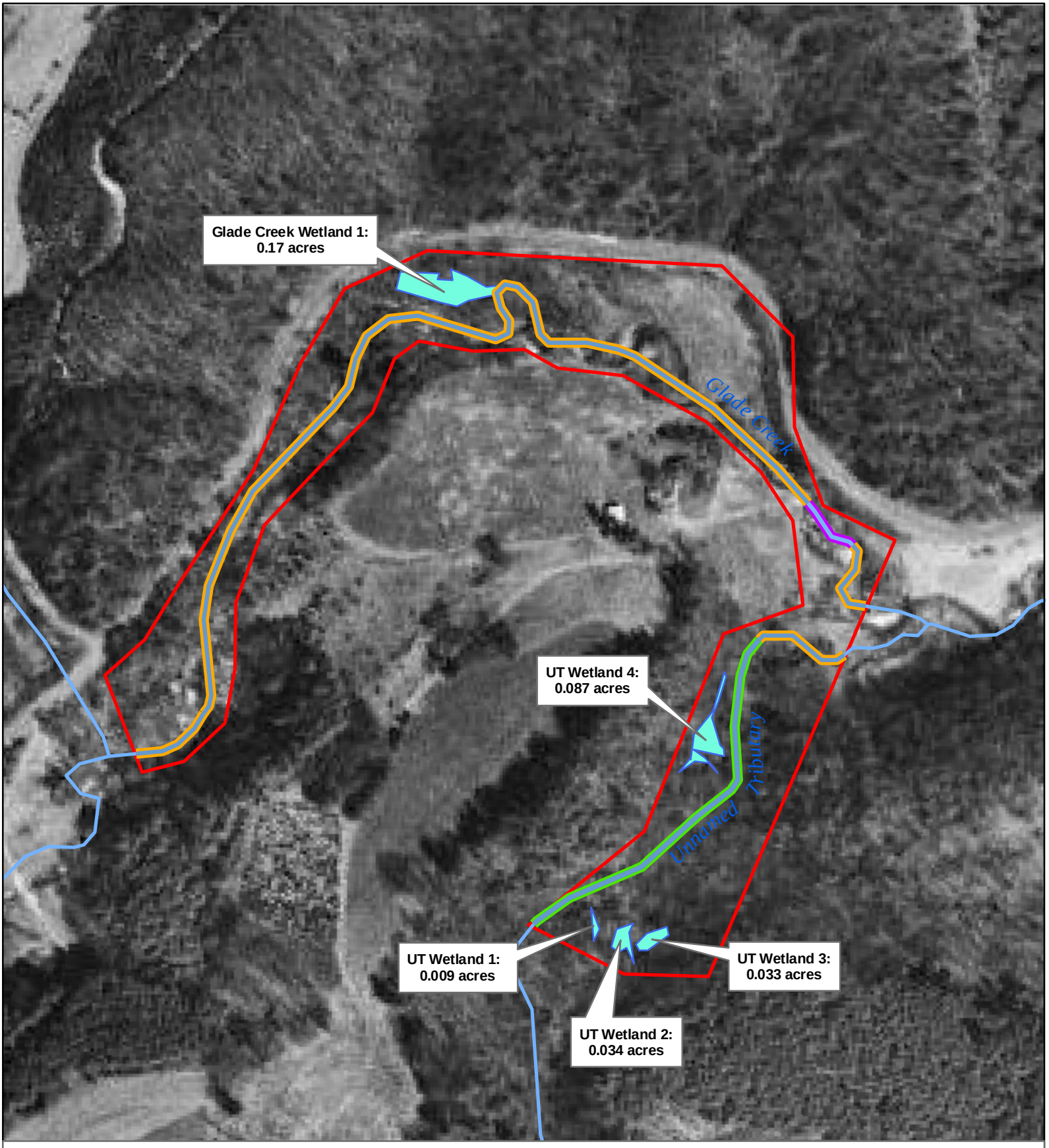

Figure 4. Project Site Hydrological Features and Wetland Delineation

Glade Creek Stream Restoration

Alleghany County, North Carolina

December 2007

0 62.5 125 250 375 500 Feet

Legend

- Project Easement Boundary
- Wetlands
- Streams

Proposed Mitigation

- Preservation
- Enhancement I
- Restoration

Ecosystem Enhancement Program

Biohabitats Southeast Bioregion Incorporated

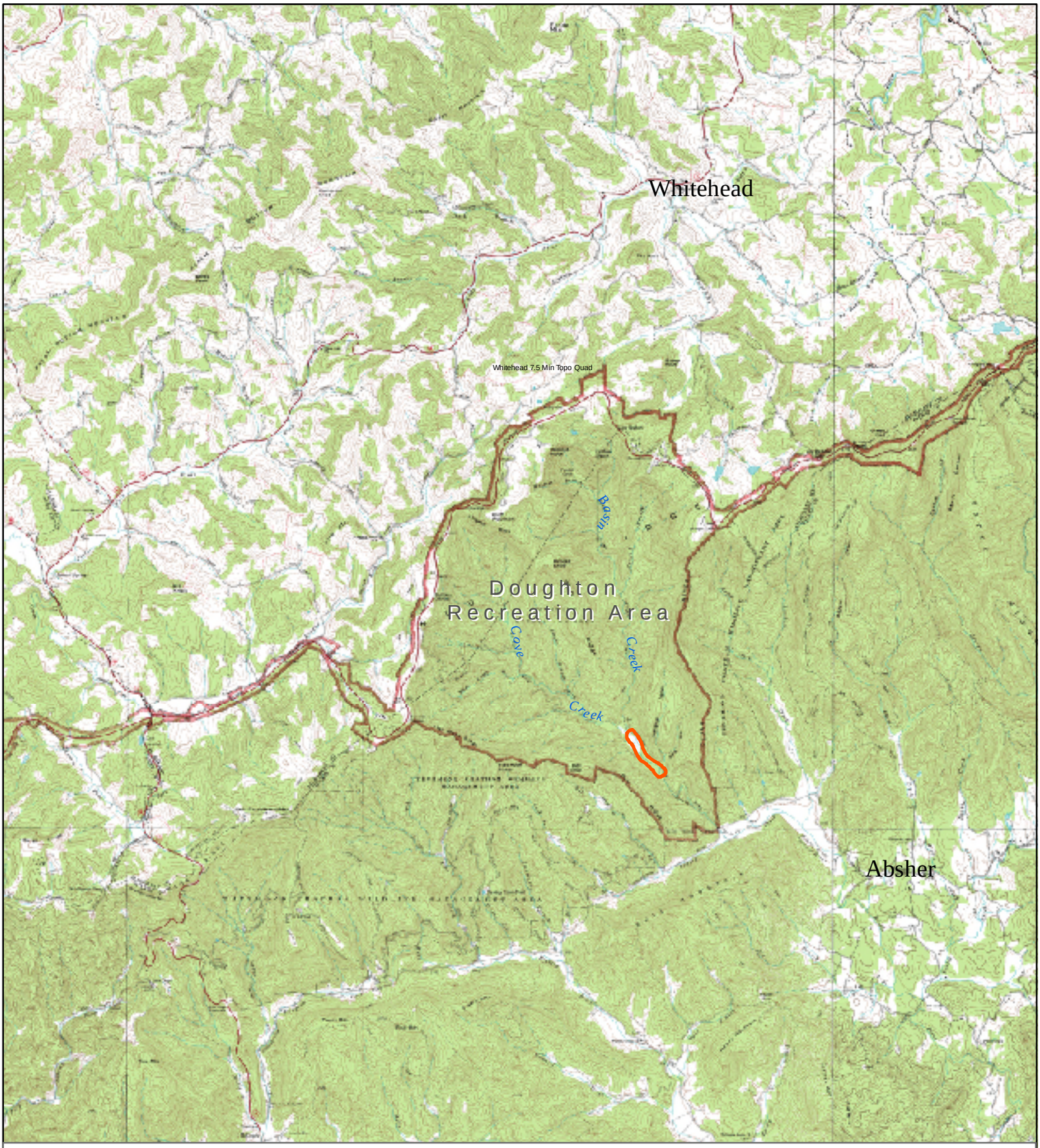

Figure 5. Reference Site Vicinity Map

Glade Creek Stream Restoration

Alleghany County, North Carolina

December 2007

Legend

Reference Reach Site

Ecosystem Enhancement Program

Biohabitats Southeast Bioregion

Figure 6. Reference Site Watershed Map

Glade Creek Stream Restoration

Alleghany County, North Carolina

December 2007

0 312.5 625 1,250 1,875 2,500 Feet

Legend

- Reference Site Watershed Boundary
- Reference Reach Site

Ecosystem Enhancement Program

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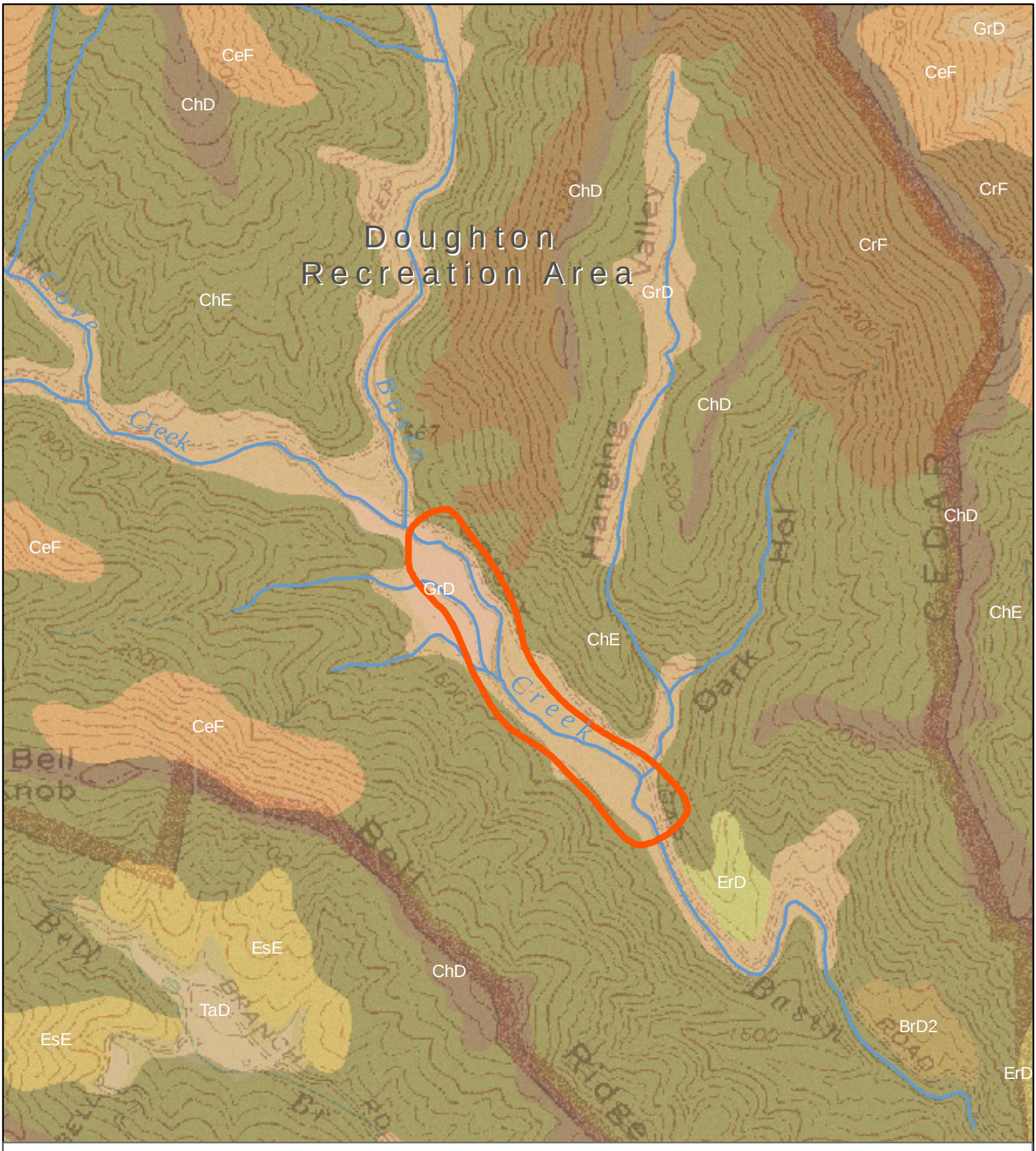

Figure 7. Reference Site NRCS Soil Survey Map

Glade Creek Stream Restoration

Alleghany County, North Carolina

December 2007

0 250 500 1,000 1,500 2,000 Feet

Legend

- Reference Reach Site
- Streams/Creeks

Reference Reach Site Soils

- Braddock clay loam, 8-25%, BrD2
- Chestnut-Ashe, 25 to 90 % slopes, CeF
- Chestnut-Edneyville, 25-60% percent slopes, ChE
- Chestnut-Edneyville, 8 to 25 % slopes, ChD
- Cleveland-Rock outcrop, 8 to 90 % slopes, CrF
- Evard gravelly sandy loam, 15 to 25 % slopes, ErD
- Evard-Cowee complex, 25 to 60 % slopes, EsE
- Greenlee-Ostin complex, 3 to 40 % slopes, GrD
- Tate fine sandy loam, 8 to 25 % slopes, TaD

Ecosystem Enhancement Program

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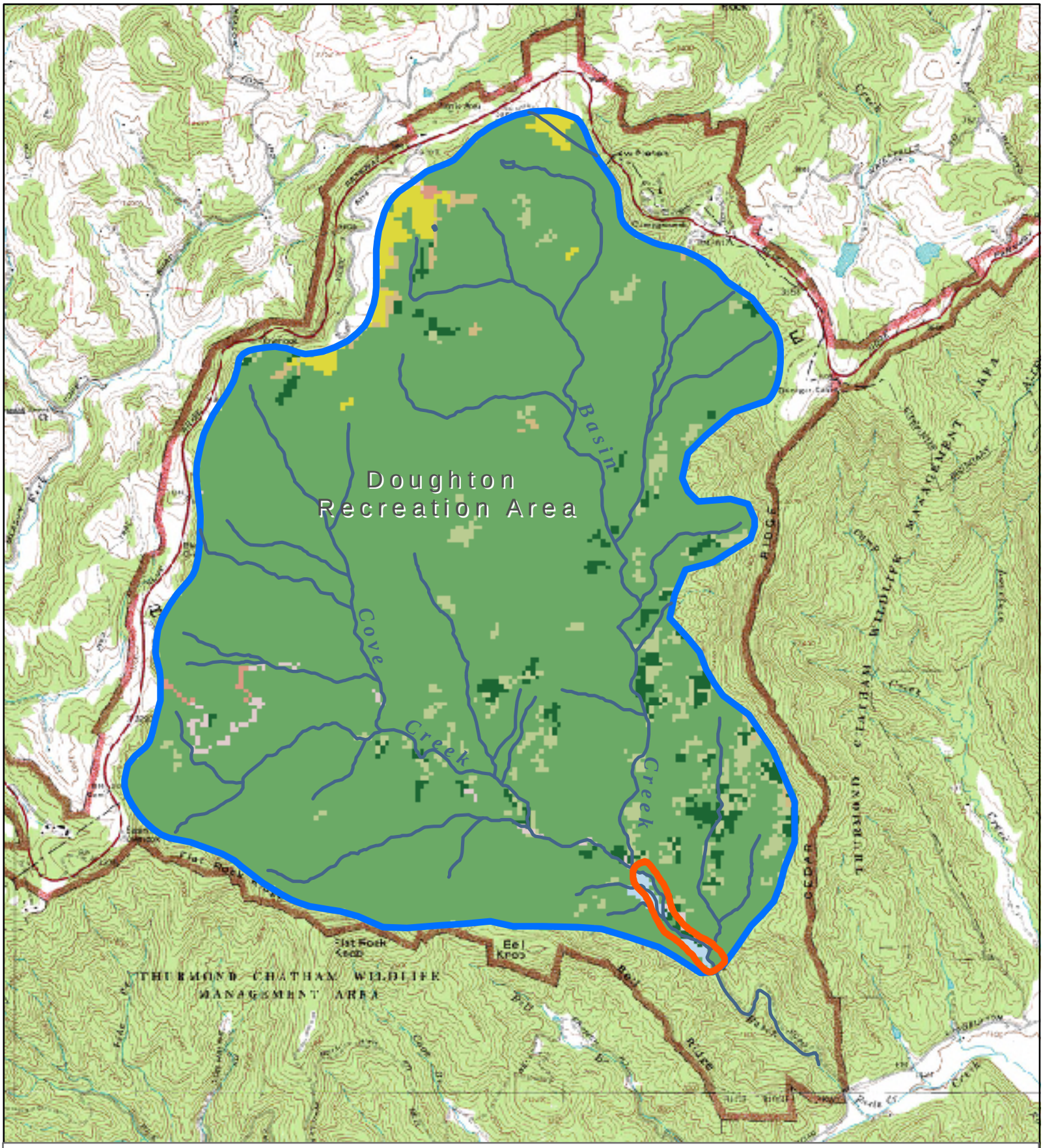


Figure 8. Reference Site Vegetation Communities Map

Glade Creek Stream Restoration

Alleghany County, North Carolina

December 2007

Legend

- Reference Reach Site
- Reference Site Watershed Boundary

Land Cover Type

- Deciduous Forest
- Developed Low Intensity
- Developed Open Space
- Evergreen Forest
- Mixed Forest
- Pasture/Hay
- Shrub Scrub
- Woody Wetlands

Ecosystem Enhancement Program

Biohabitats Southeast Bioregion

11.0 Designed Sheets

Sheet 1. Cover

Sheet 2. Designed Channel Alignment

Sheet 3. Geometry

Sheet 4. Longitudinal Profile

Sheet 5. Longitudinal Profile

Sheet 6. Restoration Plan

Sheet 7. Restoration Plan

Sheet 8. Restoration Plan

Sheet 9. Restoration Plan

Sheet 10. Restoration Plan

Sheet 11. Restoration Plan

Sheet 12. Details

Sheet 13. Details

Sheet 14. Details

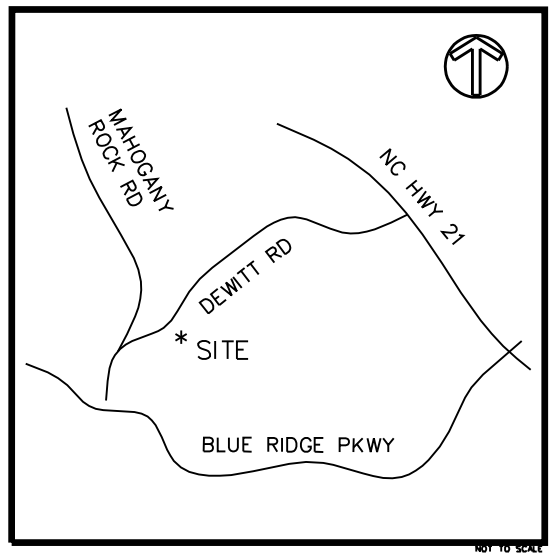
Sheet 15. Typical Cross Sections

Sheet 16. Planting Plan

GLADE CREEK
STREAM RESTORATION

LEGEND FOR DRAWINGS

- EXISTING TREE
- 352 EXISTING CONTOUR
- EXISTING THALWEG
- PROPOSED THALWEG
- PROPOSED BANKFULL LIMITS
- CONSERVATION EASEMENT
- LOD LIMIT OF DISTURBANCE
- SCE STABALIZED CONSTRUCTION ENTRANCE
- PLANTING ZONE 1
- PLANTING ZONE 2
- R.O.W. RIGHT OF WAY
- WETLANDS
- LOG VANE
- ROCK VANE
- ROCK J-VANE
- ROCK CROSS VANE
- ROCK TOE
- ROOTWAD WITH LARGE WOODY DEBRIS DEFLECTOR
- STEP POOLS



SITE VICINITY MAP

INDEX OF SHEETS

REVISIONS

Mark	Description	Date	Appr.

North Carolina
Ecosystem Enhancement Program
2728 Capitol Blvd, Suite 1H 103
Raleigh, NC 27604
Tel:919-715-0476

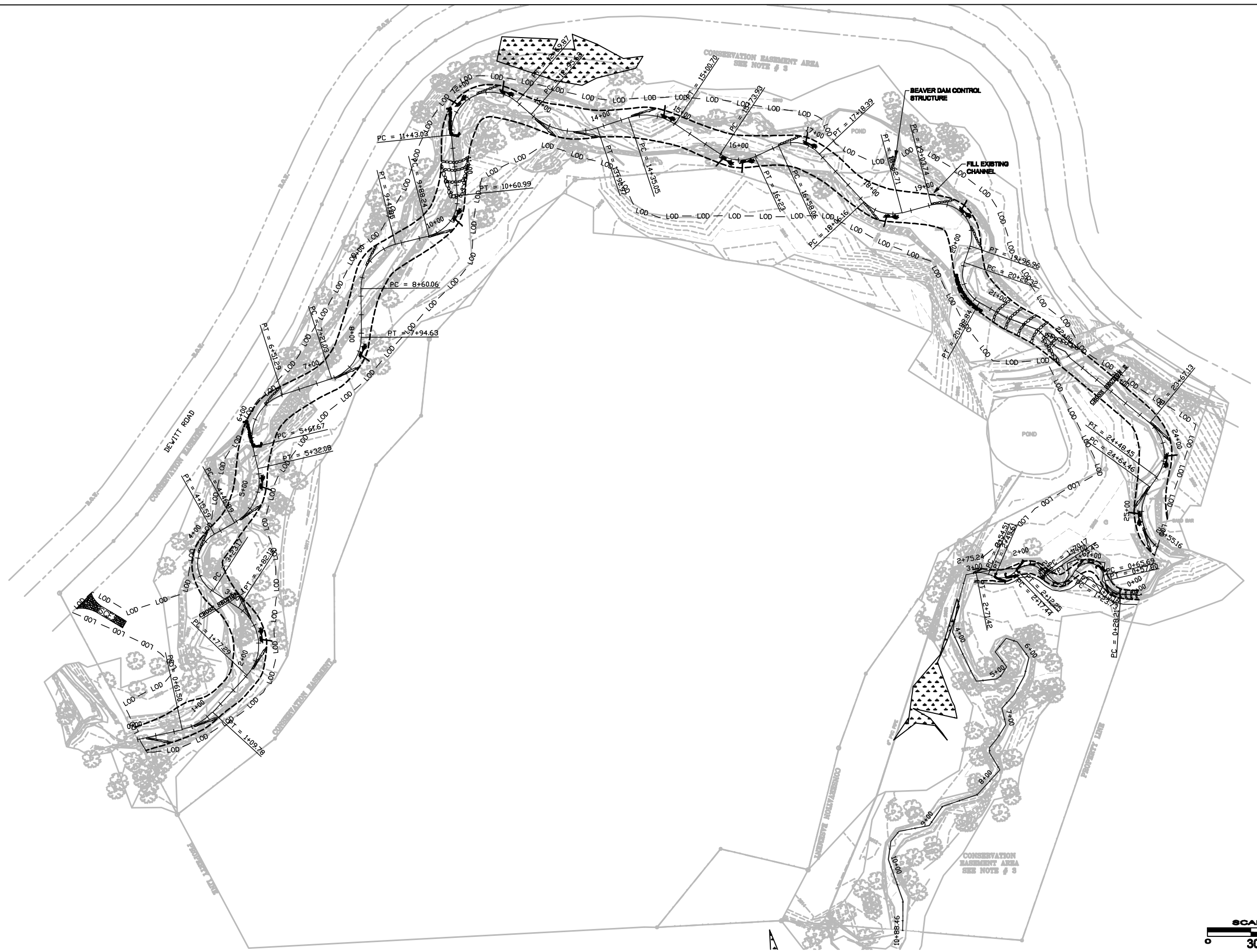
BIOHABITATS, INC.
The Stables Building
2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0156 Fax: 410-554-0168
www.biohabitats.com
Inspiring Ecological Stewardship

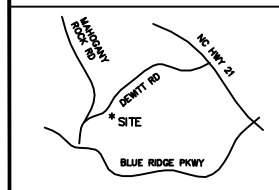
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE:
STREAM RESTORATION

PROJECT NO.: 06801.03
SCALE:
SEAL:
DESIGNED BY: VLS/KTN
DRAWN BY: JPW
CHECKED: JXR/EMM
APPROVED:
DATE: JUNE 2007
DWG. NO.:
1 OF 16





VICINITY MAP
(N.T.S.)

Mark	Description	Date	Appr.

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Ecosystem Enhancement Program
2728 Capital Blvd, Suite 1H 168
Raleigh, NC 27604
Tel:919-715-0476

BIOHABITATS, INC
The Baltimore Building
2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0165 Fax: 410-554-0166
www.biohabitats.com
Inspiring Ecological Stewardship

GLADE CREEK STREAM RESTORATION

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

Title: **DESIGNED CHANNEL ALIGNMENT**

Project No.: 08001.05	Scale: 1" = 60'-0"
File:	Designed: VLS/KTN
	Drawn: JPR
	Checked: JOW/BM
	Approved:
	Date: JUNE 2007
	Sheet No.: 2 OF 16

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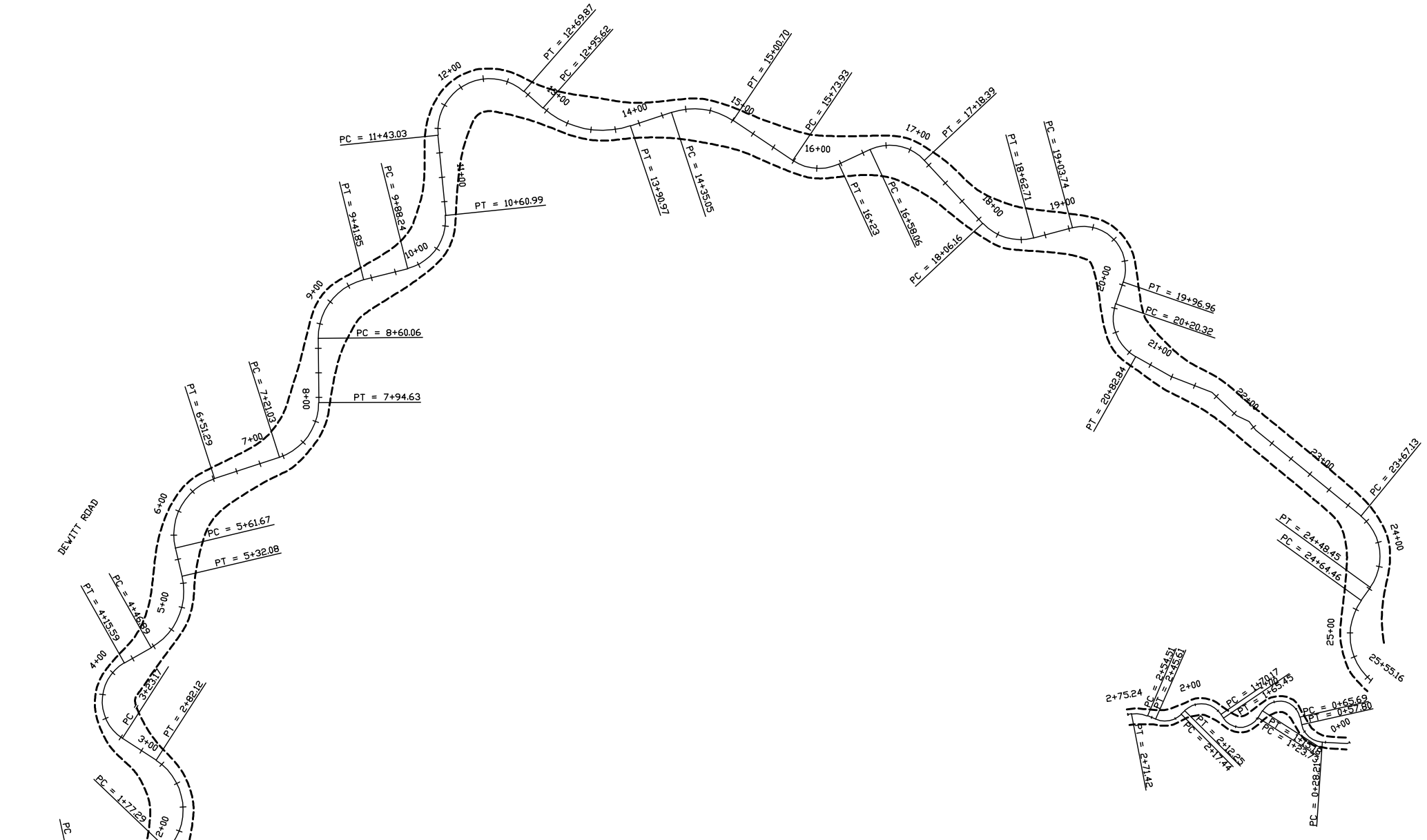

N

SCALE
0 30 60

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Ecosystem Enhancement Program
2728 Capital Blvd, Suite 1H 168
Raleigh, NC 27604
Tel:919-715-0476

BIOHABITATS, INC.
The Baldwin Building
2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0185 Fax: 410-554-0186
www.biohabitats.com
Inspiring Ecological Stewardship

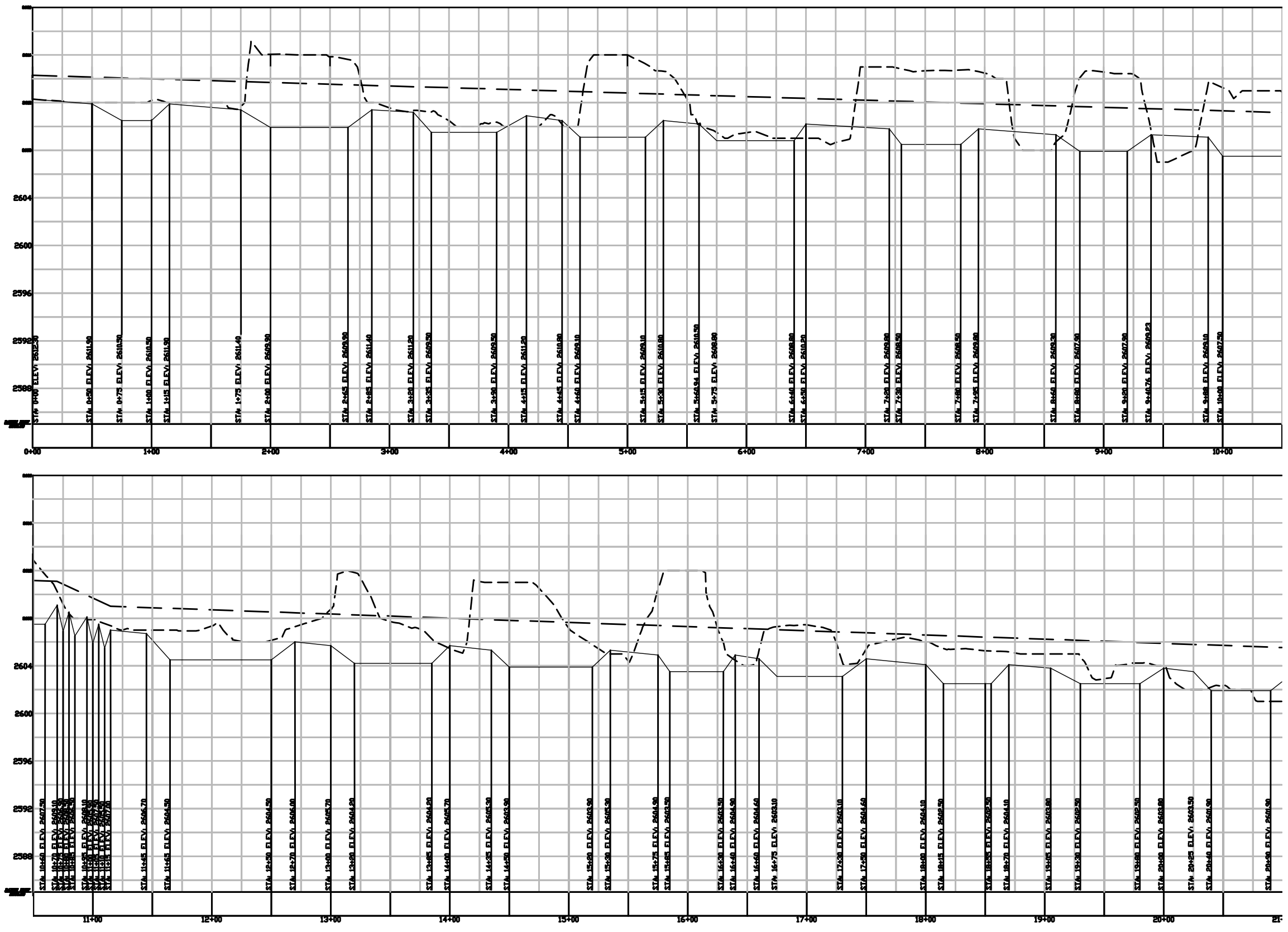
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE
STREAM RESTORATION

PROJECT NO.: 05691.03	SCALE: 1" = 60'-0"
CAD:	DESIGNED: VLEWIN / DRAWN: JPW
CHECKED: JOWENN	APPROVED:
	DATE: JUNE 2007
	SHEET NO.: 3 OF 16

RESTORATION PLAN SUBMITTAL



LEGEND

- PROPOSED BANKFULL WATER SURFACE
- EXISTING GROUND
- PROPOSED THALWEG

Mark	Description	Date	Appr.

North Carolina
Ecosystem Enhancement Program
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Tel:919-715-0476

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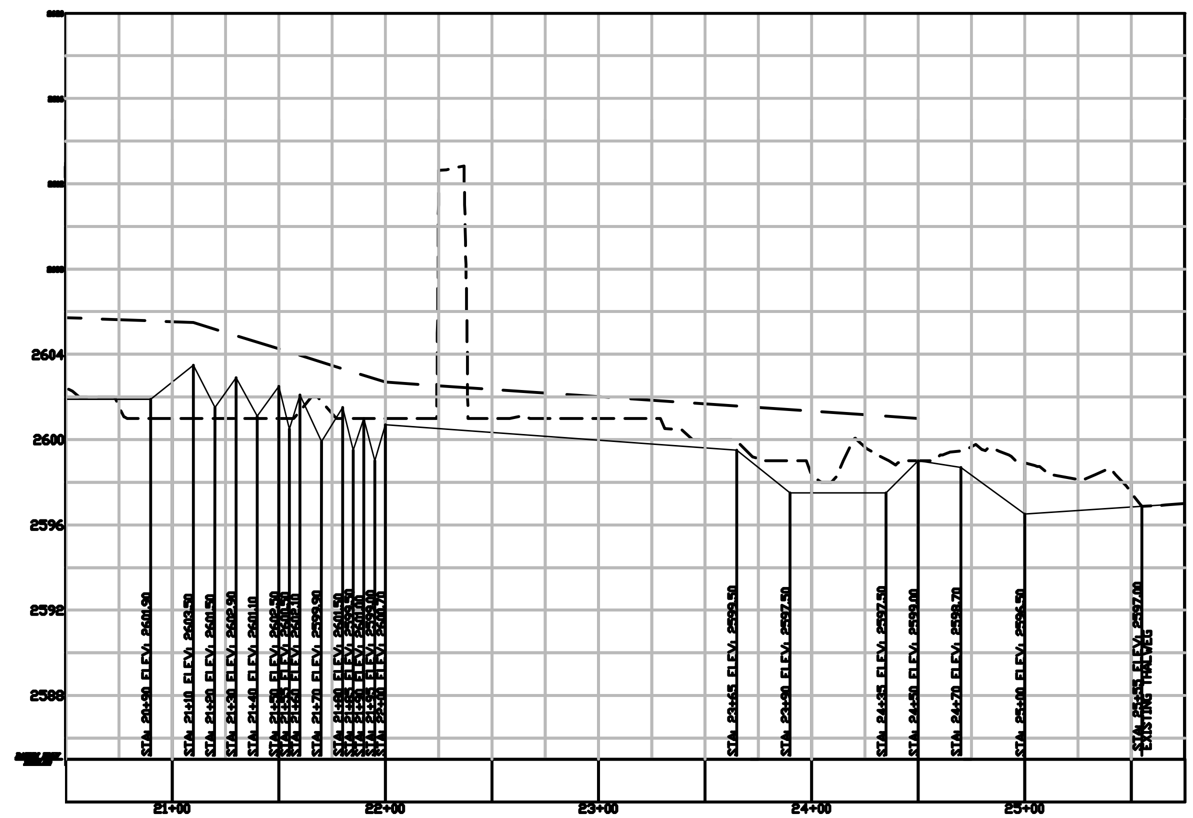
Inspiring Ecological Stewardship

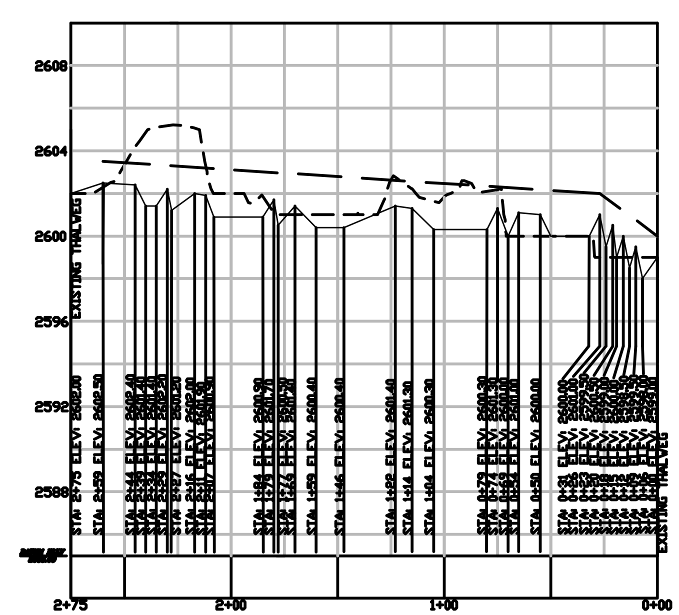
GLADE CREEK STREAM RESTORATION

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

LONGITUDINAL PROFILE

PROJECT NO.: 00891.00	SCALE: HORIZONTAL 1" = 40' VERTICAL 1" = 4'
CAD:	DESIGNED: VLB/KTN; DRAWN: SPF; CHECKED: JVP/SAM; APPROVED:
	DATE: JUNE 2007
	SHEET NO.: 4 OF 16





LEGEND

- PROPOSED BANKFULL WATER SURFACE
- EXISTING GROUND
- PROPOSED THALWEG

REVISIONS

Mark	Description	Date	Appr.

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2728 Capital Blvd, Suite 1H 103
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2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0156 Fax: 410-554-0168
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GLADE CREEK STREAM RESTORATION

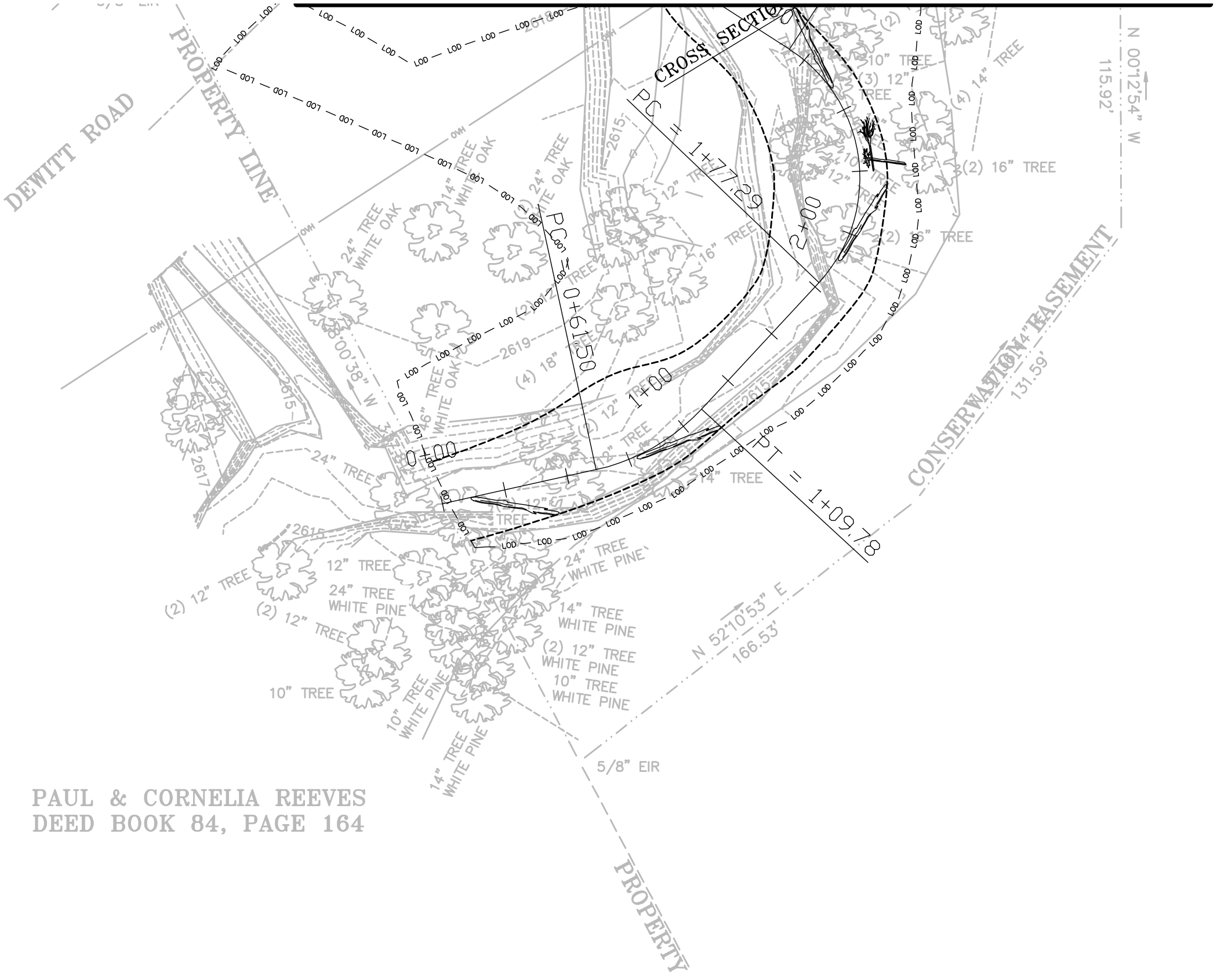
CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE:

LONGITUDINAL PROFILE

PROJECT NO.: 05501.03
SCALE: HORIZONTAL 1" = 40' VERTICAL 1" = 4'
SEAL:
DESIGNED BY: VLS/KTN
DRAWN BY: JPW
CHECKED: JXR/EMM
APPROVED:
DATE: JUNE 2007
DWG. NO.: 5 OF 16

MATCHLINE SEE SHEET 7



PAUL & CORNELIA REEVES
DEED BOOK 84, PAGE 164

N

SCALE
0 20 40

Mark	Description	Date	Appr.

North Carolina
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699
Tel: 919-715-0476

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The Rubber Building
3301 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0455 Fax: 410-554-0465
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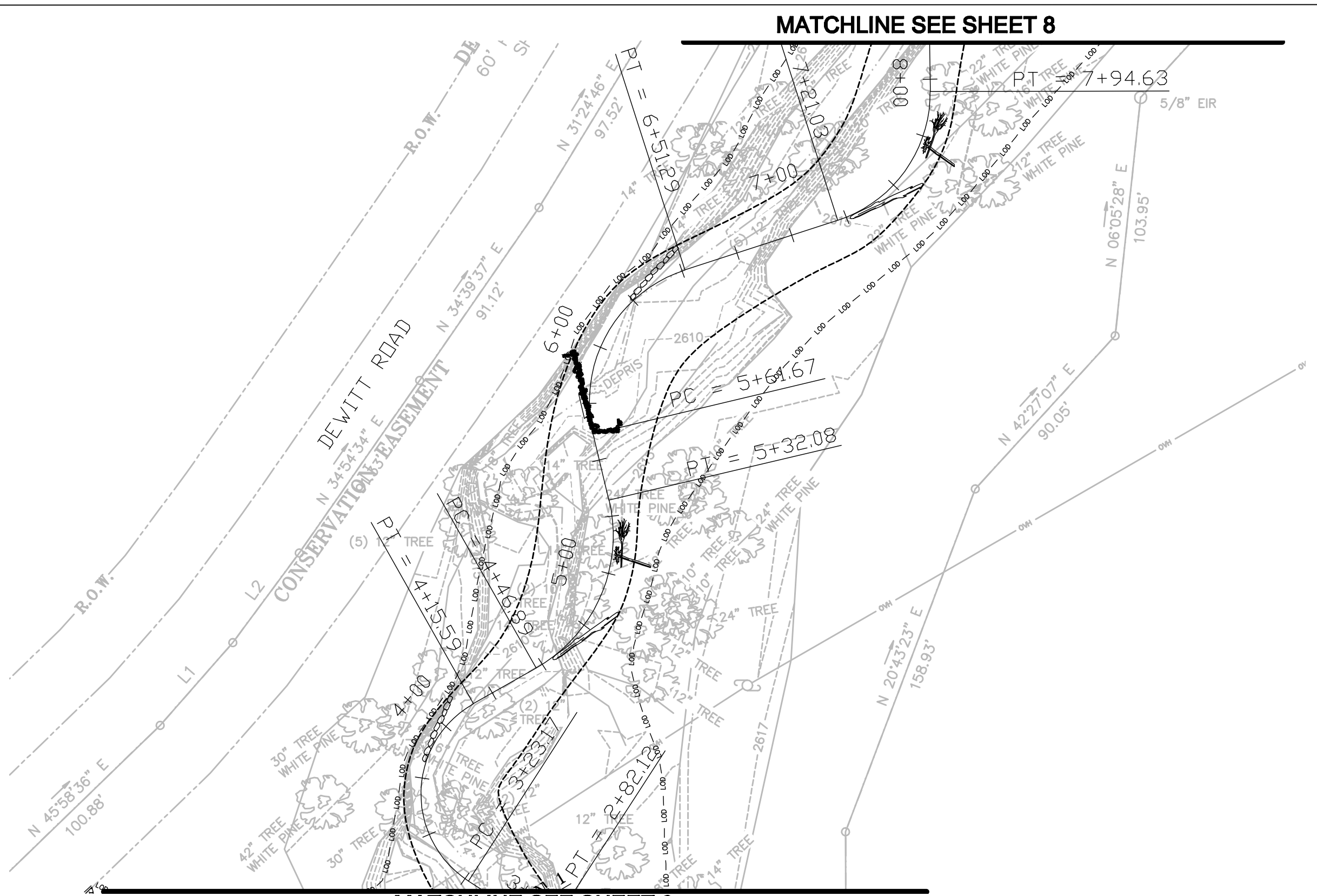
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

STREAM RESTORATION

PROJECT NO.: 66884.00
SCALE: 1" = 20'-0"
DESIGNED BY: VLSIKTN
DRAWN BY: JPW
CHECKED BY: JSWEMM
APPROVED:
DATE: JUNE 2007
SHT. NO.: 6 OF 16



SCALE
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No.	Description	Date	Appr.

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2728 Capital Blvd., Suite 1H 168
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Tel:919-715-8478

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The Baldwin Building
2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0165 Fax: 410-554-0166
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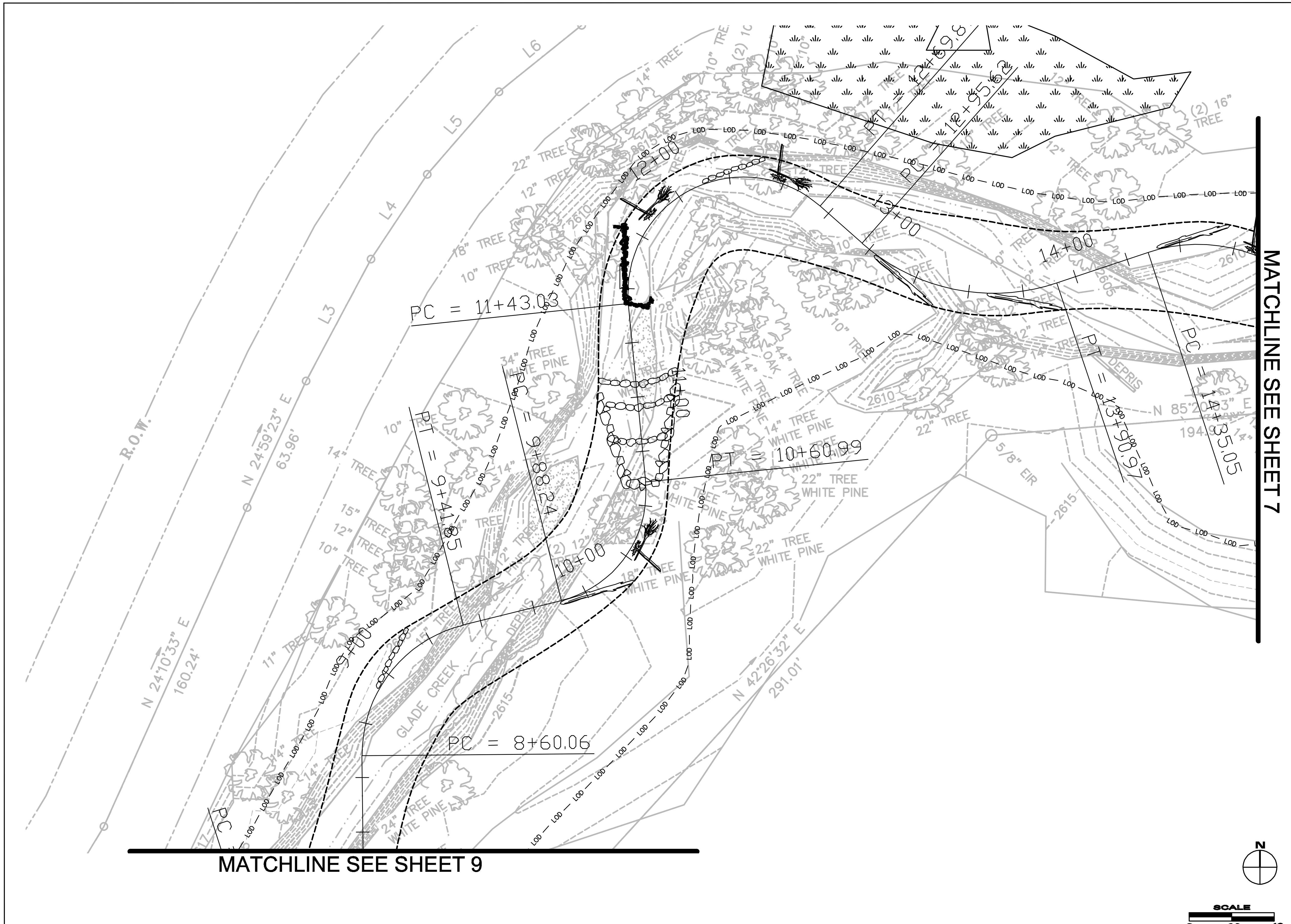
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE
STREAM RESTORATION

PROJECT NO.: 00001.00	SCALE: 1" = 20'-0"
CAD:	DESIGNED: VLSMITH / DRAWN: JPW
CHECKED: JWHAM	APPROVED:
DATE: JUNE 2007	
SHEET NO.: 7 OF 16	

RESTORATION PLAN SUBMITTAL



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Baltimore, Maryland 21211
Tel: 410-554-0156 Fax: 410-554-0168
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GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE:

STREAM RESTORATION

PROJECT NO.: 06801.03		SCALE: 1" = 20'-0"	
SEAL:		DESIGNED BY: VLS/KTN	DRAWN BY: JPW
		CHECKED: JXR/EMM	APPROVED:
		DATE: JUNE 2007	
		DWG. NO.: 8 OF 16	

CONSERVATION EASEMENT AREA
SEE NOTE # 3

MATCHLINE SEE SHEET 10

BEAVER DAM CONTROL STRUCTURE

FILL EXISTING CHANNEL

FILL AREA

POND

GLADE CREEK

R.O.W.

MATCHLINE SEE SHEET 8

N

SCALE
0 20 40

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Tel:919-715-0476

Etchebiste
2661 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0105 Fax: 410-554-0106
www.etchebiste.com
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GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

STREAM RESTORATION

PROJECT NO.: 06001.05	SCALE: 1" = 20'-0"
DESIGN: WJB/KTN	DRAWN: JPW
CHECK: JDW/BM	APPROVED:
DATE: JUNE 2007	
SHEET NO.: 9 OF 16	

RESTORATION PLAN SUBMITTAL

MATCHLINE SEE SHEET 9

EXISTING PK NAIL
N: 995409.73 FEET
E: 1392896.74 FEET

EXISTING RAILROAD SPIKE

TBM-2 SET ON 5/8" EIR W/CAP
N: 995313.78 FEET
E: 1393028.60 FEET
ELEV: 2618.67

CROSS SECTION 22

PT = 20+89.84

22+00

23+67.13

24+00

PC = 24+48.45

PT = 24+64.46

25+00

22+55.16

2+00

2+54.51

2+45.61

1+70.17

1+65.45

GRAVEL DRIVE

BRIDGE

DEPRIS

PROPERTY LINE

5/8" EIR

MATCHLINE SEE SHEET 11

SCALE
0 20 40

REVISIONS

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2728 Capital Blvd, Suite W 168
Raleigh, NC 27604
Tel:919-715-0476

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2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0456 Fax: 410-554-0455
www.biohabitats.com
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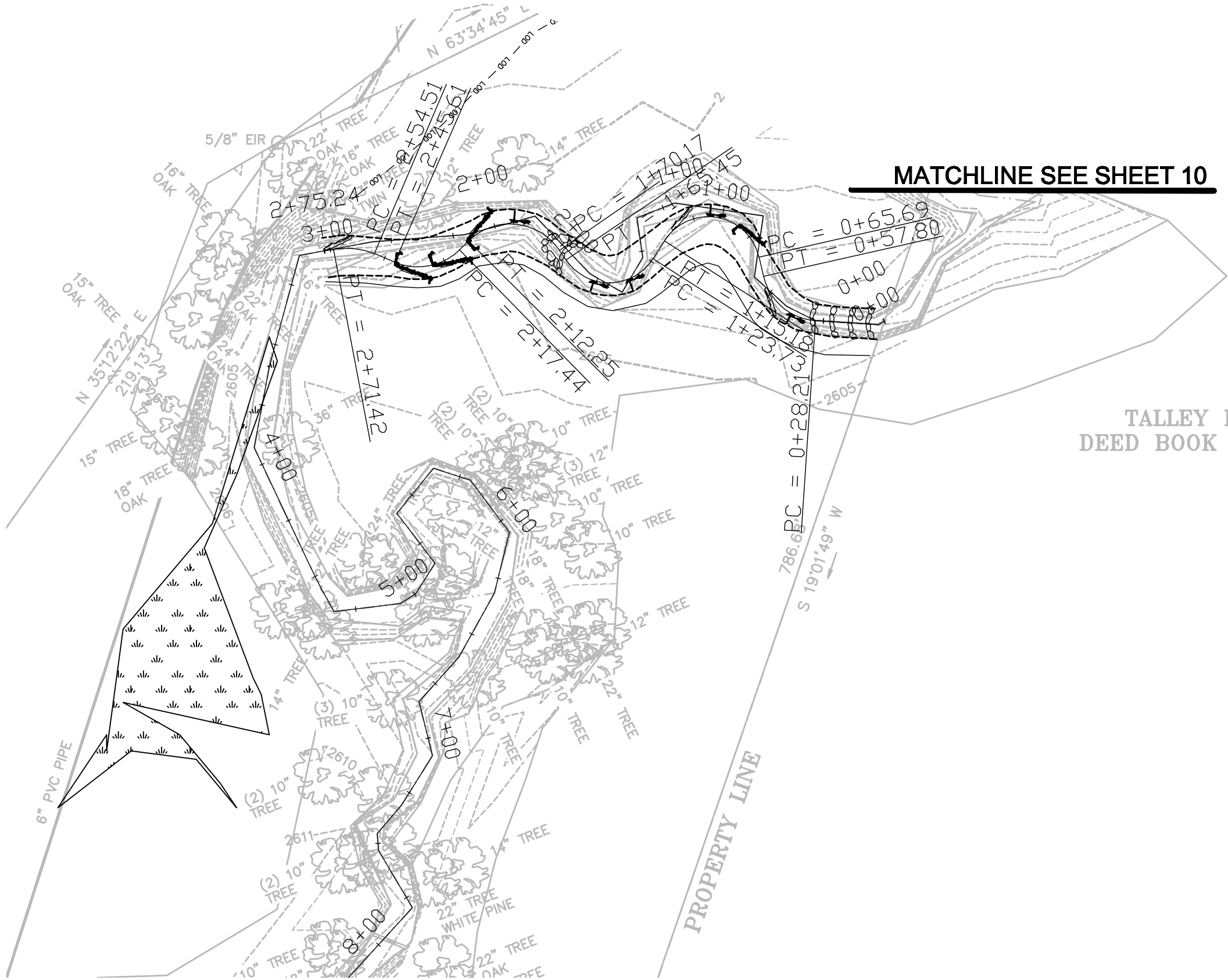
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE:
STREAM RESTORATION

PROJECT NO.: 06004.00	SCALE: 1" = 20'-0"
SHEET:	DESIGNED BY: VLB/CTN; DRAWN BY: JFW
CHECKED: JW/WBM	APPROVED:
DATE: JUNE 2007	
SHEET NO.: 10 OF 16	



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ECOHABITATS, INC.
The Station Building
2501 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0139 Fax: 410-554-0169
www.Ecohabitats.com
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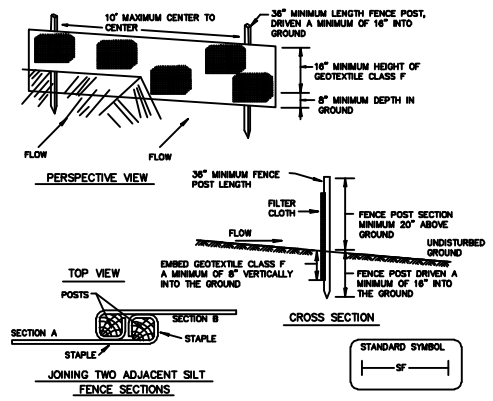
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE
STREAM RESTORATION

PROJECT NO.: 05001.03	SCALE: 1" = 20'-0"
DRN:	DESIGNER: VLERCH / CHECKED: JPW
	DRAWN: JOWENN / APPROVED:
	DATE: JUNE 2007
	SHEET NO.: 11 OF 16

RESTORATION PLAN SUBMITTAL



CONSTRUCTION SPECIFICATIONS

1. FENCE POSTS SHALL BE A MINIMUM OF 36" LONG DRIVEN 16" MINIMUM INTO THE GROUND. WOOD POSTS SHALL BE 1" X 1" SQUARE (MINIMUM) CUT, OR 1" DIAMETER (MINIMUM) ROUND AND SHALL BE OF SOUND QUALITY HARDWOOD. STEEL POSTS WILL BE STANDARD T OR U SECTION WEIGHTING NOT LESS THAN 1.00 POND PER LINEAR FOOT.

2. GEOTEXTILE SHALL BE FASTENED SECURELY TO EACH FENCE POST WITH WIRE TIES OR STAPLES AT TOP AND MID-SECTION AND SHALL MEET THE FOLLOWING REQUIREMENTS FOR GEOTEXTILE CLASS F:

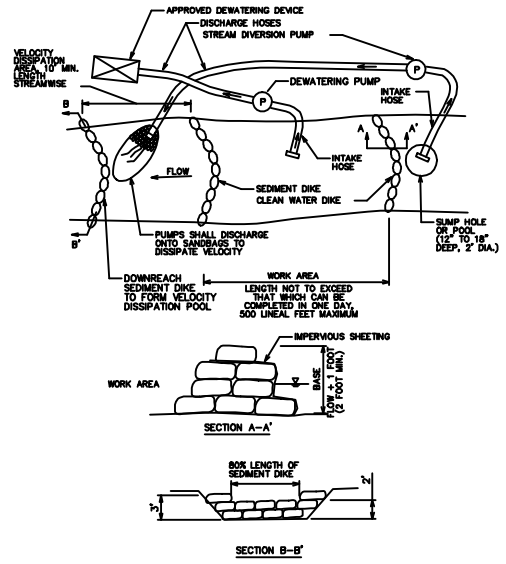
TENSILE STRENGTH	50 LBS/IN (MIN.)	TEST: MSMT 509
TENSILE MODULUS	20 LBS/IN (MIN.)	TEST: MSMT 509
FLOW RATE	0.3 GAL FT / MINUTE (MAX.)	TEST: MSMT 322
FILTERING EFFICIENCY	75% (MIN.)	TEST: MSMT 322

3. WHERE ENDS OF GEOTEXTILE FABRIC COME TOGETHER, THEY SHALL BE OVERLAPPED, FOLDED AND STAPLED TO PREVENT SEDIMENT BYPASS.

4. SILT FENCE SHALL BE INSPECTED AFTER EACH RAINFALL EVENT AND MAINTAINED WHEN BULGES OCCUR OR WHEN SEDIMENT ACCUMULATION REACHED 50% OF THE FABRIC HEIGHT.

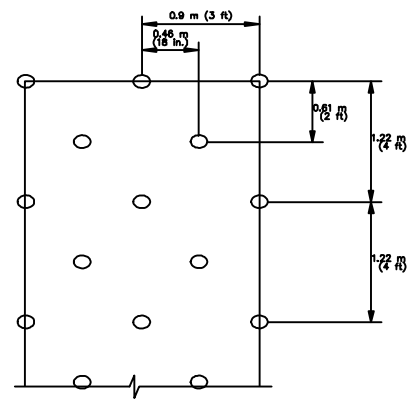
SILT FENCE

NOT TO SCALE



PUMP AROUND AND VELOCITY DISSIPATER

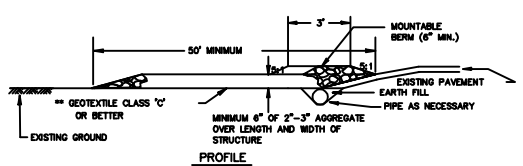
NOT TO SCALE



NOTES:
1. ANCHOR PATTERN 2.5 ANCHORS / m$^{37}/_{64}$ (2 ANCHORS / Yd$^{37}/_{64}$) FOR : 2H : 1V < SLOPES < 1H : 1V)
2. U – SHAPED WIRE STAPLES, METAL GEOTEXTILE PINS, TRIANGULAR WOODEN OR PLASTIC STAKES CAN BE USED TO ANCHOR TRMs TO THE GROUND SURFACE

COIR FIBER MATTING– STAPLE PATTERN GUIDE

NOT TO SCALE



CONSTRUCTION SPECIFICATION

1. LENGTH – MINIMUM OF 50' (*30' FOR SINGLE RESIDENCE LOT).

2. WIDTH – 10' MINIMUM, SHOULD BE FLARED AT THE EXISTING ROAD TO PROVIDE A TURNING RADIUS.

3. GEOTEXTILE FABRIC (FILTER CLOTH) SHALL BE PLACED OVER THE EXISTING GROUND PRIOR TO PLACING STONE. **THE PLAN APPROVAL AUTHORITY MAY NOT REQUIRE SINGLE FAMILY RESIDENCES TO USE GEOTEXTILE.

4. STONE – CRUSHED AGGREGATE (2" TO 3") OR RECLAIMED OR RECYCLED CONCRETE EQUIVALENT SHALL BE PLACED AT LEAST 6" DEEP OVER THE LENGTH AND WIDTH OF THE ENTRANCE.

5. SURFACE WATER – ALL SURFACE WATER FLOWING TO OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED THROUGH THE ENTRANCE, MAINTAINING POSITIVE DRAINAGE. PIPE INSTALLED THROUGH THE STABILIZED CONSTRUCTION ENTRANCE SHALL BE PROTECTED WITH A MOUNTABLE BERM WITH 5:1 SLOPES AND A MINIMUM OF 6" OF STONE OVER THE PIPE. PIPE HAS TO BE SIZED ACCORDING TO THE DRAINAGE. WHEN THE SCE IS LOCATED AT A HIGH SPOT AND HAS NO DRAINAGE TO CONVEY A PIPE WILL NOT BE NECESSARY. PIPE SHOULD BE SIZED ACCORDING TO THE AMOUNT OF RUNOFF TO BE CONVEYED. A 6" MINIMUM WILL BE REQUIRED.

6. LOCATION – A STABILIZED CONSTRUCTION ENTRANCE SHALL BE LOCATED AT EVERY POINT WHERE CONSTRUCTION TRAFFIC ENTERS OR LEAVES A CONSTRUCTION SITE. VEHICLES LEAVING THE SITE MUST TRAVEL OVER THE ENTIRE LENGTH OF THE STABILIZED CONSTRUCTION ENTRANCE.

STABILIZED CONSTRUCTION ENTRANCE

NOT TO SCALE

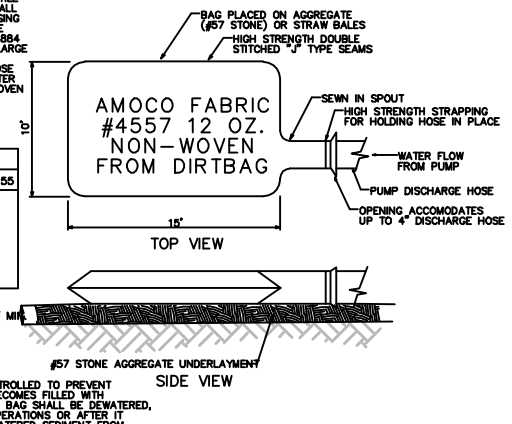
THE DEWATERING BAG SHALL BE MADE OF NON-WOVEN GEOTEXTILE WITH A MIN. SURFACE AREA OF 225 SQUARE FEET PER SIDE. ALL STRUCTURAL SEAMS SHALL BE SEWN WITH A DOUBLE STITCH USING A DOUBLE NEEDLE MACHINE WITH HIGH STRENGTH THREAD. THE SEAM STRENGTH SHALL WITHSTAND 100 lb/in. USING ASTM D-4884 TEST METHOD. THE DEWATERING BAG SHALL HAVE A NOZZLE LARGE ENOUGH TO ACCOMODATE A FOUR INCH DISCHARGE HOSE. THE NOZZLE SHALL BE SEALED TIGHTLY AROUND THE DISCHARGE HOSE WITH A STRAP OR SIMILAR DEVICE TO PREVENT UNTREATED WATER FROM ESCAPING. THE GEOTEXTILE FABRIC SHALL BE A NON-WOVEN FABRIC WITH THE FOLLOWING PROPERTIES:

NOTE:
DIRTBAG 55 TEST METHOD: ASTM D-4884
TEST RESULT: 100LB/IN

GEOTEXTILE FABRIC FOR DIRTBAG			
PROPERTIES	TEST METHOD	UNITS	NONWOVEN 55
WEIGHT	ASTM D-3776	OZ/YD	10
GRAB TENSILE	ASTM D-4632	LBS.	270
PUNCTURE	ASTM D-4833	LBS.	150
FLOW RATE	ASTM D-4491	GAL/MIN/FT2	70
PERMITTIVITY	ASTM D-4491	SEC-1	1.3
MULLEN BURST	ASTM D-3786	LBS.IN2	550
UV RESISTANT	ASTM D-4355	%	70
AOS % RETAINED	ASTM D-4751	%	100
AOS	ASTM D-4751		40-80

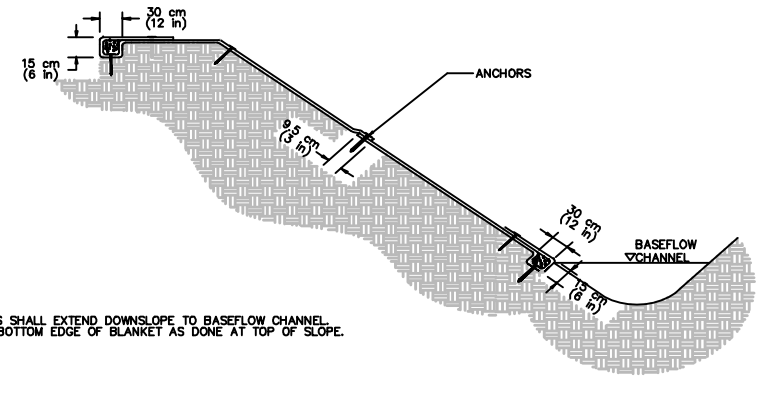
NOTE:
ALL PROPERTIES ARE MINIMUM AVERAGE ROLL VALUE EXCEPT THE WEIGHT OF THE FABRIC WHICH IS GIVEN FOR INFORMATION ONLY.

CONSTRUCTION: THE DEWATERING BAG SHALL BE INSTALLED OVER A 3 INCH #57 STONE GRAVEL BASE OR STRAW BALE BASE TO PROMOTE INFILTRATION AND DEWATERING OF THE BAG. PUMPING RATE SHALL BE CONTROLLED TO PREVENT EXCESSIVE PRESSURE WITHIN THE FILTER BAG. AS THE BAG BECOMES FILLED WITH SEDIMENT THE PUMPING RATE SHALL BE REDUCED. THE FILTER BAG SHALL BE DEWATERED, REMOVED AND DISPOSED OF UPON COMPLETION OF PUMPING OPERATIONS OR AFTER IT HAS REACHED CAPACITY, WHICHEVER OCCURS FIRST. THE DEWATERED SEDIMENT FROM THE BAG SHALL BE SPREAD IN AN UPLAND AREA AND STABILIZED WITHIN 24 HOURS.



DEWATERING BAG DETAIL FOR CONTROL OF SEDIMENT IN PUMPED WATER

NOT TO SCALE



NOTES:
1. BLANKETS SHALL EXTEND DOWNSLOPE TO BASEFLOW CHANNEL.
2. SECURE BOTTOM EDGE OF BLANKET AS DONE AT TOP OF SLOPE.

COIR FIBER MATTING – TYPICAL SLOPE CROSS SECTION

TYPICAL SLOPE CROSS SECTION

NOT TO SCALE

REVISIONS			
Mark	Description	Date	Appr.

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2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-964-0180 Fax: 410-964-0189
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GLADE CREEK

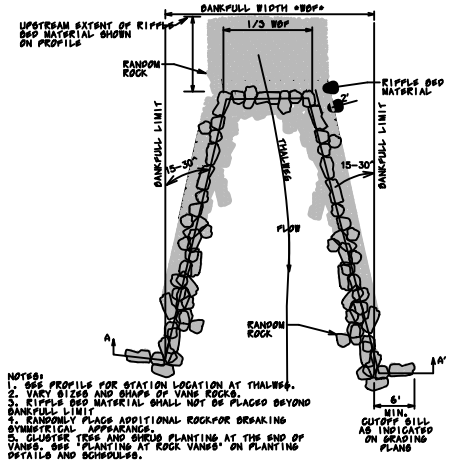
CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE:

DETAILS

PROJECT NO.: 06001.05	SCALE: NTS
DRAWN BY: VLB/KTN	CHECKED BY: JPW
DESIGN BY: JDP/EMM	APPROVED BY:
DATE: JUNE 2007	
SHEET NO.: 12 OF 16	

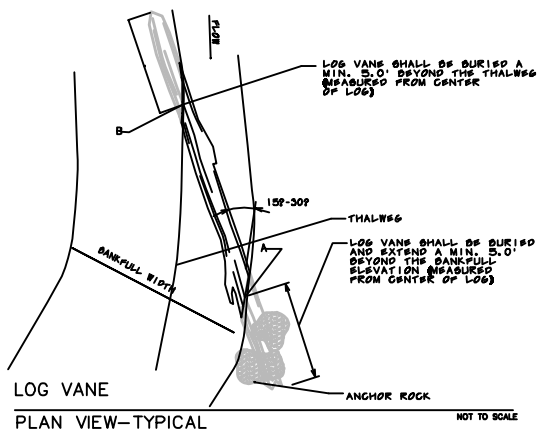
RESTORATION PLAN SUBMITTAL



NOTES:
1. BSG PROFILE FOR STATION LOCATION AT THAL-WEG.
2. VARY SIZES AND SHAPES OF VANE ROCKS.
3. RIFFLE BSG MATERIAL SHALL NOT BE PLACED BEYOND BANKFULL LIMIT.
4. RANDOMLY PLACE ADDITIONAL ROCK FOR BREAKING SYMMETRICAL APPEARANCE.
5. CLUMP TREE AND SHRUB PLANTING AT THE END OF VANES. SEE 'PLANTING AT ROCK VANES' ON PLANTING DETAILS AND SCHEDULES.

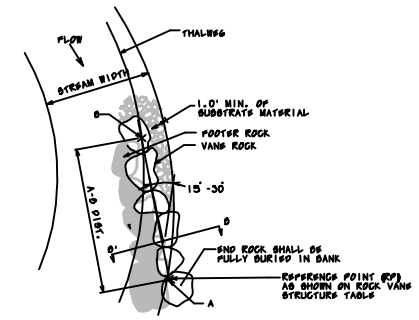
ROCK CROSS VANE
PLAN VIEW

NOT TO SCALE



LOG VANE
PLAN VIEW—TYPICAL

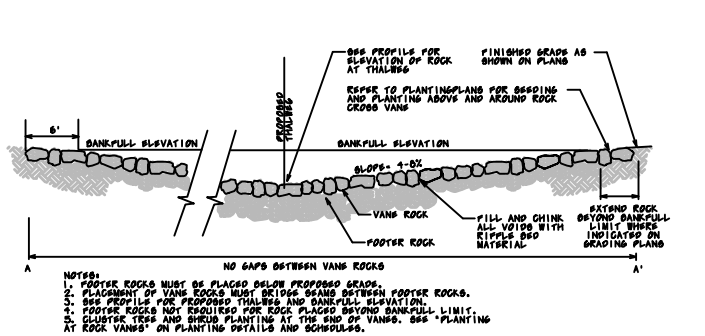
NOT TO SCALE



FOR DISTANCES AND ELEVATIONS SEE TABLE FOR ROCK VANE ON THIS SHEET.

ROCK VANE
PLAN VIEW— TYPICAL

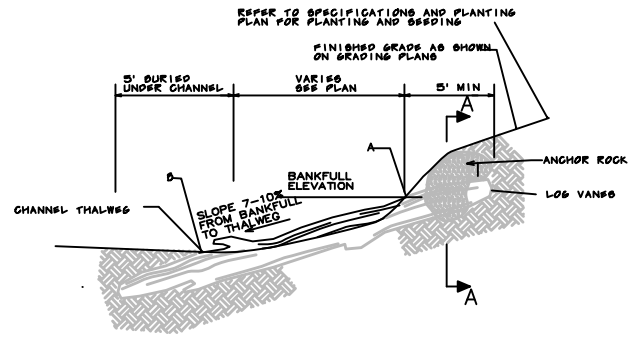
NOT TO SCALE



NOTES:
1. FOOTER ROCKS MUST BE PLACED BELOW PROPOSED GRADE.
2. PLACEMENT OF VANE ROCKS MUST BRIDGE GRADE BETWEEN FOOTER ROCKS.
3. BSG PROFILE FOR PROPOSED THAL-WEG AND BANKFULL ELEVATION.
4. FOOTER ROCKS NOT REQUIRED FOR ROCK PLACED BEYOND BANKFULL LIMIT.
5. CLUMP TREE AND SHRUB PLANTING AT THE END OF VANES. SEE 'PLANTING AT ROCK VANES' ON PLANTING DETAILS AND SCHEDULES.

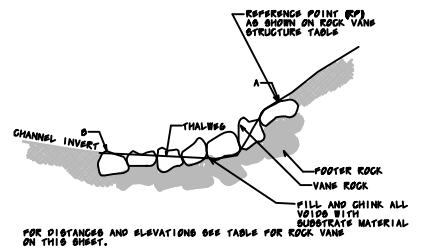
ROCK CROSS VANE
PROFILE

NOT TO SCALE



LOG VANE
PROFILE ELEVATION

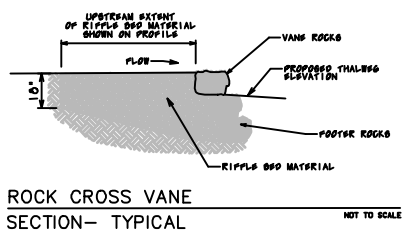
NOT TO SCALE



FOR DISTANCES AND ELEVATIONS SEE TABLE FOR ROCK VANE ON THIS SHEET.

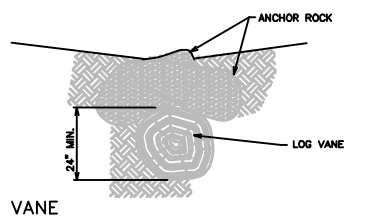
ROCK VANE
PROFILE ELEVATION — TYPICAL

NOT TO SCALE



ROCK CROSS VANE
SECTION— TYPICAL

NOT TO SCALE



LOG VANE
CROSS SECTION A—A'

NOT TO SCALE

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Tel 919-715-0476

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The Baltimore Building
2081 Clipper Park Road
Baltimore, Maryland 21211
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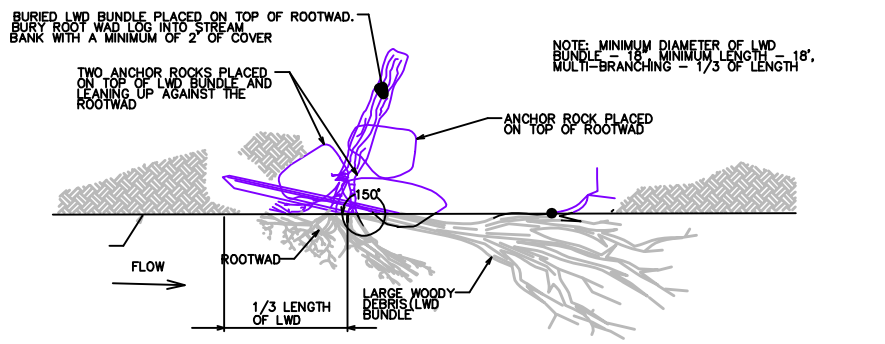
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE:
DETAILS

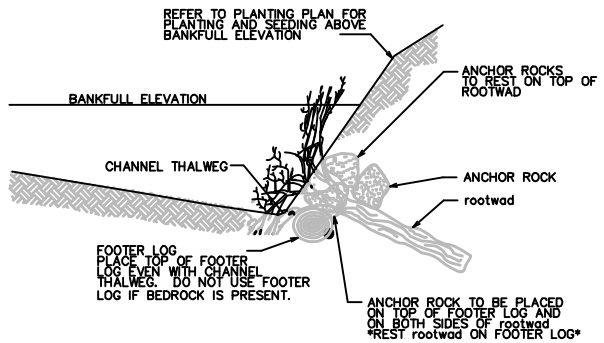
PROJECT NO.: 06001.03	SCALE: NTS
DESIGNED: VLB/KTN	DRAWN BY: JPW
CHECKED: JCD/EMM	APPROVED:
DATE: JUNE 2007	
SHEET NO.: 13 OF 16	

RESTORATION PLAN SUBMITTAL

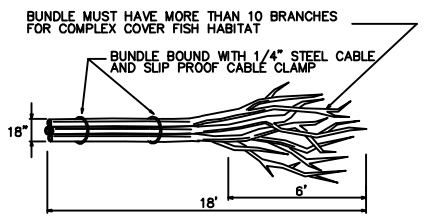


NOTE: FOOTER LOG NOT SHOWN.

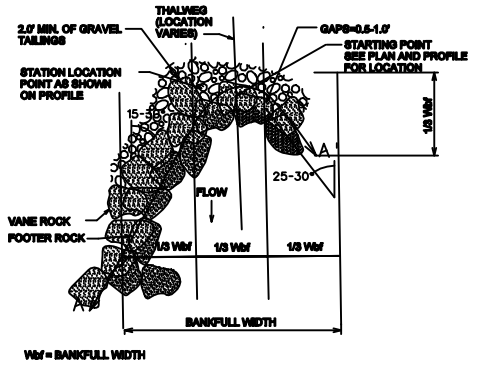
ROOTWAD/LARGE WOODY DEBRIS *LWD* DEFLECTOR
PLAN VIEW
NOT TO SCALE



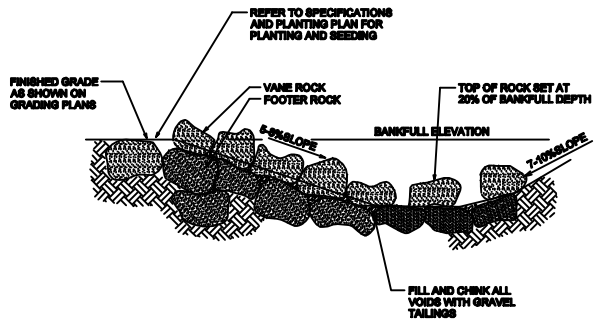
ROOTWAD/LARGE WOODY DEBRIS *LWD* DEFLECTOR
CROSS SECTION view
Rootwad Only
NOT TO SCALE



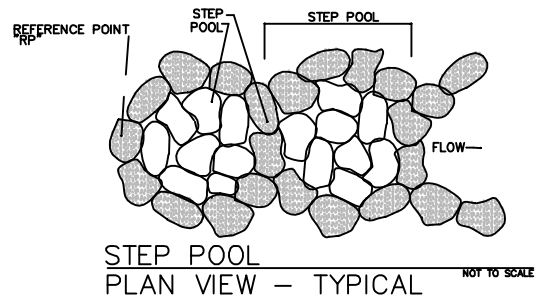
ROOTWAD/LARGE WOODY DEBRIS LWD DEFLECTOR
LARGE WOODY DEBRIS (LWD)
NOT TO SCALE



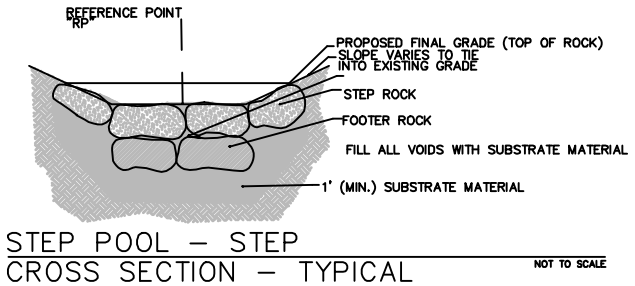
ROCK "J" VANE
PLAN VIEW- TYPICAL
NOT TO SCALE



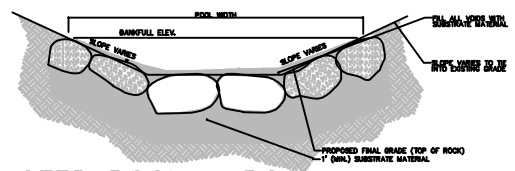
ROCK "J" VANE
SECTION A-A'
NOT TO SCALE



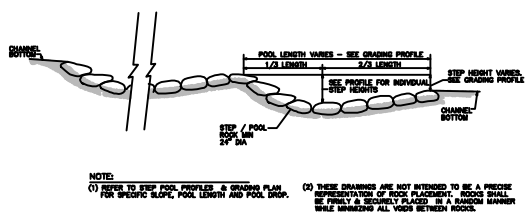
STEP POOL
PLAN VIEW – TYPICAL
NOT TO SCALE



STEP POOL – STEP
CROSS SECTION – TYPICAL
NOT TO SCALE



STEP POOL – POOL
CROSS SECTION – TYPICAL
NOT TO SCALE



STEP/POOL
PROFILE TYPICAL
NOT TO SCALE

Mark	Description	Date	Appr.

Ecosystem Enhancement Program
North Carolina
Ecosystem Enhancement Program
2728 Capital Blvd, Suite 1H 168
Raleigh, NC 27604
Tel:919-715-0476

BIOHABITATS, INC.
The Baldwin Building
2081 Clipper Park Road
Baltimore, Maryland 21211
Tel: 410-554-0165 Fax: 410-554-0169
www.biohabitats.com
Inspiring Ecological Stewardship

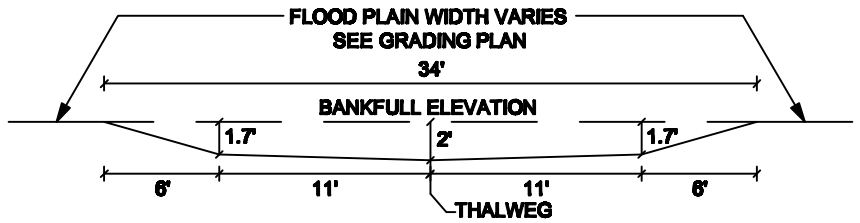
GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

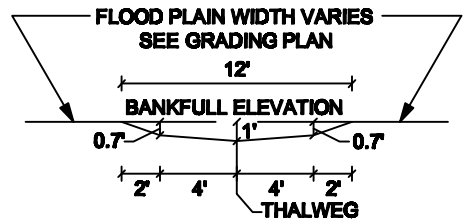
TITLE:
DETAILS

PROJECT NO.: 06001.03
SCALE: NTS
DESIGNED BY: VLB/KTN
DRAWN BY: JPW
CHECKED BY: JVW/MM
APPROVED:
DATE: JUNE 2007
DWG. NO.:
14 OF 16

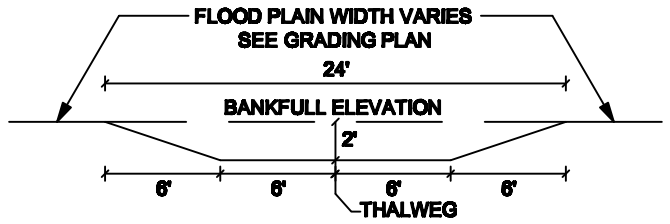
RESTORATION PLAN SUBMITTAL



MAINSTEM RIFFLE
SECTION TYPICAL
NOT TO SCALE



TRIBUTARY RIFFLE
SECTION TYPICAL
NOT TO SCALE



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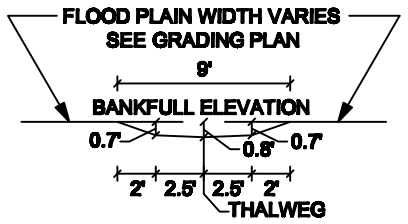
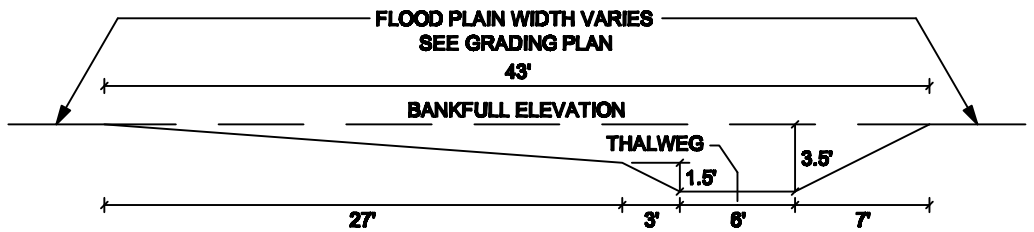
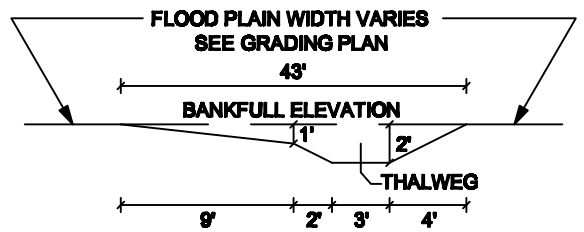
NOT TO SCALE



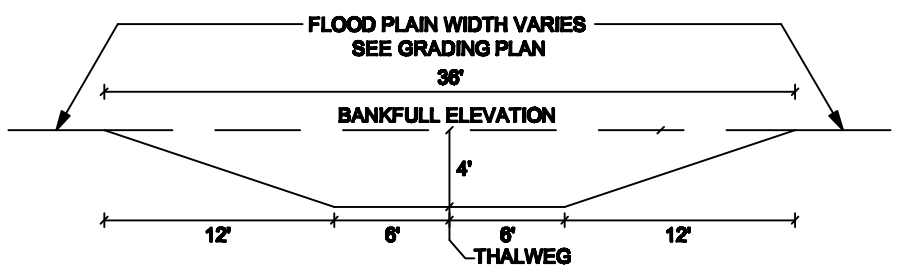
TRIBUTARY STEP
SECTION TYPICAL
NOT TO SCALE



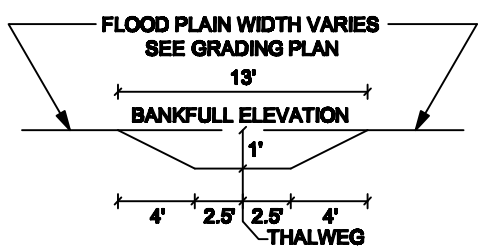
MAINSTEM MEANDER POOL
SECTION TYPICAL
NOT TO SCALE



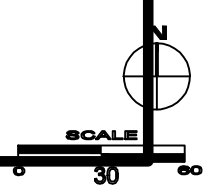
TRIBUTARY MEANDER POOL
SECTION TYPICAL
NOT TO SCALE

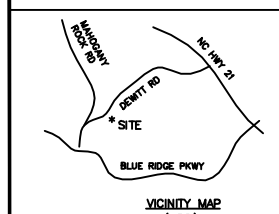


MAINSTEM STEP POOL
SECTION TYPICAL
NOT TO SCALE



TRIBUTARY STEP POOL
SECTION TYPICAL
NOT TO SCALE





VICINITY MAP
(N.T.S.)

Mark	Description	Date	Appr.

North Carolina
Ecosystem Enhancement Program
2728 Capital Blvd, Suite 1H 168
Raleigh, NC 27604
Tel.919-715-0476

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GLADE CREEK STREAM RESTORATION

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

TITLE:
DESIGNED CHANNEL ALIGNMENT

PROJECT NO.: 06001.03	SCALE: 1" = 60'-0"
DWN.:	DESIGNED: VLB/KTN; DRAWN BY: JPW
	CHECKED: AWM/BM; APPROVED:
	DATE: JUNE 2007
	DWG. NO.: 15 OF 16

RESTORATION PLAN SUBMITTAL

TEMPORARY HERBACEOUS SEED					
Date	Species Name	Common Name	Unit	Additional Amendment	Quantity LBS/per acre
Jan.1-May 15	*Secale cereale*	Rye grain	LB of P.L.S. 76 %		35
				Ground Limestone	4,000
				Organic Fertilizer	320
				Straw Mulch	4,000
May 15-Aug.15	*Setaria italica*	German millet	LB of P.L.S. 76 %		40
				Ground Limestone	4,000
				Organic Fertilizer	320
				Straw Mulch	4,000
Aug. 15-Dec. 31	*Secale cereale*	Rye grain	LB of P.L.S. 76 %		35
				Ground Limestone	4,000
				Organic Fertilizer	320
				Straw Mulch	4,000

Notes:
1. SELECT AN APPROPRIATE TEMPORARY SPECIES BASED ON THE DATES GIVEN.
2. AVOID SEEDING IN DECEMBER OR JANUARY. IF NECESSARY TO SEED AT THESE TIMES, USE RYE GRAIN AND A SECURELY TACKED MULCH.
3. APPLY SOIL AMENDMENTS EVENLY AND INCORPORATE TO A DEPTH OF 4-6 INCHES. LOOSEN SURFACE JUST BEFORE BROADCASTING.
4. MULCH MUST COVER 75% OF THE GROUND SURFACE.

LINE TABLE		
LINE	BEARING	LENGTH
L1	N41°16'39"E	47.89
L2	N38°32'36"E	48.31
L3	N28°01'12"E	63.28
L4	N33°25'14"E	48.69
L5	N40°39'03"E	50.13
L6	N51°11'26"E	48.62
L7	N60°02'04"E	48.46
L8	N70°16'50"E	47.92
L9	N77°22'36"E	48.37
L10	N88°43'42"E	48.41
L11	S87°23'38"E	47.98
L12	S78°43'01"E	50.07
L13	S82°07'28"E	48.56
L14	S85°03'36"E	48.35
L15	S30°17'41"E	49.01
L16	S16°19'42"E	49.95
L17	S28°36'11"E	49.76
L18	S40°26'10"E	48.76
L19	S47°26'39"E	30.66
L20	S47°36'39"E	18.00
L21	S82°09'41"E	27.03
L22	S86°32'06"E	48.69
L23	S82°40'39"E	52.42
L24	S82°02'26"E	15.51
L25 (TIE)	N70°05'58"E	9.18

PLANT COMPOSITION SCHEDULE[1]

NOTE: EACH TREE SPECIES SHOULD COMPRISE AT LEAST 10% AND NO MORE THAN 25% OF THE TOTAL STEMS PLANTED IN EACH VEGETATION STRATA-A MINIMUM OF 680 STEMS PER ACRE WILL BE OF PLANTED IN ZONE 1-A MINIMUM OF 1,210 STEMS PER ACRE WILL BE PLANTED IN ZONE 2. (The taxonomic standard follows Flora of the Carolinas, Virginia Georgia and Surrounding Areas by Alan S. Weakley)

Zone 1: Riparian Woodlands - Mesic — **Size (acres): 3.6**

Overall Spacing (feet off center)	Quantity per acre	Maximum Frequency (%)	Maximum Stem Quantity	Vegetation Strata / Species Name	Common Name	Unit Type[2]	Size[3]	Spacing Type	Individual Spacing (ft.)
14	226			TREES: Minimum of 5 Species, Minimum # of Trees = 230					
		N/A	N/A	*Quercus alba*	White Oak	c, bb	2" dbh min	Random	200
		N/A	N/A	*Pinus strobus*	White Pine	c, bb	2" dbh min	Random	200
		N/A	N/A	*Tsuga canadensis*	Eastern Hemlock	c, bb	2" dbh min	Random	200
		20	163	*Quercus rubra*	N. Red Oak	br, c, t	18-36"	Random	31
		20	163	*Betula alleghaniensis*	Yellow Birch	br, c, t	18-36"	Random	31
		20	163	*Liriodendron tulipifera*	Yellow Poplar	br, c, t	18-36"	Random	31
		20	163	*Tilia americana*	Basswood	br, c, t	18-36"	Random	31
		20	163	*Platanus occidentalis*	Sycamore	br, c, t	18-36"	Random	31
		20	163	*Betula nigra*	River Birch	br, c, t	18-36"	Random	31
		20	163	*Acer saccharum*	Sugar Maple	br, c, t	18-36"	Random	31
		20	163	*Acer rubrum*	Red Maple	br, c, t	18-36"	Random	31
		20	163	*Prunus serotina*	Black Cherry	br, c, t	18-36"	Random	31
			815	TOTAL					
14	226			MIDSTORY TREES: Minimum of 5 Species, Minimum # of Trees = 230					
		20	163	*Carpinus caroliniana*	Ironwood	br, c, t	18-36"	Random	31
		20	163	*Ostrya virginiana*	American Hophornbeam	br, c, t	18-36"	Random	31
		20	163	*Ilex opaca*	Holly	br, c, t	18-36"	Random	31
		20	163	*Oxydendron arboretum*	Sourwood	br, c, t	18-36"	Random	31
		20	163	*Amelanchier arborea*	Serviceberry	br, c, t	18-36"	Random	31
		20	163	*Chionanthus virginicus*	Fringetree	br, c, t	18-36"	Random	31
		20	163	*Cornus florida*	Flowering Dogwood	br, c, t	18-36"	Random	31
			815	TOTAL					
14	226			SHRUBS: Minimum of 5 Species, Minimum # of Shrubs = 230*					
		20	163	*Lindera benzoin*	Spicebush	br, c, t	18-36"	Random	31
		20	163	*Sambucus canadensis*	Elderberry	br, c, t	18-36"	Random	31
		20	163	*Calycanthus florida*	Sweetshrub	br, c, t	18-36"	Random	31
		20	163	*Callicarpa americana*	American Beautyberry	br, c, t	18-36"	Random	31
		20	163	*Hydrangea arborescens*	Wild Hydrangea	br, c, t	18-36"	Random	31
		20	163	*Symplocos tinctoria*	Horse Sugar	br, c, t	18-36"	Random	31
		20	163	*Rhododendron maximum*	Rhododendron	br, c, t	18-36"	Random	31
		20	163	*Hamamelis virginiana*	Witchhazel	br, c, t	18-36"	Random	31
			815	TOTAL					
8			2,445	GRAND TOTAL					

Zone 2: Floodplain Bench — **Size (acres): 2.2**

Overall Spacing (feet off center)	Quantity per acre	Maximum Frequency (%)	Stem Quantity	Vegetation Strata / Species Name	Common Name	Unit Type	Size	Spacing Type	Individual Spacing (ft.)
7	870			LIVE STAKES: Min. # of Stems = 870					
		34	651	*Salix nigra*	Black Willlow	live stake	2-3'	Random	12
		33	632	*Salix sericea*	Silky Willlow	live stake	2-3'	Random	12
		33	632	*Cornus amomum*	Silky Dogwood	live stake	2-3'	Random	12
			1,915	TOTAL					
16	340			SHRUB AND TREES: Minimum # = 340					
		34	254	*Sambucus canadensis*	Elderberry	br, c, t	18-36"	Random	19
		33	247	*Alnus serrulata*	Tag Alder	br, c, t	18-36"	Random	20
		33	247	*Betula nigra*	River Birch	br, c, t	18-36"	Random	20
			748	TOTAL					
6			2,663	GRAND TOTAL					

[1] All planting stock provided shall be secured from a local producer located in the mountain physiographic province, not more than 200 miles from the site. Planting shall occur during the last full week of February through March. Bare root material must be stored in a refrigerated truck from nursery pick-up to no more than 30 minutes before planting. All planting stock must be stored properly before planting to avoid freezing or desiccation, and must be approved by the Designer before it can be planted. Bare root seedlings that have been shipped by commercial carriers will not be accepted. If proper care of the material has not been taken, the material will be rejected for planting.

[2] unit type c, bb = container or balled in burlap, unit type br, c, t = bare root, container or tubling. NOTE-White Oak, White Pine and Eastern Hemlock minimum size is 2" dbh. At least 10 stems of each of these species must be planted if available. There should be at least 50 feet between 2" dbh stems and at least 200' between 2" dbh stems of the same species.

[3] Sizes listed are recommended, but are not meant to be a restriction in size.

LEGEND

ZONE 1

ZONE 2

N

SCALE 0 30 60

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No.	Description	Date	Appr.

Ecosystem Enhancement Program
North Carolina Ecosystem Enhancement Program
2728 Capital Blvd, Suite 1H 103
Raleigh, NC 27604
Tel: 919-715-0476

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Inspiring Ecological Stewardship

GLADE CREEK

CHERRY LANE TOWNSHIP
ALLEGHANY COUNTY, NC.

PLANTING PLAN

PROJECT NO.: 06004.00
SCALE: 1" = 60'-0"
DESIGNED: V.MARTH
DRAWN: JFW
CHECKED: D.WILLIAMS
APPROVED:
DATE: JUNE 2007
SHEET NO.: 16 OF 16

12.0 Appendices

Appendix 1. Project Site Photographs

Appendix 2. Project Site USACE Routine Wetland Determination Data Forms

Appendix 3. Project Site NCDWQ Stream Classification Forms

Appendix 4. HEC-RAS Analysis

Appendix 5. EEP Floodplain Requirements Checklist

Upstream view at ~ sta 0+00 on Glade Creek

Glade Creek-right bank at ~ sta 2+00

Upstream cross section view from right bank at ~ sta 2+25 on Glade Creek

Pool beside large 30”white oak at ~ sta 3+25

View of left bank d/s of the 30” white oak at ~ sta 3+25 on Glade Creek

Glade Creek-right bank at ~ sta 6+75 – 8+00

Mid-channel bar and eroding right bank at ~ sta 10+00 on Glade Creek

Left bank on meander right ~ sta 11+50 on Glade Creek

View of right bank, just upstream of beaver pond ~ sta 16+00 on Glade Creek

Glade Creek-right bank at ~ sta 16+50 u/s of beaver pond

Beaver dam view at ~ sta 17+75 on Glade Creek

View of left bank d/s of beaver dam at ~ sta 19+75

Looking upstream from downstream of bridge at cross section ~ sta 23+00 on Glade Cr.

Looking upstream at ~ sta 24+75 on Glade Creek

Confluence of unnamed tributary and Glade Creek just downstream of project boundary

Upstream view of unnamed tributary at d/s end of property line, ~ sta 0+00

Upstream view at ~ sta 0+50 on unnamed tributary

Upstream view at ~ sta 1+00 on unnamed tributary

Upstream view at ~ sta 1+75 on unnamed tributary

Upstream view at ~ sta 2+25 on unnamed tributary

Upstream view at ~ sta 2+00 to u/s beginning of restoration reach on unnamed tributary

Downstream view at ~ sta 2+50, beginning of restoration reach, on unnamed tributary

Upstream view at ~ sta 0+60 on Basin Creek

Downstream view at ~ sta +70, beginning of reference reach, on Basin Creek

Upstream view of reference stream- Basin Creek

Downstream view of reference stream, Basin Creek

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

Project/Site: Glade Creek - wetland on unnamed trib. Applicant/Owner: NCEEP Investigator: Kevin Nunnery	Date: 3/6/07 County: Alleghany State: NC
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes (No) (If needed, explain on reverse.)	Community ID: _____ Transect ID: _____ Plot ID: Wetland 1 @ u/s easement boundary flags 1-3

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. red maple Acer rubrum	tree	FAC	9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 100

Remarks: red maple only vegetation within wetland

HYDROLOGY

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

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:

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

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: saturated and very shallow ponding

SOILS

Map Unit Name (Series and Phase): Allegheny County not mapped

Drainage Class: _____

Taxonomy (Subgroup): _____

Field Observations
Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-1	org	7.5YR 3/1			sc loam
1-18		10YR 2/1			sc loam

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

			(Circle)
Hydrophytic Vegetation Present?	(Yes)	No	
Wetland Hydrology Present?	Yes	No	
Hydric Soils Present?	(Yes)	No	
Is this Sampling Point Within a Wetland?	(Yes)	No	

Remarks: UT Wetland 1

Approved by HQUSACE 3/92

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

Project/Site: Glade Creek - Wetland on unnamed trib Applicant/Owner: NCEEP Investigator: Kevin Nunnery	Date: 3/6/07 County: Alleghany State: NC
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes (No) (If needed, explain on reverse.)	Community ID: _____ Transect ID: _____ Plot ID: Wetland 2 flags 1-7

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. red maple Acer rubrum	tree	FAC	9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)
Depth to Free Water in Pit: 0 (in.)
Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
✓ Saturated in Upper 12 Inches
✓ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): Alleghany County not mapped

Drainage Class: _____

Field Observations Confirm Mapped Type? Yes No

Taxonomy (Subgroup): _____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-18		10YR 2/1			sandy clay loam

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? (Yes) No (Circle)
Wetland Hydrology Present? (Yes) No
Hydric Soils Present? (Yes) No

(Circle)
Is this Sampling Point Within a Wetland? (Yes) No

Remarks: UT Wetland 2

Approved by HQUSACE 3/92

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

Project/Site: Glade Creek-wetland on unnamed trib. Applicant/Owner: NCEEP Investigator: Kevin Nunnery	Date: 3/6/07 County: Alleghany State: NC
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes (No) (If needed, explain on reverse.)	Community ID: _____ Transect ID: _____ Plot ID: Wetland 3 linear, at toe of slope flags 1-6

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. red maple Acer rubrum			9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)
Depth to Free Water in Pit: 0 (in.)
Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
✓ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
✓ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks: possibly old creek bed

SOILS

Map Unit Name (Series and Phase): Allegheny County not mapped

Drainage Class: _____

Taxonomy (Subgroup): _____

Field Observations
Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-1	org	7.5YR 3/1			organic, loam
1-18		10YR 2/1			sandy clay loam

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? (Yes) No (Circle)
Wetland Hydrology Present? (Yes) No
Hydric Soils Present? (Yes) No

(Circle)
Is this Sampling Point Within a Wetland? (Yes) No

Remarks: UT Wetland 3

Approved by HQUSACE 3/92

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

Project/Site: Glade Creek - wetland on unnamed trib. Applicant/Owner: NCEEP Investigator: Kevin Nunnery	Date: 3/6/07 County: Alleghany State: NC
Do Normal Circumstances exist on the site? Yes No Is the site significantly disturbed (Atypical Situation)? Yes No Is the area a potential Problem Area? Yes No (If needed, explain on reverse.)	Community ID: _____ Transect ID: _____ Plot ID: Wetland 4 Transect on unnamed trib. flags 1-18

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. red maple Acer rubrum	tree	FAC	9.		
2.			10.		
3. Juncus effusus	herb	OBL	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)
Depth to Free Water in Pit: 0 (in.)
Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
✓ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
✓ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): _____ Drainage Class: _____

Taxonomy (Subgroup): _____ Field Observations
Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-18		10YR 2/1			sandy loam

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? (Yes) No (Circle)
Wetland Hydrology Present? (Yes) No
Hydric Soils Present? (Yes) No

(Circle)
Is this Sampling Point Within a Wetland? (Yes) No

Remarks: largest wetland of wetlands (4) on unnamed trib. to Glade Cr.

UT Wetland 4

Approved by HQUSACE 3/92

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

Project/Site: Glade Creek - upland on unnamed trib. Applicant/Owner: NCEEP Investigator: Kevin Nunnery	Date: 3/6/07 County: Alleghany State: NC
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes (No) Is the area a potential Problem Area? Yes (No) (If needed, explain on reverse.)	Community ID: _____ Transect ID: _____ Plot ID: upland

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Liriodendron tulipifera	tree	FAC
2. Rhododendron maximum	shrub	FAC-
3. Quercus rubra		FACU
4. Pinus strobus		FACU
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 25

Remarks: upland

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:
Depth of Surface Water: _____(in.)
Depth to Free Water in Pit: _____(in.)
Depth to Saturated Soil: _____(in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
___ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks: no hydrology indicators

SOILS

Map Unit Name (Series and Phase): Allegheny County not mapped

Drainage Class: _____

Taxonomy (Subgroup): _____

Field Observations
Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-15		10YR 4/3			clay loam
15-18		10YR 3/6			clay loam

Hydric Soil Indicators:

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

Remarks: no hydric soils indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes (No) (Circle)	(Circle)
Wetland Hydrology Present?	Yes (No)	Is this Sampling Point Within a Wetland? Yes (No)
Hydric Soils Present?	Yes (No)	

Remarks:

upland plot - wetlands on unnamed tributary are very close together

UT

Approved by HQUSACE 3/92

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

Project/Site: Glade Cr - big wetland b/w mainstem & road Applicant/Owner: NCEEP Investigator: Kevin Nunnery	Date: 3/6/07 County: Alleghany State: NC
Do Normal Circumstances exist on the site? (Yes) No Is the site significantly disturbed (Atypical Situation)? Yes No Is the area a potential Problem Area? Yes No (If needed, explain on reverse.)	Community ID: _____ Transect ID: _____ Plot ID: only wetland on Glade Cr. (wetland 1)

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Acer rubrum	tree	FAC	9.		
2. Alnus serrulata	sap	FACW+	10.		
3. Juncus effusus	herb	OBL	11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____ (in.)
Depth to Free Water in Pit: 0 (in.)
Depth to Saturated Soil: _____ (in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
✓ Saturated in Upper 12 Inches
✓ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): Allegheny County not mapped

Drainage Class: _____

Field Observations Confirm Mapped Type? Yes No

Taxonomy (Subgroup): _____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-18		7.5YR 4/2	Oxidized root	channels	loam

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? (Yes) No (Circle)
Wetland Hydrology Present? (Yes) No
Hydric Soils Present? (Yes) No

(Circle)
Is this Sampling Point Within a Wetland? (Yes) No

Remarks: Glade Cr Wetland 1

Approved by HQUSACE 3/92

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

Project/Site: Glade Creek Applicant/Owner: NCEEP Investigator: Kevin Nunnery	Date: 3/6/07 County: Alleghany State: NC
Do Normal Circumstances exist on the site? Yes No Is the site significantly disturbed (Atypical Situation)? Yes No Is the area a potential Problem Area? Yes No (If needed, explain on reverse.)	Community ID: _____ Transect ID: Plot ID: upland plot for wetland on Glade mainstem

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Pinus strobus	tree	FACU
2. Liriodendron tulipifera	tree	FAC
3. Rhododendron maximum	shrub	FAC-
4.		
5.		
6.		
7.		
8.		

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

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 33

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____(in.)

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

Depth to Saturated Soil: _____(in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
___ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks: no wetland hydrology indicators

SOILS

Map Unit Name (Series and Phase): Allegheny County not mapped

Drainage Class: _____

Taxonomy (Subgroup): _____

Field Observations
Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-12		10YR 4/3			clay loam
12-18		10YR 3/6			clay loam

Hydric Soil Indicators:

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

Remarks: no hydric soils indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes (No) (Circle)		(Circle)
Wetland Hydrology Present?	Yes (No)	Is this Sampling Point Within a Wetland?	Yes (No)
Hydric Soils Present?	Yes (No)		

Remarks:

upland plot for Glade Cr wetland

Approved by HQUSACE 3/92

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 3/6/07	**Project:** EEP Stream Restoration site (this form is for the unnamed tributary to Glade Cr.)	**Latitude:** 36° 3 58.73	
Evaluator: Kevin Nunnery	**Site:** Glade Cr + unnamed tributary	**Longitude:** 36° 28 6.12	
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 58.5	**County:** Alleghany	**Other** *e.g. Quad Name:*	

A. Geomorphology (Subtotal = 30)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	1	2	(3)
3. In-channel structure: riffle-pool sequence	0	1	2	(3)
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	2	(3)
7. Braided channel	0	1	2	(3)
8. Recent alluvial deposits	0	1	2	(3)
9[a] Natural levees	0	(1)	2	3
10. Headcuts	0	1	(2)	3
11. Grade controls	0	0.5	1	(1.5)
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	(1)	0.5	0
17. Sediment on plants or debris	0	(0.5)	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	(1.5)
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = 10)				
20[b]. Fibrous roots in channel	3	2	(1)	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	0.5	(1)	1.5
23. Bivalves	(0)	1	2	3
24. Fish	0	0.5	1	(1.5)
25. Amphibians	0	0.5	1	(1.5)
26. Macrobenthos (note diversity and abundance)	0	0.5	(1)	1.5
27. Filamentous algae; periphyton	0	(1)	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0)			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Many mayflies found, fewer caddis flies

Sketch:

INTERMITTENT CHANNEL EVALUATION FORM

ACTION ID _____ APPLICANT NAME NCEEP DATE 3/6/07

PROPOSED CHANNEL WORK (i.e., culvert, relocation, etc.) channel preservation

WATERBODY/RIVER BASIN unnamed trib to Glade Cr/Little R./New R. COUNTY/CITY Alleghany / 4 mis. S of Sparta

RECENT WEATHER CONDITIONS _____

P	SP	NP	Observation	Comments or Description
	✓		Fish/Shellfish/Crustaceans Present	
	✓		Benthic Macro Invertebrates	
	✓		Amphibians Present/Breeding	
		✓	Algae And/Or Fungus (water quality function)	
	✓		Wildlife Channel Use (i.e. tracks, feces, shells, others)	
		✓	Federally Protected Species Present (Discontinue)	
	✓		Riffle/Pool Structure	
✓			Stable Streambanks	Some areas somewhat unstable
			Channel Substrate (i.e. gravel, cobble, rock, coarse sand)	D50 = small gravel
	✓		Riparian Canopy Present (SP =/> 50% closure)	
	✓		Undercut Banks/Instream Habitat Structure	
	✓		Flow In Channel	
✓			Wetlands Adjacent To/Contig. With Channel (Discontinue)	Wetlands near channel delmerated → channel preservation proposed
	✓		Persistent Pools/Saturated Bottom (June through Sept.)	owner says it flows year round
	✓		Seeps/Groundwater Discharge (June through Sept.)	" " " " " "
✓			Adjacent Floodplain Present	
	✓		Wrack Material or Drift Lines	
	✓		Hydrophytic Vegetation in/adjacent to channel	

Important To Domestic Water Supply? Y / (N)

Does Channel Appear On A Quad Or Soils Map? (Y) / N **Approx. Drainage Area:** 21 mile^2

Determination:

- [✓] Perennial Channel (stop)
- [ ] Intermittent Channel (proceed)
- [ ] Ephemeral Channel (no jd)
- [ ] Ditch Through Upland (no jd)
- [ ] Important Channel: _____ LF
- [ ] Unimportant Channel: _____ LF

(attach map indicating location of important/unimportant channel)

PROJECT MGR. Initials _____

Evaluator's Signature: Kevin J. Nunnery
(if other than C.O.E. project manager)

P=Present SP=Stongly Present NP=Not Present

11/4/98

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 3/6/07	**Project:** EEP stream Restoration site	**Latitude:** 81° 3 58.73
Evaluator: Kevin Nunnery	**Site:** Glade Creek main-stem	**Longitude:** 36° 28 6.12
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 59	**County:** Alleghany	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 34)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	1	2	(3)
3. In-channel structure: riffle-pool sequence	0	1	2	(3)
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	2	(3)
7. Braided channel	0	1	2	(3)
8. Recent alluvial deposits	0	1	2	(3)
9[a] Natural levees	0	1	2	(3)
10. Headcuts	0	(1)	2	3
11. Grade controls	0	0.5	1	(1.5)
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		(Yes = 3)	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 11.5)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	(1)	0.5	0
17. Sediment on plants or debris	0	0.5	1	(1.5)
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	(1.5)
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = 13.5)				
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	0.5	(1)	1.5
23. Bivalves	0	(1)	2	3
24. Fish	0	0.5	1	(1.5)
25. Amphibians	0	0.5	(1)	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	(1.5)
27. Filamentous algae; periphyton	0	(1)	2	3
28. Iron oxidizing bacteria/fungus.	0	(0.5)	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0)			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

mayflies very numerous, some caddisflies, no stoneflies found during pebble counts

Sketch:

INTERMITTENT CHANNEL EVALUATION FORM

ACTION ID _____ APPLICANT NAME NCEEP DATE 3/6/07

PROPOSED CHANNEL WORK (i.e., culvert, relocation, etc.) restoration, enhancement of channel

WATERBODY/RIVER BASIN Glade Cr/Little R./New R. COUNTY/CITY Alleghany / 4 mi. S of Sparta

RECENT WEATHER CONDITIONS no rain in >48 hrs

P	SP	NP	Observation	Comments or Description
	✓		Fish/Shellfish/Crustaceans Present	
	✓		Benthic Macro Invertebrates	
	✓		Amphibians Present/Breeding	
✓			Algae And/Or Fungus (water quality function)	
	✓		Wildlife Channel Use (i.e. tracks, feces, shells, others)	
		✓	Federally Protected Species Present (Discontinue)	
	✓		Riffle/Pool Structure	
✓			Stable Streambanks	stable in limited areas ⇒ restoration needed
			Channel Substrate (i.e. gravel, cobble, rock, coarse sand)	D_{50} = gravel
	✓		Riparian Canopy Present (SP =/> 50% closure)	
✓			Undercut Banks/Instream Habitat Structure	
	✓		Flow In Channel	
✓			Wetlands Adjacent To/Contig. With Channel (Discontinue)	one wetland delineated near channel
			Persistent Pools/Saturated Bottom (June through Sept.)	
	✓		Seeps/Groundwater Discharge (June through Sept.)	
	✓		Adjacent Floodplain Present	
	✓		Wrack Material or Drift Lines	
✓			Hydrophytic Vegetation in/adjacent to channel	

Important To Domestic Water Supply? Y / (N)

Does Channel Appear On A Quad Or Soils Map? (Y) / N **Approx. Drainage Area:** _____

Determination:

- [✓] Perennial Channel (stop)
- [ ] Intermittent Channel (proceed)
- [ ] Ephemeral Channel (no jd)
- [ ] Ditch Through Upland (no jd)

- [ ] Important Channel: _____ LF
- [ ] Unimportant Channel: _____ LF

(attach map indicating location of important/unimportant channel)

PROJECT MGR. Initials _____

Evaluator's Signature: Kevin J. Nunnery
(if other than C.O.E. project manager)

P=Present SP=Stongly Present NP=Not Present

11/4/98

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	2567	1 Yr	204	2612.38	2614.93	3.94					0.39	0.51
Main stem	2567	2 Yr	335	2612.38	2615.71	4.46	0.15	0.14	0.01	0.01	0.46	0.51
Main stem	2567	10 Yr	1637	2612.38	2618.62	9.57	1.09	1.04	0.28	0.27	1.64	0.73
Main stem	2567	100 Yr	3367	2612.38	2620.47	12.77	1.59	2.09	0.52	0.79	2.64	0.84
Main stem	2377	1 Yr	204	2611	2613.06	7.28					1.43	1
Main stem	2377	2 Yr	335	2611	2613.71	8.43	0.59	0.28	0.15	0.05	1.75	1
Main stem	2377	10 Yr	1637	2611	2617.67	10.72	2.21	1.53	0.84	0.48	2	0.76
Main stem	2377	100 Yr	3367	2611	2619.97	12.51	2.14	2.65	0.78	1.08	2.45	0.76
Main stem	2245	1 Yr	204	2610	2612.82	3.22					0.26	0.4
Main stem	2245	2 Yr	335	2610	2613.38	4.11	0.15	0.24	0.01	0.02	0.39	0.46
Main stem	2245	10 Yr	1637	2610	2616.99	8	0.75	0.76	0.14	0.13	1.1	0.57
Main stem	2245	100 Yr	3367	2610	2619.77	9.29	1.5	1.73	0.38	0.48	1.31	0.55
Main stem	2132	1 Yr	204	2610	2612.31	4.16					0.49	0.64
Main stem	2132	2 Yr	335	2610	2612.9	4.69	0.43	0.3	0.07	0.04	0.55	0.6
Main stem	2132	10 Yr	1637	2610	2616.84	7.09	1.22	0.72	0.28	0.13	0.87	0.52
Main stem	2132	100 Yr	3367	2610	2619.57	8.74	1.75	1.6	0.47	0.41	1.16	0.53

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	2054	1 Yr	204	2609.11	2611.18	6.45					1.18	0.99
Main stem	2054	2 Yr	335	2609.11	2611.69	7.6	0.27	0.33	0.05	0.06	1.48	1
Main stem	2054	10 Yr	1637	2609.11	2616.25	8.99	0.42	1.61	0.06	0.46	1.36	0.63
Main stem	2054	100 Yr	3367	2609.11	2618.78	11.49	0.45	2.25	0.07	0.78	1.99	0.68
Main stem	2009	1 Yr	204	2609.02	2611.09	3.45					0.32	0.49
Main stem	2009	2 Yr	335	2609.02	2611.78	3.9	0.26	0.33	0.03	0.04	0.36	0.46
Main stem	2009	10 Yr	1637	2609.02	2616.58	5.73	0.89	0.78	0.15	0.12	0.53	0.38
Main stem	2009	100 Yr	3367	2609.02	2619.11	8.08	1.26	1.32	0.26	0.29	0.95	0.46
Main stem	1922	1 Yr	204	2608.42	2610.69	4.04					0.42	0.53
Main stem	1922	2 Yr	335	2608.42	2611.36	4.81	0.25	0.24	0.03	0.03	0.54	0.55
Main stem	1922	10 Yr	1637	2608.42	2615.99	7.73	1.04	0.74	0.22	0.13	0.98	0.51
Main stem	1922	100 Yr	3367	2608.42	2618.26	10.66	1.94	1.78	0.59	0.52	1.69	0.62
Main stem	1844	1 Yr	204	2608	2610.48	3.63					0.32	0.45
Main stem	1844	2 Yr	335	2608	2611.14	4.49	0.26	0.26	0.03	0.03	0.46	0.49
Main stem	1844	10 Yr	1637	2608	2615.87	7.47	0.86	0.88	0.16	0.16	0.9	0.48
Main stem	1844	100 Yr	3367	2608	2618.08	10.5	1.78	1.83	0.51	0.53	1.63	0.6

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	1789	1 Yr	204	2608	2610.23	4.17					0.44	0.53
Main stem	1789	2 Yr	335	2608	2610.83	5.22	0.4	0.31	0.06	0.04	0.63	0.58
Main stem	1789	10 Yr	1637	2608	2615.57	8.22	1.11	0.96	0.24	0.2	1.09	0.54
Main stem	1789	100 Yr	3367	2608	2616.83	13.34	1.94	2.09	0.68	0.76	2.73	0.81
Main stem	1739	1 Yr	204	2608	2609.96	4.54					0.54	0.61
Main stem	1739	2 Yr	335	2608	2610.5	5.66	0.43	0.45	0.07	0.08	0.76	0.66
Main stem	1739	10 Yr	1637	2608	2615.61	7.46	0.9	1.13	0.17	0.24	0.9	0.48
Main stem	1739	100 Yr	3367	2608	2616.39	13.09	1.73	2.27	0.58	0.86	2.66	0.81
Main stem	1669	1 Yr	204	2607	2609.72	4.02					0.39	0.48
Main stem	1669	2 Yr	335	2607	2610.16	5.48	0.28	0.18	0.04	0.02	0.7	0.6
Main stem	1669	10 Yr	1637	2607	2615.55	7.14	0.77	1.11	0.13	0.22	0.81	0.45
Main stem	1669	100 Yr	3367	2607	2616.28	12.45	1.54	2.2	0.47	0.8	2.39	0.74
Main stem	1637	1 Yr	204	2607	2609.74	2.87					0.21	0.36
Main stem	1637	2 Yr	335	2607	2610.23	3.76	0.16	0.16	0.01	0.01	0.33	0.42
Main stem	1637	10 Yr	1637	2607	2615.79	4.54	0.51	0.84	0.05	0.12	0.32	0.28
Main stem	1637	100 Yr	3367	2607	2616.65	7.92	1.1	1.57	0.22	0.38	0.95	0.47

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	1621	1 Yr	204	2608	2609.64	3.44					0.33	0.53
Main stem	1621	2 Yr	335	2608	2610.15	4.07	0.16	0.15	0.01	0.01	0.42	0.53
Main stem	1621	10 Yr	1637	2608	2615.83	3.91	0.42	0.76	0.04	0.09	0.24	0.25
Main stem	1621	100 Yr	3367	2608	2616.77	6.71	0.95	1.39	0.16	0.29	0.69	0.41
Main stem	1610	1 Yr	204	2608	2609.54	3.8					0.43	0.63
Main stem	1610	2 Yr	335	2608	2610.08	4.19	0.11	0.12		0.01	0.46	0.58
Main stem	1610	10 Yr	1637	2608	2615.83	3.76	0.42	0.74	0.04	0.09	0.23	0.24
Main stem	1610	100 Yr	3367	2608	2616.77	6.52	0.92	1.34	0.15	0.27	0.65	0.4
Main stem	1593	1 Yr	204	2608	2609.47	3.54					0.35	0.54
Main stem	1593	2 Yr	335	2608	2610.02	4.13	0.31	0.38	0.04	0.05	0.43	0.53
Main stem	1593	10 Yr	1637	2608	2615.8	4.01	0.52	0.76	0.05	0.09	0.25	0.25
Main stem	1593	100 Yr	3367	2608	2616.69	6.96	1.1	1.39	0.21	0.3	0.73	0.42
Main stem	1581	1 Yr	204	2608	2609.3	4.3					0.54	0.7
Main stem	1581	2 Yr	335	2608	2609.87	4.74	0.27	0.48	0.04	0.08	0.58	0.63
Main stem	1581	10 Yr	1637	2608	2615.8	4.01	0.54	0.82	0.06	0.1	0.25	0.26
Main stem	1581	100 Yr	3367	2608	2616.68	7	1.05	1.48	0.19	0.33	0.74	0.42

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	1441	1 Yr	204	2606	2608.79	3.39					0.29	0.44
Main stem	1441	2 Yr	335	2606	2609.36	4.21	0.16	0.24	0.01	0.03	0.42	0.49
Main stem	1441	10 Yr	1637	2606	2615.74	3.96	0.4	0.73	0.03	0.09	0.24	0.24
Main stem	1441	100 Yr	3367	2606	2616.52	6.99	0.83	1.37	0.13	0.28	0.73	0.4
Main stem	1186	1 Yr	204	2606	2607.77	4.07					0.46	0.61
Main stem	1186	2 Yr	335	2606	2608.4	4.57	0.33	0.34	0.04	0.05	0.51	0.57
Main stem	1186	10 Yr	1637	2606	2615.67	3.39	0.67	0.63	0.07	0.06	0.17	0.2
Main stem	1186	100 Yr	3367	2606	2616.29	6.3	1.29	1.2	0.24	0.21	0.57	0.35
Main stem	1073	1 Yr	204	2604	2607.41	3.42					0.3	0.44
Main stem	1073	2 Yr	335	2604	2608.06	4.17	0.35	0.08	0.04		0.4	0.47
Main stem	1073	10 Yr	1637	2604	2615.64	3.49	0.67	0.62	0.07	0.06	0.18	0.19
Main stem	1073	100 Yr	3367	2604	2616.15	6.59	1.3	1.18	0.25	0.21	0.62	0.36
Main stem	984	1 Yr	204	2604	2606.91	4.64	0.05				0.57	0.64
Main stem	984	2 Yr	335	2604	2606.99	7.29	0.22	0.19	0.03	0.03	1.39	0.99
Main stem	984	10 Yr	1637	2604	2615.55	4.12	0.83	0.56	0.1	0.05	0.24	0.23
Main stem	984	100 Yr	3367	2604	2615.73	8.21	1.67	1.12	0.4	0.22	0.96	0.45

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	555	1 Yr	204	2602	2604.8	3.82					0.4	0.56
Main stem	555	2 Yr	335	2602	2606.18	3.02	0.39	0.35	0.04	0.04	0.21	0.33
Main stem	555	10 Yr	1637	2602	2615.54	2.51	0.57	0.5	0.04	0.03	0.09	0.13
Main stem	555	100 Yr	3367	2602	2615.71	5.07	1.15	1.02	0.17	0.14	0.35	0.26
Main stem	519	1 Yr	204	2601	2604.78	2.68					0.19	0.36
Main stem	519	2 Yr	335	2601	2606.18	2.35	0.26	0.27	0.02	0.02	0.12	0.24
Main stem	519	10 Yr	1637	2601	2615.55	2.22	0.46	0.49	0.03	0.03	0.07	0.11
Main stem	519	100 Yr	3367	2601	2615.74	4.48	0.92	0.99	0.11	0.13	0.27	0.22
Main stem	462	1 Yr	204	2601	2604.75	2.04					0.1	0.24
Main stem	462	2 Yr	335	2601	2606.17	1.99	0.27	0.24	0.02	0.02	0.08	0.18
Main stem	462	10 Yr	1637	2601	2615.56	1.93	0.48	0.46	0.03	0.03	0.05	0.09
Main stem	462	100 Yr	3367	2601	2615.78	3.88	0.97	0.94	0.11	0.11	0.2	0.19
Main stem	388	1 Yr	204	2601	2604.64	2.75					0.15	0.25
Main stem	388	2 Yr	335	2601	2606.02	3.28					0.19	0.26
Main stem	388	10 Yr	1637	2601	2615.51	2.63	0.34	0.54	0.02	0.04	0.09	0.12
Main stem	388	100 Yr	3367	2601	2615.58	5.36	0.71	1.11	0.08	0.16	0.38	0.25

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	378		Bridge									
Main stem	370	1 Yr	204	2601	2603.37	4.32					0.44	0.5
Main stem	370	2 Yr	335	2601	2604.07	5.46					0.64	0.55
Main stem	370	10 Yr	1637	2601	2606.95	13.73					3.23	0.99
Main stem	370	100 Yr	3367	2601	2610.58	17.5					4.48	1
Main stem	334	1 Yr	204	2601	2603.36	3.26					0.27	0.42
Main stem	334	2 Yr	335	2601	2604.14	3.66	0.13	0.13	0.01	0.01	0.32	0.42
Main stem	334	10 Yr	1637	2601	2608.18	6.11	0.89	1.49	0.16	0.34	0.63	0.43
Main stem	334	100 Yr	3367	2601	2610.34	9	1.89	2.52	0.54	0.82	1.24	0.54
Main stem	277	1 Yr	204	2600.32	2602.47	6.81					1.29	1.01
Main stem	277	2 Yr	335	2600.32	2603.04	7.94	0.66	0.77	0.17	0.21	1.56	0.99
Main stem	277	10 Yr	1637	2600.32	2606.56	11.85	2.14	2.14	0.85	0.86	2.48	0.89
Main stem	277	100 Yr	3367	2600.32	2609.72	12.15	2.03	1.96	0.69	0.66	2.24	0.73
Main stem	197	1 Yr	204	2598	2602	2.72					0.2	0.4
Main stem	197	2 Yr	335	2598	2602.73	2.94	0.19	0.44	0.02	0.05	0.21	0.35
Main stem	197	10 Yr	1637	2598	2606.57	4.94	0.47	0.86	0.06	0.14	0.42	0.36
Main stem	197	100 Yr	3367	2598	2608.51	7.25	0.9	1.3	0.16	0.28	0.82	0.45

HEC-RAS Plan: Maintstem River: Glade Creek Reach: Main stem												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Main stem	101	1 Yr	204	2598.01	2601.03	6.24	0.11	0.23		0.03	1.04	0.87
Main stem	101	2 Yr	335	2598.01	2601.58	7.58	0.81	0.73	0.22	0.19	1.4	0.91
Main stem	101	10 Yr	1637	2598.01	2605.2	10.75	2.02	1.14	0.74	0.31	2.02	0.79
Main stem	101	100 Yr	3367	2598.01	2607.07	13.4	2.97	1.94	1.34	0.71	2.86	0.85

HEC-RAS Plan: Tributary River: Glade Creek Reach: Tributary												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Tributary	1205	1 Yr	16	2611.43	2611.9	2.89	0.37		0.08		0.4	0.99
Tributary	1205	2 Yr	25	2611.43	2611.99	3.3	0.53	0.21	0.14		0.48	0.98
Tributary	1205	10 Yr	98	2611.43	2612.49	5.17	1.17	0.73	0.42	0.21	0.87	0.99
Tributary	1205	100 Yr	184	2611.43	2612.91	6.38	1.48	1	0.58	0.32	1.16	1
Tributary	1127	1 Yr	16	2610	2610.56	1.65					0.12	0.47
Tributary	1127	2 Yr	25	2610	2610.71	1.87	0.17	0.13	0.02	0.01	0.13	0.46
Tributary	1127	10 Yr	98	2610	2611.63	2.63	0.48	0.38	0.07	0.05	0.19	0.38
Tributary	1127	100 Yr	184	2610	2612.38	3.19	0.67	0.39	0.1	0.05	0.24	0.38
Tributary	1057	1 Yr	16	2609.3	2610.18	2.11					0.17	0.52
Tributary	1057	2 Yr	25	2609.3	2610.34	2.5	0.17	0.18	0.02	0.02	0.22	0.53
Tributary	1057	10 Yr	98	2609.3	2611.24	4.17	0.56	0.38	0.1	0.06	0.46	0.58
Tributary	1057	100 Yr	184	2609.3	2611.96	5.07	0.71	0.76	0.14	0.16	0.6	0.59
Tributary	954	1 Yr	16	2608.29	2609.01	3.82					0.59	1
Tributary	954	2 Yr	25	2608.29	2609.17	4.4		0.3		0.06	0.72	1.01
Tributary	954	10 Yr	98	2608.29	2610.05	6.33		1.05		0.36	1.16	1
Tributary	954	100 Yr	184	2608.29	2610.73	7.36		1.42		0.54	1.42	1
Tributary	927	1 Yr	16	2607	2608.26	2.41					0.2	0.48
Tributary	927	2 Yr	25	2607	2608.47	2.95	0.2	0.21	0.02	0.02	0.28	0.53
Tributary	927	10 Yr	98	2607	2609.42	5.75	0.76	0.87	0.18	0.22	0.84	0.73
Tributary	927	100 Yr	184	2607	2609.93	8.3	1.25	1.38	0.43	0.49	1.61	0.94
Tributary	787	1 Yr	16	2606.33	2606.96	3.58					0.54	1.01
Tributary	787	2 Yr	25	2606.33	2607.1	4.13	0.31	0.19	0.06		0.66	1.01
Tributary	787	10 Yr	98	2606.33	2607.88	6.34	1.04	0.69	0.34	0.18	1.14	0.98
Tributary	787	100 Yr	184	2606.33	2608.61	7.23	1.08	0.78	0.33	0.2	1.28	0.89

HEC-RAS Plan: Tributary River: Glade Creek Reach: Tributary												
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Vel Left (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Chan (lb/sq ft)	Froude # Chl
Tributary	438	1 Yr	16	2603	2604.1	2.04					0.16	0.48
Tributary	438	2 Yr	25	2603	2604.28	2.42	0.2	0.05	0.02		0.2	0.5
Tributary	438	10 Yr	98	2603	2605.24	3.99	0.72	0.51	0.14	0.09	0.41	0.54
Tributary	438	100 Yr	184	2603	2606.08	4.83	0.99	0.64	0.22	0.12	0.53	0.54
Tributary	300	1 Yr	16	2601	2601.81	4.1					0.65	1.01
Tributary	300	2 Yr	25	2601	2601.99	4.69	0.39	0.39	0.08	0.09	0.78	1
Tributary	300	10 Yr	98	2601	2602.99	7.2	1.21	1.29	0.42	0.46	1.36	0.98
Tributary	300	100 Yr	184	2601	2603.87	8.63	1.49	1.5	0.54	0.55	1.69	0.95
Tributary	188	1 Yr	16	2600	2600.83	2.04					0.15	0.44
Tributary	188	2 Yr	25	2600	2601.05	2.36	0.19	0.08	0.02		0.18	0.46
Tributary	188	10 Yr	98	2600	2602.33	3.54	0.62	0.54	0.1	0.08	0.3	0.43
Tributary	188	100 Yr	184	2600	2603.33	4.35	0.84	0.45	0.15	0.06	0.4	0.44
Tributary	78	1 Yr	16	2599	2599.78	4.24					0.68	1
Tributary	78	2 Yr	25	2599	2599.98	4.88	0.42	0.45	0.09	0.1	0.82	1
Tributary	78	10 Yr	98	2599	2601.03	7.71	1.28	1.31	0.46	0.48	1.53	1.01
Tributary	78	100 Yr	184	2599	2602.11	8.44	1.21	1.43	0.38	0.49	1.56	0.88

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Glade Creek Stream Restoration
Name if stream or feature:	Glade Creek and unnamed tributary to Glade Creek
County:	Alleghany
Name of river basin:	New
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Alleghany
DFIRM panel number for entire site:	As of September 26, 2007, County Not Mapped by NC Floodmaps
Consultant name:	Biohabitats, Inc
Phone number:	919-518-0311
Address:	8218 Creedmoor Road, Suite 200 Raleigh, NC 27613

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".
The site is located off Dewitt Road, approximately 3 miles south of Sparta, N.C. on property owned by Steven Faw. Rosgen Priority II stream restoration and enhancement are proposed for the Glade Creek channel and preservation and Rosgen Priority II restoration are proposed for the unnamed tributary channel.

Summarize stream reaches or wetland areas according to their restoration priority.

Reach	Length	Priority
Glade Creek	*2,430'*	*Two (Restoration)*
Glade Creek	*125'*	*Two (Enhancement)*
Unnamed Tributary	*788'*	*Preservation*
Unnamed Tributary	*275'*	*Two (Restoration)*

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

☐ Yes ☒ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☐ AE Zone

- ☐ Floodway
- ☐ Non-Encroachment
- ☒ None

☐ A Zone

- ☐ Local Setbacks Required
- ☐ No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

☒ Yes ☐ No

Land Acquisition (Check)

☐ State owned (fee simple)

☐ Conservation easment (Design Bid Build)

☐ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

☑ Yes ☐ No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator:
Phone Number:

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☐ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision

☐ Other Requirements

List other requirements:

Comments:

Name: _____ Signature: _____

Title: _____ Date: _____