

# MUDDY CREEK WATERSHED RESTORATION INITIATIVE

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## Feasibility Report and Restoration Plan for The Muddy Creek Watershed

Burke and McDowell Counties, North Carolina  
Catawba River Basin



December, 2003

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## Executive Summary

The Muddy Creek watershed is impaired. Fish and benthic macroinvertebrate data from the NC Division of Water Quality, NC Wildlife Resources Commission, and Duke Energy Corporation all indicate “fair” to “good-fair” water quality. Duke water chemistry monitoring show mean coliform bacteria concentrations at levels higher than the state health standard at six of eight data stations dispersed throughout the watershed. The Muddy Creek Restoration Partners own physical assessment of the entire 96 square mile watershed indicates widespread habitat degradation and impaired stream functionality.

Stream entrenchment is severe and pervasive on 36 miles of the main stems of North and South Muddy Creeks, their larger tributaries, and at the mouths of smaller tributaries. This condition reduces or eliminates in many cases the functionality of adjacent floodplains. Resulting exposed barren banks are actively eroding, with bank pin data at 38 of 886 total barren bank sites confirming a minimum of 350 tons of sediment loaded into the Muddy Creek watershed in the last year and a half alone. Since bank pin data is collected at only 4% of barren bank sites, it is no exaggeration to speculate that the remaining barren banks contributed a minimum of ten times that amount of sediment (3,500 tons) or more to the watershed during the last year during normal and above normal rainfall. This is part of the reason that silt and fine sands are the predominant substrate materials at 40% of riffle areas and 100% of pools surveyed, reducing quality in-stream habitat for an appropriately diverse aquatic community. Another reason for the imbedded stream substrate is overland flows of sediment that enter the watershed, primarily from smaller 1st and 2nd order tributaries. Riparian forest vegetation is less than 25 feet wide on 780,000 feet of creekside land, which is inadequate in most circumstances to filter those additional overland flows, especially those occurring from rapidly increasing development and clearcutting of timber on the steeper hillsides. The lack of riparian buffer coverage also diminishes detrital inputs and tree canopy shade, both functions that are critical to fish and wildlife diversity and overall stream health. In addition to those sediment sources, livestock are known to regularly access 20,000 feet of stream at minimum, trampling creekbanks and contributing also to the coliform problem.

The Muddy Creek Restoration Partners believe that a reversal of this condition is feasible, but it will likely require a minimum commitment of 10 more years and an additional \$17.5 million beyond the \$1.1 million already raised and used toward restoration. This benchmark budget includes preservation costs for intact riparian lands, which accounts for \$15 million of project costs. The time and money required would be invested on implementation of four restoration strategies that include natural channel design stream restoration; riparian reforestation; livestock exclusion; and riparian forest preservation. A random, haphazard approach at restoration will not work. Successful attainment of project goals will require adherence to the conservation project priorities list generated by this plan. Additional on-the-ground conservation projects may also prove necessary but should not be pursued to the neglect of the priority sites. While this plan establishes scientifically sound priorities for conservation, it does not factor for contingencies; such as what to do about intact riparian forest lands once prioritized for preservation that are logged before acquisition is possible. Other contingencies may also appear throughout the project duration that require Partner value judgments and an occasional shift in immediate emphases to manage for those contingencies.

The Partners can expect an investment in the four restoration strategies as follows.

- **Natural Channel Design Stream Restoration**

This plan reveals six high priority stream reaches in the watershed totaling approximately 12,000 linear feet that would benefit from natural channel design stream restoration. These reaches contain 18 of the 26 highest priority barren bank sites identified during field inventories that were responsible for the sediment delivery estimates stated above. Natural channel design stream restoration here will likely consume \$1.053 million of the benchmark cost estimate given above.

- **Riparian Reforestation**

This plan reveals approximately 32,000 feet of creekside land without any riparian forest vegetation that are first priorities for riparian reforestation projects. Three additional sub-watersheds lack adequate riparian forest coverage on over 50% of their stream lengths. Riparian forest enhancement should extend to these drainage areas as well. Riparian reforestation of these inadequate buffer areas would likely consume \$224,000 of the benchmark estimate.

- **Livestock Exclusion**

This plan prioritizes 15 livestock exclusion projects, which should eliminate an estimated 1/2 - 2/3 of the cattle access issues in the watershed. The Partners would like to do more, but livestock market forces make prioritization unpredictable since lands grazed with cattle last year may not have cattle this year. These projects would likely consume \$124,000.

- **Riparian Forest Preservation**

This plan also recognizes that gains made in these restoration strategies will be nullified if intact upstream areas become degraded. Therefore, approximately 15,200 acres have been prioritized for riparian forest preservation. Most of this acreage is in large tract holdings and occurs at headwater areas and in sub-watersheds whose riparian zones are currently forested and intact. The \$15 million preservation estimate is a ballpark figure and would require purchase of conservation easements and donations of conservation easements to cover anticipated costs. Fee simple purchase agreements would likely increase the cost estimate.

A fully supporting rating for the Muddy Creek watershed and a trophy trout fishery on the Catawba River tailrace at Lake James have been the two driving goals of the project since its inception in 1998. These goals are lofty but they can be attained. Success will require participation from a critical mass of watershed landowners, continued private/public partnerships, local government support, and adequate funding. Some substantial successes have already been realized. Since 1999, the Partners have restored over 8,000 feet of barren banks through natural channel design stream restoration and have reforested an additional 6,000 feet of riparian land that had absolutely no riparian forest buffer. Water quality and ecological integrity should be improving at these areas. The other restoration projects recommended by this plan will deliver additional water quality and ecological benefits to the watershed, but they will ultimately do more. The Partners believe that a successful restoration of Muddy Creek could deliver over \$1.2 million annually to the economies of Burke and McDowell Counties through capitalization of Farm Bill conservation programs and a bonafide trophy tailrace fishery. This figure does not include other financial benefits derived from restoration such as the improvements in wastewater treatment capacity, which can be used as an industrial/commercial recruitment tool; and cost savings due to improved efficiency in treatment capabilities of drinking water supplies downstream. The economic benefit calculation also does not include quality of life improvements.

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# Chapter 1: Introduction to the Muddy Creek Watershed and the Muddy Creek Restoration Partners

## Introduction

In the early 1990's biologists with the North Carolina Wildlife Resources Commission (NCWRC) and Duke Power Company (Duke) began exploring the idea of a trophy tailrace trout fishery on the Catawba River between Lake James and Morganton. Deepwater hydro-power releases from the Bridgewater Dam supply clean cold water, and the rocky substrate of the Catawba River contains riffle areas that oxygenate the water and provide habitat for aquatic organisms and fish. A limiting factor to the success of this fishery is thought to be the large sediment load delivered to this system from the 96 square mile Muddy Creek watershed whose confluence is located approximately 1 mile downstream from the Bridgewater Dam (Figures 1 and 2).

Figure 1: Confluence of Muddy Creek and the Catawba River

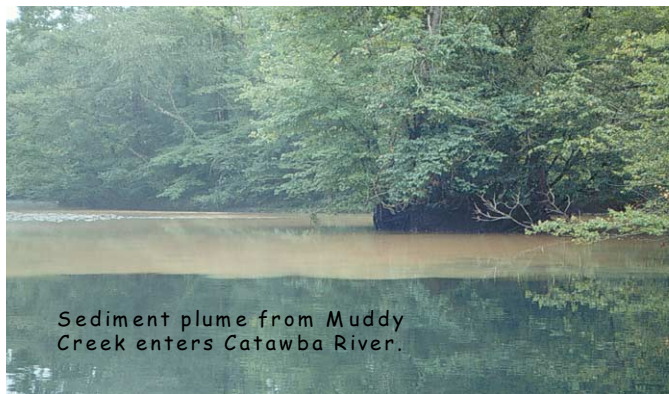
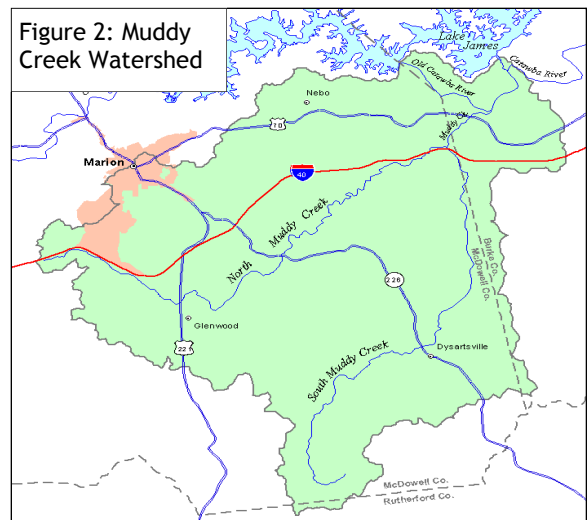


Figure 2: Muddy Creek Watershed



In 1998, Duke and NCWRC formed a partnership with the following other organizations in an effort to address the sediment problem in the Muddy Creek watershed that is compromising water quality and habitat there and downstream in the Catawba River.

- Trout Unlimited
- Foothills Conservancy of North Carolina
- McDowell County Soil and Water Conservation District
- McDowell County
- Burke County
- USDA Natural Resources Conservation Service
- North Carolina Cooperative Extension Service
- Mountain Valleys Resource, Conservation, and Development Council (joined in 2002)

In addition to staffing and financial commitments from the partners, the Muddy Creek Restoration Partners have received funding from the NC Division of Water Resources, NC Clean Water Management Trust Fund, National Fish and Wildlife Foundation, Trout and Salmon Foundation, US Environmental Protection Agency, and NC Wildlife Federation. Vulcan Materials and Confluence Watersports, Inc. have graciously donated materials and supplies.

## **A. Project Goals and Objectives**

The Muddy Creek Restoration Partners is working to accomplish two main goals.

- 1) improve water quality in the Muddy Creek watershed to the degree that it promotes a trophy tailrace trout fishery in the Catawba River below Lake James.
- 2) achieve a State of NC fully supporting designation for all water courses in the watershed.

The Partnership has established the following objectives, designed specifically to help the project reach its goals.

Objective A. Recruit and build a broad level of watershed resident and landowner support for the project such that landowners participate in restoration projects and ultimately assume project ownership and oversight.

Objective B. Attain a complete and thorough understanding of stream and riparian conditions in the Muddy Creek watershed on which to determine restoration feasibility and base restoration priorities.

Objective C. Install stream restoration and riparian best management practices in the watershed at identified locations and preserve intact riparian forest buffers as a means of producing water quality benefits and demonstrating the benefit of these restoration tools to watershed residents and landowners.

Objective D. Actively seek and obtain the necessary funding to pay for project coordination, planning, landowner outreach and education, on-the-ground restoration, assessment work, and project administration.

The Muddy Creek Restoration Partners have developed a *Landowner Outreach and Education Committee* comprised of partners and watershed landowners to help strategize and personally recruit other landowner involvement in the project. The Committee has promoted its goals and objectives through press releases, its own traveling presentation about the project, periodic newsletters and other informative mailings, a bi-annual barbeque and restoration tour, and involvement in schools and 4-H. The Landowner Outreach and Education Committee may develop other innovative methodologies as need dictates and time and money allows.

A *Technical Committee* has been charged with the oversight of a watershed restoration feasibility study, of which this watershed restoration plan is the end product, that will guide all future on-the-ground restoration projects. This study has included a comprehensive watershed assessment involving biological, chemical, and physical parameters. The data generated from the assessment of stream and riparian conditions are being combined with an assessment of cost and benefits of restoration and landowner attitudes to help determine restoration feasibility. A priority list of restoration and preservation sites is included in Chapter 4 of this document.

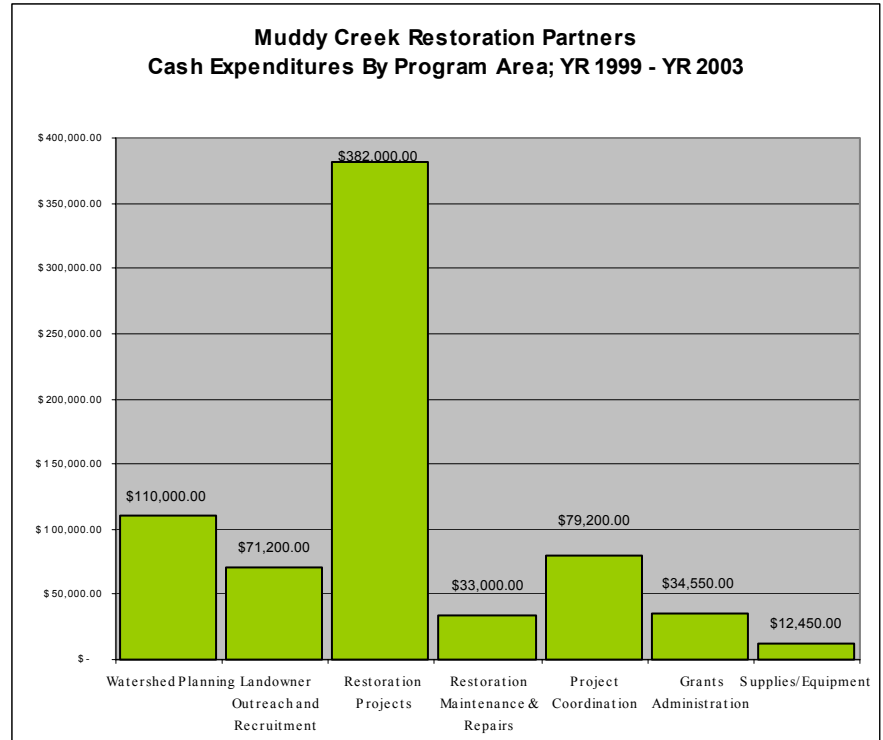
The Technical Committee has, since its inception, been actively involved in restoration as some sites were obvious candidates upon the first quick glimpse of watershed conditions. Other restoration projects have been undertaken where need also existed of getting projects on the ground that could easily be seen by other landowners in the watershed. Restoration projects have ranged from innovative and costly bio-engineering techniques to simple and more affordable native plant reforestation on riparian landscapes. The Technical Committee is also

actively promoting existing state and federal agricultural programs that provide cost share for farmers who desire to fence cattle, obtain alternative watering systems, replant vegetative buffers, or preserve their critical riparian areas, farmsteads and non-pervious surfaces through conservation easements.

The Partners' *Executive and Funding Committee* addresses funding issues for the project. To date, this Committee has been successful in generating over \$1 million in cash and in-kind contributed services from a variety of funding sources. Those sources are listed on page 1 of this document. Cash funding allocations by program area are exhibited in Figure 3. A *Steering Committee* has final authority on decisions made by any of the other sub-committees and provides oversight for the entire initiative.

The Partners have made substantial progress toward the objectives described on the preceding page. Action tasks associated with each objective are ongoing. However, much work remains to be done. The Partners believe that if these goals and objectives can be achieved, this project will ultimately have an extraordinary impact on the economic as well as ecological conditions of the region.

Figure 3: Muddy Creek Restoration Partners Cash Funding by Program Area



**B. Economic Benefits of Watershed Conservation**

**1) Potential Local Investment from Agricultural Cost-Share Programs**

The 2002 US Farm Bill appropriated \$17 million federal dollars to North Carolina in 2003, not including the Conservation Reserve Program, to help farmers implement agricultural best management practices on their lands (Smith - NRCS, personal communication, October 2002). This amounts to approximately \$340,000 per county if the funds were allocated evenly among each county. However, most of these dollars are available only upon demand and require each landowner to express a desire to participate. Therefore, some counties have greater participation rates than others. As the Farm Bill is currently written, this federal investment is expected to increase 20 - 50 % over the coming years but will be dependent upon annual congressional appropriations. In addition to the federal farm conservation programs, North Carolina administers its own Agricultural Cost Share program and had \$5.6 million available state-wide last year of which McDowell and Burke Counties claimed only \$65,000 each.

The different programs in the Farm Bill and State Agricultural Cost Share program can help underwrite land and water conservation in the Muddy Creek watershed by providing fencing and alternative watering systems for livestock, riparian vegetation plantings, and idle land rental payments on ecologically sensitive portions of a farm. At current Farm Bill appropriation rates, roughly \$450,000 per year could be made available to McDowell and Burke County farm owners from these federal and state conservation programs if they choose to participate (Table 1). Money available to participating landowners could be in the form of a paycheck for those who perform their own labour in the installation of conservation practices.

Table 1: Available County Investment from Federal and State Conservation Cost Share Programs; YR 2002

<b>Program</b>	<b>State Allocation</b>	<b>County Portion</b>
Environmental Quality Incentives Program	\$8,600,000	\$172,000
Wildlife Habitat Incentives Program	\$275,000	\$5,500
Wetland Reserve Program	\$5,800,000	\$116,000
Farmland Preservation Program	\$2,200,000	\$44,000
Conservation Reserve Program	N/a	\$0
NC Agricultural Cost Share Program	\$5,600,000	\$112,000
<b>Total Fed and State Conservation Investment</b>	<b>\$22,475,000</b>	<b>\$449,500</b>

## 2) Potential Local Investment from Trophy Tailrace Fishery

The potential economic benefits to Burke and McDowell Counties from the establishment of a bonafide tailrace trout fishery on the Catawba River should not be underestimated. Surveys indicate that anglers in the southeastern US spend \$107 million per year directly on trout fishing which generates an additional \$212 million in related spending, creating over 2,800 jobs (USFWS, 2002). Recent surveys of nearby tailrace fisheries in the region indicate that anglers spend approximately \$100 per day at each site while on a fishing trip (Table 2).

Table 2: Southeastern US Tailrace Trout Fishing Economic Surveys  
Source Data: Fiss - Tennessee Wildlife Resources Agency; Unpublished; 2002

<b>Tailwater / River</b>	<b>Survey Period* (weeks)</b>	<b>Survey year**</b>	<b>Total Value*** Per Angler Day</b>	<b>Number of Angler Days Per Survey Period</b>	<b>Total Value Per Survey Period</b>
Dale Hollow / Obey	32	2001	\$97	10,914	\$1,059,204
Center Hill / Caney Fork	32	1997	\$112	21,300	\$2,380,275
J Percy Priest / Stones	3	2000	no data	779	
Normandy / Duck	26	2000	\$75	6,698	\$502,948
South Holston / South Holstor	32	1997	\$82	29,000	\$2,380,264
Norris / Clinch	34	2001	\$85	24,392	\$2,063,885
Tims Ford / Elk	28	2000	\$108	2,786	\$300,252
Wilbur / Watauga	32	1998	\$124	21,300	\$2,650,440
Apalachia / Hiwassee	42	1999	\$127	20,761	\$2,638,569
Cherokee / Holston	no data	no data	no data	no data	no data
Fort Patrick Henry / Holston	no data	no data	no data	no data	no data
<b>TOTAL</b>				<b>137,930</b>	<b>\$13,975,837</b>
* Period always includes peak fishing season.					
** These are the most recent survey data available.					

“It's not just the bait dealer, it's the gas station owner, it's the hotel proprietor and restaurant owner that feel the effects of fishing,” said economist Jim Caudill of the US Fish and Wildlife Service. The regional tailraces average 17,000 angler days per year with a total average investment by anglers of over \$1.7 million to these local economies. Conservatively assuming the Catawba River tailrace would produce 10,000 angler days with anglers spending on average \$80 per day, \$800,000 per year would accrue to the economies of Burke and McDowell Counties. Though these results are not guarantees of success for the Catawba tailrace, they do illuminate its potential economic benefit.

### **3) Water Resources for Industrial/Commercial Enterprise**

The availability of abundant clean water is a driving resource concern for many corporations seeking to locate new industries whether they be high technology or traditional manufacturing. Commercial and industrial enterprises will often first analyze a community's waters supply and waste treatment capacity before committing to site review. One strategy to maintain high treatment capacity with the goal of attracting new industry is to ensure that ambient water entering the water purification process is already of high quality. If the Muddy Creek restoration project is successful, treatment capacity could theoretically be improved at the Corpening Creek wastewater treatment plant and perhaps even downstream in Burke County and Morganton, provided contributions of sediment and other pollutants remain at current levels or decrease over time.

Studies also suggest that business location criteria is shifting to a focus on “optimizing human resources” (Naisbett 1982, Decker and Crompton 1990; in Kask, 1999, p. 1). “Brainpower” has become just as important or even moreso to today's industry and commercial enterprise than having a workforce available that can produce mass quantities of manufactured goods. Such studies are suggesting that successful innovative companies will choose to locate in communities that bright, creative people find attractive (Birch 1987; in Kask, 1999, p. 2). A clean healthy environment with adequate recreational amenities will help maintain current and draw future human capital and could be a tremendous asset on which McDowell and Burke Counties build a strong, sustainable economy.

### **4) Conservation as a Property Insurance Tool**

When streambanks collapse during storm events, not only is sediment entering the stream jeopardizing the aquatic ecosystem, but the loss of land is an actual loss of equity for the landowner whose property is washed away. Before restoration, streambank erosion was claiming approximately 800 and 3,000 square feet per year respectively at the North Muddy Creek Banner and Higgins restoration sites (Jennings, personal communication, December 2002). This equates to roughly 1/12 of an acre of land loss per year. At \$2,500 per acre, these two property owners were losing a combined \$200 of land value each year. Streambank restoration at these two sites eliminated this economic loss. Significant vocal opposition has formed in the watershed over the last few years predicated by the potential “taking” of riparian property by the State government through its proposed buffer protection regulations. Unfortunately, the volunteer participation mode under which the Muddy Creek Restoration Partners operate has been overlooked by many landowners and in some cases ignored or seen as identical to State mandatory protection rules. This has hurt the effectiveness of the Muddy Creek program. Unfortunately, without adequate restoration, many of these same landowners opposed to mandatory buffers will likely

find much of their riparian lands taken away over time, regardless of their political efforts, by the erosive forces of Muddy Creek.

### **5) Lowered Water Treatment Costs**

The City of Morganton uses the Catawba River as its primary source of drinking water and has an intake several miles downstream from the Muddy Creek confluence. According to one municipal official, reductions in the sediment load from Muddy Creek could result in 10% lower water treatment costs (Don Danford, personal communication, 2000).

Hydroacoustic mapping in 1995 of the Lake Rhodhiss basin, located approximately 16 miles downstream on the Catawba River and the ultimate repository for Muddy Creek sediment, revealed areas of the lake have filled in with “several feet” of sediment since it was constructed in 1925 (Duke Energy; in DWQ, August 1998, p.48). The costs of dredging a lake in order to maintain recreational uses and water storage capacity can be staggering. Lake Lure and Lake Junaluska are two nearby lakes on which millions of taxpayer and private dollars have been invested to maintain their functions, all of which may have been in vain unless the sources of sediment are eliminated. This same fate may be in store for Lake Rhodhiss if sedimentation is not controlled.

### **6) Conservation Benefits to Irrigation and Crop Management**

Irrigation is a common practice in the Muddy Creek watershed. In times of drought, such as from 1998 - 2002, irrigation systems which draw water from the various creeks in the watershed may be the only water that crops receive for a month at a time or more. Sediment laden stream flow can clog filtration devices on these systems, which may result in increased labor, repair, and materials costs. In extreme drought conditions, inefficient irrigation may actually result in costly crop losses. One landowner approached the MCWRI in 2001 with exactly these complaints of upstream sediment runoff damaging his ability to irrigate his nursery crops.

### **7) Vegetation Improvements on Residential Property Values**

Though site-specific appraisals are needed to establish actual value of a well landscaped property, it is generally accepted that adding trees and shrubs in a well designed manner will increase the appraised value of a residential property by 3 - 10% (Naeger, personal communication, 2003). Vegetation on a streamside residential landscape therefore has potential to not only buffer a stream from potential land use impacts but also increase the marketability and sale price of a home or property.

## **C. Ecological Benefits of Watershed Conservation**

### **1) Water Resources Fully Supporting Intended Uses**

Based on data contained in the NC Division of Water Quality’s Catawba River Basinwide Water Quality Plan, the water quality rating of streams in the Muddy Creek watershed is approximately 98% Support-Threatened and 2% Partially Supporting. Sediment is considered the primary problem parameter (DWQ, 1999, p. A-III). Duke Power Company has been collecting data on suspended sediment concentrations in North and South Muddy Creeks since 1995. Total suspended solids (TSS) entering the Catawba River from the Muddy Creek watershed are

estimated to be between 15,000-20,000 tons per year under typical streamflow conditions. These estimates do not include bedload transport, which adds unknown tons per year to the total. Eliminating major sources of sedimentation such as streambank erosion and unbuffered croplands and residential development is the first step toward recovery of a fully supporting rating for this watershed.

## **2) Enhanced Fishery**

The potential establishment of a coldwater fishery in the Catawba River tailrace is at the center of this project and one purpose for its founding. The Catawba River will likely not support brook trout nor rainbow trout, but indications are that brown trout can thrive here. The 14 mile stretch of tailrace water between Lake James and Morganton has the potential to support 20 - 30 inch trophy brown trout (Besler; in Horan, November 17, 2002). Currently, Muddy Creek's heavy sediment load fills pools, blankets important riffle areas and associated invertebrate communities on which trout feed, and reduces water clarity making it difficult for fish to find adequate foods. Sand is the predominant substrate in at least 64% of the river miles in the Catawba River between Muddy Creek and Lake Rhodhiss (WRC, unpublished data). Upstream of the Muddy Creek confluence substrate in the Catawba River consists mainly of cobble.

Less turbid water would also potentially improve the fishery in Muddy Creek itself. Fish diversity in Muddy Creek is currently low compared to other streams in similar watersheds with similar physiographic characteristics. Degraded instream and riparian habitat is thought to be one contributing factor. Restoration techniques employed by the Muddy Creek Restoration Partners provide instream rock structures that mimic native riffle/pool habitat, helping to oxygenate waters and provide substrate materials and cover that benthic macroinvertebrates and fish in this region desire. Rootwads, in addition to armouring streambanks, provide woody debris on which certain macroinvertebrates colonize. Native riparian forest vegetation, which is a component to every restoration project undertaken by the Partners, provides a stream canopy that cools water temperatures, detrital input that promotes aquatic macroinvertebrate populations, and it acts as a filtration device for overland transport of stormwater runoff.

## **3) Other Ecological Benefits**

Restoration activities typically include an invasive exotic weed control component coupled with native plant revegetation. Native plants are specified that have aesthetic qualities, provide foodstuffs and habitat for wildlife, and when mature, will grow to shade streams. Wild turkey, deer, and other small game, in addition to migratory and native songbirds all benefit from this project. In addition to enhancing habitat value, the trees, shrubs, and grasses also help filter and conserve topsoil. Native plant restoration in streamside areas can also help control the spread of worrisome non-native weeds such as kudzu, Japanese stiltgrass, multiflora rose, and oriental bittersweet.

## **Chapter 2: The Feasibility of a Restored Muddy Creek Watershed**

### **A. Goal 1: Establish Trout Fishery on Catawba River Tailrace**

It is still unknown whether the amount of sediment delivered to the tailrace of the Catawba River from the Muddy Creek watershed can be reduced enough to establish a reproducing cold-water fishery population. The Muddy Creek Restoration Partners originally estimated that perhaps 15,000 - 20,000 tons of sediment enter the Catawba each year during normal flow conditions, although no exact figures are available. The Partners do know with some degree of accuracy that after having taken over 200 stormflow samples at the lower end of the watershed near the confluence of North and South Muddy Creeks, that the median TSS concentration during stormflow events far exceeds the tolerance level of most salmonids before they suffer ill health effects. Median readings range from 377 mg/L on South Muddy Creek to 483 mg/L on North Muddy Creek with maximum stormflow concentrations of TSS exceeding 2,350 mg/L and 3,725 mg/L on South Muddy Creek and North Muddy Creek, respectively. Newcombe and Jensen report that a 15 minute exposure to 250 mg/L TSS concentration can cause ill health effects on trout (1996, p. 721).

Fish survey results on the Catawba River are promising for a brown trout fishery. The NC Wildlife Resources Commission in their 2001 study report that the spring stocking of fingerling brown trout is producing a quality brown trout population in the tailrace (Besler, 2002). It must also be noted that this area has been suffering through an extreme drought since 1998 and annual sediment loads to the Catawba from Muddy Creek have likely dropped from previous estimates as a result of less stormwater runoff and bank scour from high stream flows. It remains to be seen whether a return to normal rainfall will deliver sediment loads that potentially limit the viability of the coldwater fishery, but the fish population data to date are encouraging. It does appear that site-specific streambank restoration projects undertaken by the partners are helping to trap some sediments and are actually building up some banks that were previously eroding and delivering sediment to the system (Jennings and Harmon, 2002).

Progress toward goal one, a trophy tailrace trout fishery on the Catawba River, is being made and can be accounted for. However, an analysis of sedimentation and trout survivability after a return to normal rainfall is needed to ascertain the long-term prognosis for the fishery. Bank Pin measurements taken for over two years in the Muddy Creek watershed indicate that the last year's storm events have caused significant bank erosion on a widespread scale throughout the watershed, and without storm events there is very little bank erosion. Pebble counts also indicate stream substrates throughout the watershed are comprised primarily of fine sediments, which would likely require multiple storm events to flush from the watershed.

### **B. Goal 2: Fully Supporting Uses for All Waterbodies in Muddy Creek Watershed**

A restored State of NC fully supporting rating for all waterbodies in the Muddy Creek watershed will be difficult to accomplish given practical time and financial resource limitations. Site specific restoration, if undertaken at priority sites as prescribed in this plan, will undoubtedly reduce current sediment loads - perhaps to the extent that biological samples taken at the lower end of the watershed improve to "good" or "excellent" classifications from their current "fair" and "good-fair" ratings. A greater question is how much money and time will be required to

implement restoration projects at priority areas, and implement other projects if deemed necessary to achieve this goal.

### **1) Severity of Watershed Conditions**

Nearly every stream surveyed in the watershed is entrenched and separated from surrounding floodplains with the exception of headwater areas on South Muddy Creek and where bedrock is the foundational geology in the middle of the North Muddy Creek drainage. The vertical banks on nearly 8.5 of 36 stream miles surveyed are barren and unarmoured by vegetation, which makes them highly susceptible to erosion during storm events. Even at some intact riparian forest locations, the depth of stream entrenchment is so severe that normal water levels are several feet below tree root systems. Trees in these locations actually exacerbate bank erosion potential due to their proclivity to fall into the stream and push flowing water into the creekbanks.

There are over 32,000 linear feet of stream bordering lands that have no trees nor shrubs to buffer them from impacts of surrounding land use activities. This figure was closer to 40,000 before the partners reforested over 1 mile of stream in 2002 and 2003. Approximately 739,000 additional linear feet of riparian land have less than 25 feet of vegetated buffer, which in most circumstances is not wide enough to form an effective buffer or offer bank protection against floodwater scour. Combined, these unbuffered areas comprise fully 30% of the immediate riparian landscape in this 98 square mile watershed.

Duke's YR 2001 monthly coliform sampling program indicate average fecal coliform levels at six of eight sites exceed 200 mg/L, the limit upon which the State of NC has established its health standard. One site exceeded 200 mg/L by a factor of two and another site exceeded this reading by 4 times. Sources are unknown at this time.

Benthic survey results continue to indicate only fair water quality. And qualitative fish surveys performed throughout the watershed indicate a chronically degraded stream system.

### **2) Cost of Watershed Restoration**

There are 12,400 linear feet of streambank erosion which comprise the Partners' list of priority sites. Based on an \$88 per linear foot cost paid for two streambank stabilization projects performed thus far in the watershed, the Partners would need to raise \$1.1 million in restoration funding alone to stabilize banks and reduce erosion from our priority sites. This estimate drops to roughly \$434,000 when a lower cost of \$35 per linear foot is applied, which is the cost paid for a stream restoration project in 2001. Stabilizing these areas would only "fix" 6.5% of the barren bank areas identified in the watershed. Other areas would continue to erode and deliver sediments and other pollutants even as restoration occurs on the priority sites.

Riparian reforestation is less costly per linear foot than engineered streambank stabilization projects and is an effective restoration strategy on smaller tributaries where the disconnect between the streams and their floodplains are not as severe. Year 2002 costs for native plant revegetation totaled approximately \$7.00 per foot for design, plant materials, and installation oversight. These costs would be less if fewer container stock of native shrubs and trees were

used. Costs would rise however if contractors were used to install the vegetation instead of volunteers. Revegetating the remaining 32,000 linear feet of streambank currently deemed to have “no” buffer at a width of 35 feet would cost an estimated \$224,000. While this investment would restore those riparian lands with no buffer, there will remain 739,000 linear feet of additional streamside land of which most could benefit from riparian forest enhancement.

### 3) Societal Belief Systems and Attitudes

While the poor physical conditions of the watershed and sheer cost of restoration projects are difficult to overcome, prevailing landowner attitudes and belief systems about riparian land use may prove to be even more challenging for restoration in the watershed. Over the last three years, a grass roots anti-riparian buffer movement has developed in the watershed in response to the State’s proposed riparian buffer protection regulations for the Catawba River Basin. Intended or not, this group’s activities in the watershed appears to have generated deep misgivings among many landowners about becoming involved in any type of riparian land conservation.

Anecdotal evidence confirming this observation is the fact that landowner participation in established federal and state agricultural programs runs well behind participation rates just one county and watershed away (Moore, personal communication, 2002). The participation rate in the Partners’ barbeque and restoration tour dropped from approximately 65 in 2000 to 15 in 2002, which again suggests landowner reluctance to being involved with riparian conservation initiatives. To make matters worse, some landowners in the last year have even begun stripping all existing vegetation from their riparian zones presumably in a misguided effort to obtain “grandfather” status as land under existing use in case the buffer regulations are implemented by the State (Figure 4).

### 4) Difficult Nature Of Restoration Projects

Another difficulty the Partners recognize during pursuit of project goals is the fact that restoration projects are never easy. They require an enormous amount of coordinator and partner time and energy to recruit landowner participation, ensure attainment of an easement if necessary, perform more site specific planning for the restoration design, recruit a good designer and construction contractor, oversee the construction, recruit and supervise volunteers if applicable to work on the project, and monitor the project over time to ensure that the design is working.

### 5) Historical Reference of Muddy Creek

The Partnership should also not ignore the historical record that indicates as early as the late 1700’s, this watershed was first referenced as “Muddy Creek”.



Figure 4: “No Buffer” Impacts



This predates the massive European and North American colonial settlement of the area and precludes the wholesale clearcutting of surrounding mountains that took place in the late 19th century. Only Native American and a few European settlement activities would have influenced the flow regime here at that time. It may be that this watershed's natural inclination is to contain waters with higher natural sediment loads.

### **C. Program Success**

Indications are such that substantial progress is being made toward the trophy tailrace fishery sought through Goal 1. How much success can be attributed to sediment reductions in Muddy Creek due to restoration efforts is still of question. A fully supporting designation for all of the Muddy Creek watershed as stated in Goal 2 will require much more concerted effort among the partners at areas deemed priorities for restoration.

Partners can report successful biological enhancement of over 12,000 feet of previously degraded stream and riparian conditions. Progress to date represents a tremendous investment of partner and volunteer time and private and public financial resources. Any decision the partners make about how long this project should continue must factor into the feasibility equation these investments and investor expectations.

#### **1) Conservation On-the-Ground**

Since 1999, the Muddy Creek Restoration Partners have restored seven major streambank erosion sites totaling over 8,000 linear feet on North Muddy Creek, Corpening Creek, and Bobs Creek. At least four of these sites were of highest priority and were scientifically determined to be main contributors of sediment to the system. The bio-engineered solutions at these four sites have reduced sediment delivery to the watershed by an estimated 795 tons per year (Jennings, personal communication, November 2002). Data is incomplete to suggest the amount of sediment reduced by restoring the other three sites, though it would not be an exaggeration to estimate that reduction in the 500 ton range. In addition to these restoration projects, the Partners have completed two large riparian revegetation projects totaling almost 1 mile of stream frontage along Goose Creek and Stanfords Creek. These projects provided low-tech riparian buffer solutions to areas currently having little or no buffer. Through these two revegetation projects, approximately 12.5% of the riparian area in the watershed deemed to have "no" buffer through the physical assessment now has native trees, shrubs, and grasses to armour the streambanks, provide shade and habitat, and filter runoff. In addition, the native plants used in the plans offer wildlife habitat and aesthetic value, which should prove useful as the partners attempt to demonstrate the total value of riparian vegetation to watershed landowners.

Success with both the riparian revegetation projects and at least one of the above mentioned stream restoration projects would not have been possible without the steady support of the Partners' volunteer base. Over 40 Trout Unlimited members across NC have invested over 180 hours in 2002 helping to install native plants at those restoration sites. The Partners have \$110,000 available for stream and riparian restoration in 2003/2004. The priorities and recommendations revealed in this plan along with landowner willingness to participate will dictate where and what type of restoration will occur in 2003 and beyond.

## **2) Completed Watershed Restoration Plan**

The Partners have recently completed a watershed restoration feasibility study. This work illuminates the economic and ecological benefit of restoration in this watershed and reveals the opportunities and constraints for restoration. The study has culminated in this document, our Watershed Restoration Plan. This Plan also identifies priority areas of conservation need so the Partners can build upon past successes and more effectively and efficiently tailor restoration solutions to identified areas of need. This plan provides a road map that outlines an aggressive course for the Partners to pursue for the next 10 years. Recommendations are provided that should help the Partners overcome constraints, take advantage of opportunities, and increase the chances of attaining its goals and objectives. This restoration plan also urges the Partners to continue with this project now that the pathway to success is more clear and time and financial commitments are better established.

## **3) Awards and Honors**

The Muddy Creek Restoration Partners have raised over \$1 million dollars in cash and contributed goods and services in the last four years. It received the Governors Conservation Achievement Award for Water Conservationist of the Year given by the NC Wildlife Federation in 2000 and the Fisheries Conservationist of the Year Award given by the NC Chapter of the American Fisheries Society in 2002. The partners are deserving of the credit and accolades received, and the trust that has been built over the years with funders. The credibility of the Partners has resulted in the continued support of regulatory and private agencies. The Partners' credibility is a valuable asset from which to draw in coming years' restoration work.

## **4) Watershed Outreach**

The Muddy Creek Restoration Partners have made some inroads with the watershed community. Presentations have been given about the project to four civic organizations in the watershed. A restoration tour and barbeque event has been held twice in the watershed to demonstrate to landowners conservation accomplishments and recruit new participants. The Partners regularly contribute staff persons to the local 4-H fair, Earth Day events, and the McDowell County schools curriculum. Duke has supported local school teachers' participation in water resource stewardship workshops. The Partners have reinvigorated its Landowner Outreach Committee with four new members from the local watershed and expects to become more active promoting the project in Year 2003 and 2004. Without the Partners' presence in the watershed over the last four years, it is highly unlikely that water and riparian conservation issues would receive the positive press it has received.

In August 2003, the Partners began building on this success by funding an outreach technician to actively market federal and state farm conservation programs and other restoration solutions to owners of properties deemed to be priorities for restoration. In four months, substantial interest has been perked among 8 - 10 landowners who are considering fencing their cattle from streams or allowing a natural channel design stream restoration project to occur on their lands. A solid foundation is being built on which the Partners could base multiple restoration projects over the next few years.

## Chapter 3: Results from the Watershed Assessment

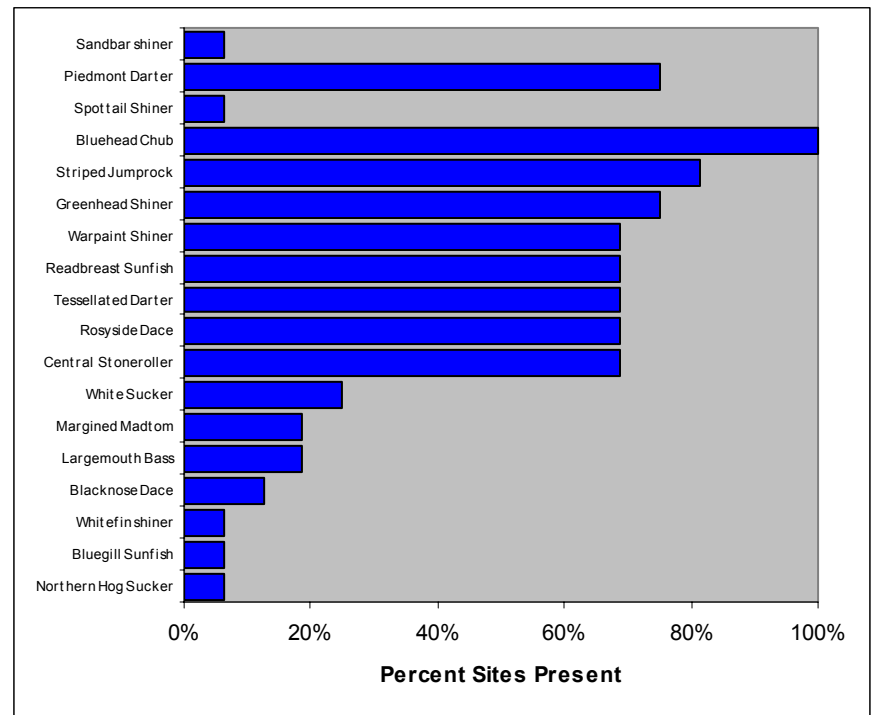
Since 2000, the Muddy Creek Restoration Partners have been engaged in a comprehensive assessment of stream and riparian conditions in the Muddy Creek watershed (Map A: Locations of All Data Stations in the Muddy Creek Watershed; Map B: Physical Survey of Streams and Their Banks in the Muddy Creek Watershed). The NCWRC has performed qualitative fish community surveys at 18 sites in the watershed. Duke has conducted watershed wide suspended sediment sampling at 17 sites, water chemistry sampling at eight sites, and targeted benthic macroinvertebrate sampling in relation to four of the stream restoration projects at the lower section of the watershed on North Muddy Creek. The Partners contracted with Equinox Environmental Consultation and Design, Inc. to perform aerial photo analysis and in-stream surveys of the watershed to gauge the physical conditions of the stream substrate, streambanks, and riparian areas. Duke also provided four undergraduate level interns over two summers to assist in the physical assessment.

### A. Biological Condition of the Muddy Creek Watershed

Biological data from NCWRC, NCDWQ, and Duke all suggest that Muddy Creek is an impaired watershed.

The NCWRC concludes from their qualitative fish studies that the effects of sediment have a cumulative impact on the fish community as one moves downstream and the entire watershed is impacted. A total of 18 species of fish were collected in October 2000. Of these, only two are intolerant of pollution, the spot tailed shiner and piedmont darter, while the remaining 16 species have an intermediate tolerance rating. The piedmont darter was observed in 12 of the 16 sampling sites whereas the spot tailed shiner was reported at only one site. This information is consistent with NCDWQ ratings of “fair” at their two fish community sampling stations (NCDWQ, 1999, p. 83).

Figure 5: Fish Survey Results in Muddy Creek Watershed



NCDWQ’s North Muddy Creek benthic site registers a “good” rating while their South Muddy Creek benthic site registers a “Good-Fair” rating. Duke’s benthic monitoring in North Muddy Creek up and downstream of the Partners’ first restoration sites indicates “fair” water quality.

Both DWQ and Duke’s sampling locations are also very near DWQ’s fish sampling sites. When benthic and fish community data conflict, the fish community results normally take precedence as a superior indicator of long-term water quality.

**B. Chemical Condition of the Muddy Creek Watershed**

Duke sampled the Muddy Creek Watershed from August 2000 to June 2001 at eight stations for the following chemical parameters:

- temperature
- pH
- Nitrogen
- Phosphorous
- Alkalinity
- Fecal coliform
- Total suspended sediment

pH, Nitrogen, Alkalinity, and Phosphorous readings are all within acceptable parameters.

Of potential concern is the fecal coliform count whose mean concentration at six of eight sampling sites in the watershed exceed concentrations allowed under State of NC health standards. Figure 6 shows the mean number of colonies for each site. Coliform readings on some streams reflected counts well over 10 times the state standard. Sources of this contamination are not known. Early assumptions for the Corpening Creek drainage are that faulty septic and sewer system failures may be responsible for high coliform counts.

Total suspended solid (TSS) measurements are also higher in the watershed compared to the UNC-A VWIN program’s regional average (Figure 7). This NC state certified lab has established over 200 sites in 13 counties in western NC and have a quantity of data to use as a good regional comparison. These grab samples suggest chronically high TSS levels in the watershed.

Figure 6: Mean coliform counts in Muddy Creek watershed

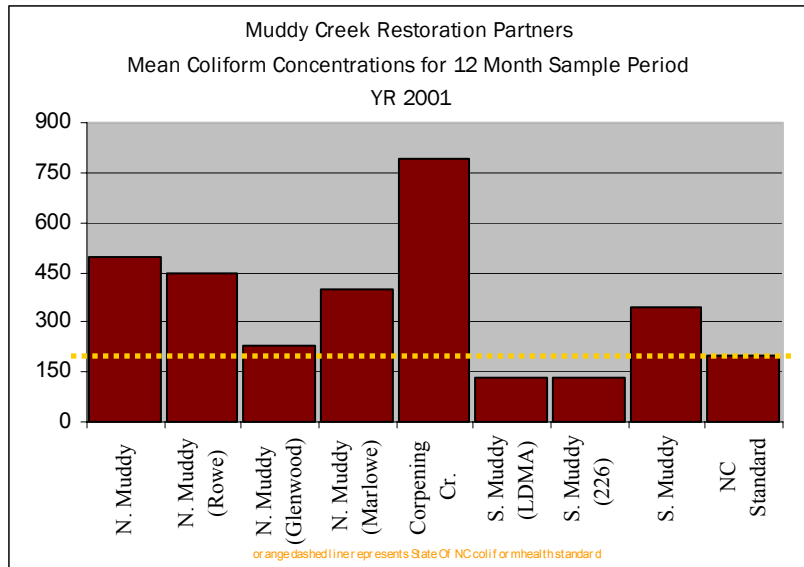
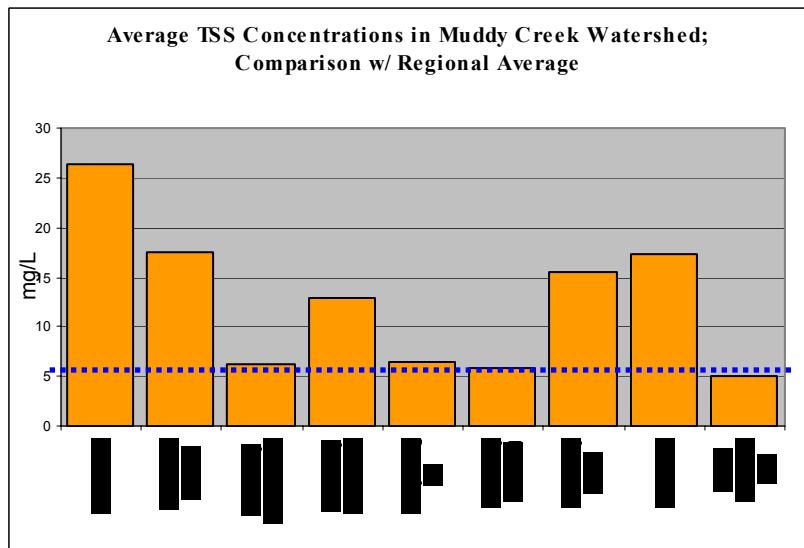


Figure 7: Mean TSS concentrations in the Muddy Creek watershed



Both coliform and TSS results reflect conditions at time of sample. Most were taken during low-flow periods. Stormflow sediment calculations for the Muddy Creek watershed are still being analyzed and are currently unavailable.

**C. Physical Condition of Muddy Creek Watershed**

The physical condition of streambanks, stream substrate, and riparian vegetation reflects a watershed that is well worn and a stream system suffering the impacts of chronic sedimentation.

**1) Stream Substrate**

Modified Wolman pebble counts were taken at 55 locations throughout the watershed to determine dominant stream substrate (See Map C: Bank Pin and Pebble Count Locations). Most of these measurements were of associated riffles and pools, though some counts were taken only at riffles. At most sites, counts were taken both on the major stream course and an associated tributary, but upstream from the zone of influence of each. The diameter of the median pebble count size is referred to as the D50 of the pebble count sample. Pebble counts are ordered by size from smallest particle to largest as silt/clay, sand, gravel, cobble, boulder, and bedrock.

Figure 8: Riffle and Pool D50 Distribution

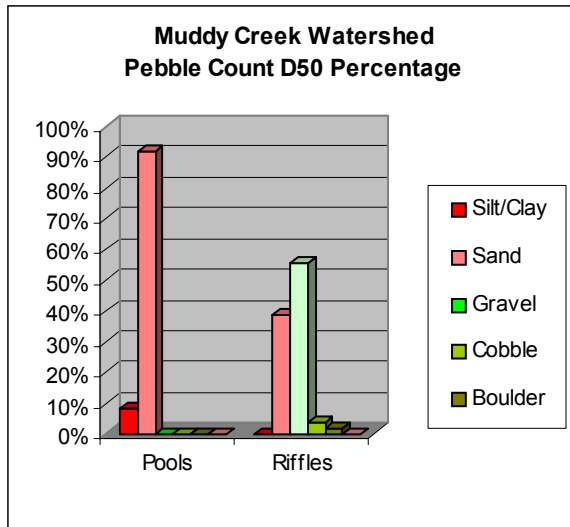
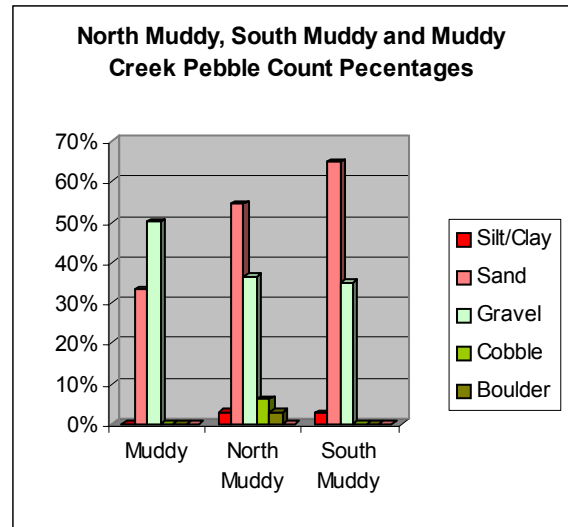


Figure 9: Watershed Substrate Composition



Thirty eight percent of riffles and 100% of pools surveyed in the Muddy Creek watershed are comprised primarily of sand and fine particles, typically poor invertebrate and fish habitat in a southern Appalachian/Piedmont aquatic system. Substrate material was gravel and cobble in 60% of the riffle areas with sand comprising the remaining 40% of riffle material.

When dividing the watershed into sub-drainages, it becomes clear that South Muddy Creek and its associated tributaries are dominated by sand and silt. The substrate on North Muddy Creek and its associated drainages exhibits a more balanced composition of fine particles, gravel, cobble, and bedrock though fine particles are still the predominant substrate composition.

## 2) Bank Erosion

The great majority of the watershed is entrenched, meaning that the elevation of water flow is disconnected from adjacent floodplain areas. The depth of entrenchment typically ranges from 8 - 14 feet throughout the watershed, though there are some reaches with 20 feet high and greater incised banks. When viewed from within the stream, these entrenched areas may or may not contain roots from streamside vegetation. Barren banks are defined as those exposed banks having no visible rooting structure to help maintain bank integrity. As a result, barren banks are highly susceptible to erosion and collapse due to increased stormflow velocities and the pressure they exert on the banks. The Partners recognize that barren banks are a tremendous source of sediment to the watershed. Therefore, an assessment of barren banks was performed to determine location and significance of this sediment source. This physical criterion is not to be confused with un-vegetated or unbuffered riparian land.

The in-stream site assessment has revealed 886 barren bank sites that comprise 17 of 73 surveyed miles of stream-bank or nearly 25% of the watershed surveyed in this manner (Map D: Location of All Barren Bank Sites and Their Corresponding Length). This includes both banks of 36.5 miles of navigable stream that was assessed by direct observation from within the stream channel. Seven hundred forty of these barren bank sites are less than 150 feet in length. Only 14 are greater than 500 feet long. Barren banks less than 30 feet were not recorded. Figures 10 and 11 and Map D do not include any measures of barren banks along smaller non-navigable streams. These streams were not surveyed for barren banks due to potential trespass issues and the prohibitive costs involved in accessing the large number of streams. The total number and length of barren bank sites including small tributaries is certainly much higher than the actual surveyed sites referenced above.

Figure 10: Barren Banks in Muddy Creek Watershed

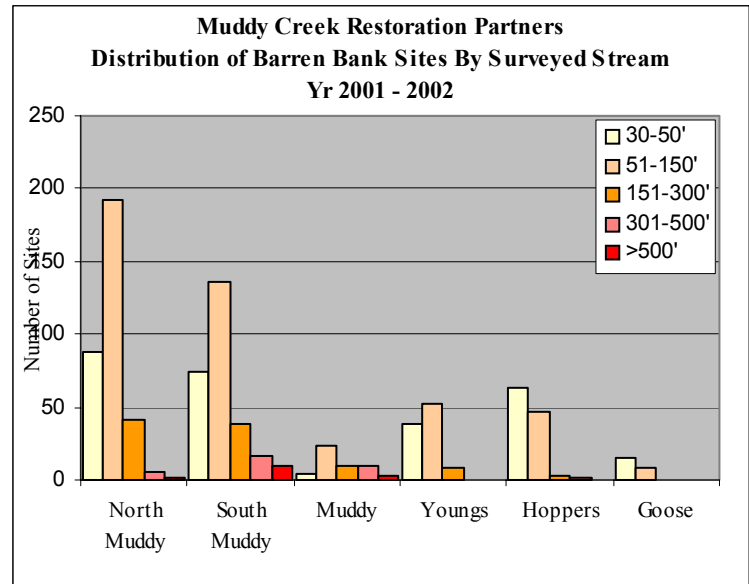
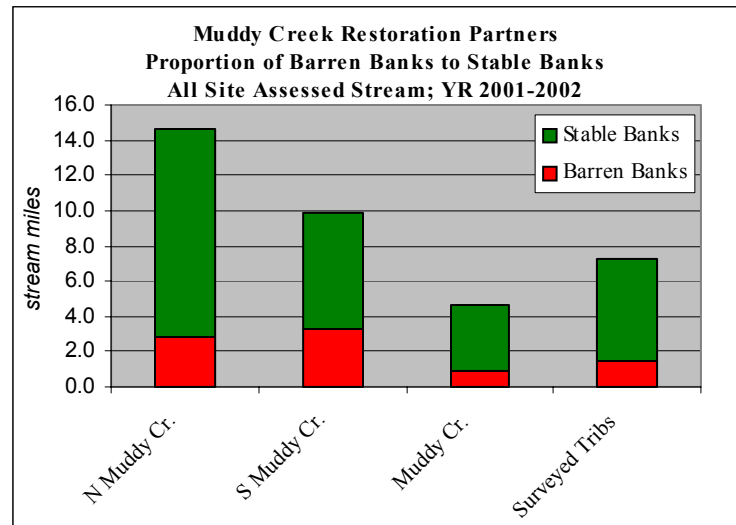


Figure 11: Ratio of Barren to Stable Banks in Muddy Creek



South Muddy Creek has a greater ratio of barren banks to vegetated banks (Figure 11). Much

of this occurs along stretches of the creek that have been dredged and straightened in the past, including former historical wetlands along South Muddy Creek and adjacent to the South Muddy/Hoppers Creek confluence. Most of the central portion of North Muddy Creek shows no sign of barren banks. This is likely because this stretch flows for roughly nine miles through an area dominated by bedrock and deep forestlands. There are barren banks along North Muddy Creek nearer its headwaters where the land is flatter and agricultural and residential land uses intensify in the riparian zone.



Figure 12

Identifying barren bank sites is an important first step toward prioritizing restoration, but this information alone provides an incomplete picture of the threat these barren bank sites present to watershed health. Some barren banks may be eroding, collapsing, and delivering sediment to the Muddy Creek system while other sites may not. The Muddy Creek Restoration Partners strategically installed bank erosion pins at 38 barren bank sites to gauge the activity level of certain areas (Map C). Some sites contain only one four foot long pin while others contain up to 11 pins. Most contain 6 - 10 pins distributed laterally and vertically across the surveyed barren bank area (Figure 12).

Results are clear. During periods of below normal rainfall, only a few barren bank sites are significant sources of sediment to the watershed. However, during normal to above normal rainfall, erosion from barren banks increases dramatically

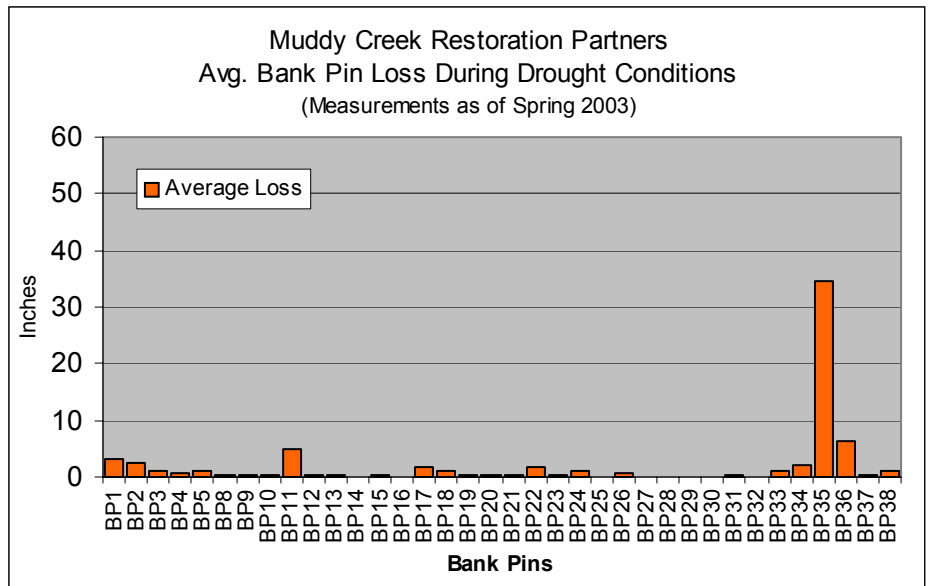
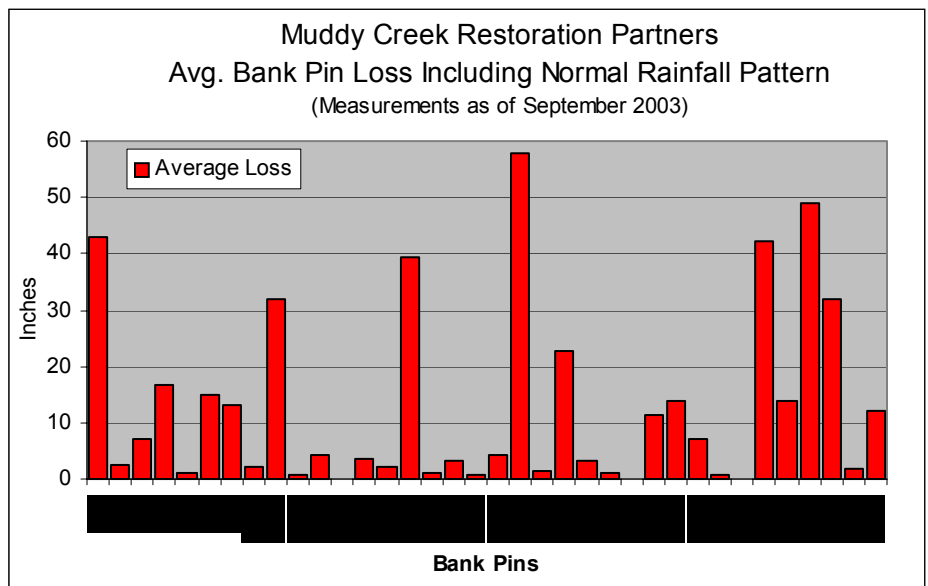


Figure 13: Average Bank Pin Loss in Muddy Creek Watershed After Normal Rains



all sites. Since September 2002, the project area has received normal or above-normal rainfall, which has raised the flow level in the watershed substantially. In contrast, during 1998 - 2002, the area was suffering through an extreme drought.

It also appears that a few barren banks in the watershed are not significant contributors of sediment, regardless of rainfall events. The field assessment team speculates from firsthand observation that one reason some sites are less susceptible to bank erosion is the clay composition of their soils. Field observations also revealed that barren banks are susceptible to the forces of freeze/thaw and wind erosion, often overlooked as catalysts of sediment delivery to the watershed. Though likely not as powerful as stormflow to collapsing barren banks, wind and freeze thaw action do contribute over time to the problem.

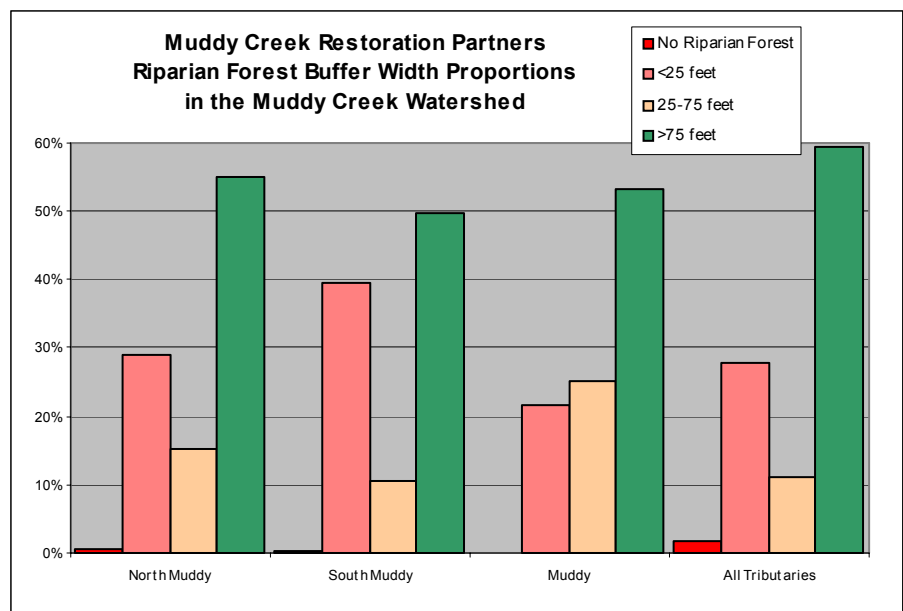
### 3) Riparian Zone Conditions

#### Riparian Forest Buffers

The riparian zone of the watershed is generally well forested. In 59% of the watershed a riparian forest buffer is greater than 75 feet wide (Figure 14). At the same time however, at least 30% or 780,000 linear feet of stream bordering lands have

less than a 25 feet wide riparian forest buffer. Of this total, 32,000 feet (40,000 feet before riparian reforestation project in 2002/2003) has no riparian forest vegetation at all. Most natural resource agencies suggest, at minimum, a 25 - 30 feet riparian forest buffer on lands in active use to adequately filter nonpoint source pollutants, armor streambanks, and supply habitat requirements. Generally speaking, greater widths translate to greater ecological integrity and more water quality benefits. The calculations

Figure 14: Riparian Forest Buffer Width Proportions in the Muddy Creek Watershed

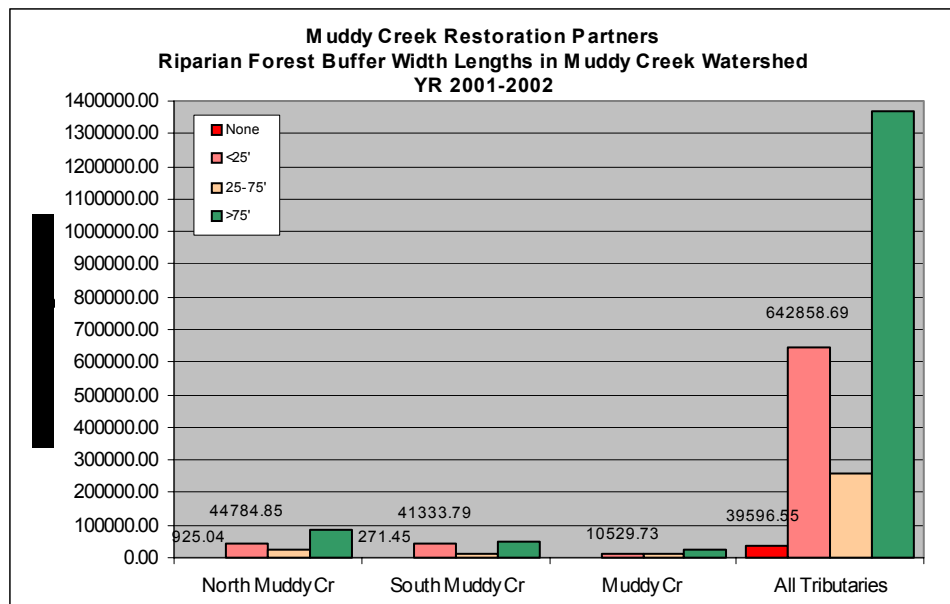


above are derived from both the in-stream field survey conducted on navigable streams and an analysis of infrared aerial photographs (Map E: Riparian Forest Buffer Widths of Navigable Streams in the Muddy Creek Watershed; Map F: Riparian Forest Buffer Status of 2nd Order and Above Non-Navigable Streams in the Muddy Creek Watershed).

By far, the greater amount of stream frontage with less than 25 feet of riparian forest buffer occurs on tributaries (Figure 15). Many of these smaller, non-navigable streams dissect residential lots, pastures, fields in row crops, and logged forest lands. In most cases, these streams

individually are not large enough, nor do they carry enough water to be an impediment to intensive use of adjacent lands. As a result, the Partners find that many landowners will plow fields, build, or graze cattle directly to the top of the bank - and in the case of cattle, allow their livestock to roam freely through these small creeks. Though the Partners have not conducted site-specific experiments on individual small streams, field observations and pebble counts taken at the mouths of many of these small streams indicate that the cumulative sediment impact to the broader Muddy Creek watershed from such intensive land use on these smaller streams is severe.

Figure 15: Riparian Forest Buffer Width Lengths in the Muddy Creek Watershed



Smaller inaccessible tributaries account for 39,000 of the approximately 40,000 linear feet in the watershed having “no” buffer (Table 3; Map F). Most of them are in the North Muddy

Table 3: Riparian Forest Buffer Characterization Along Streams Absent a Buffer in the Muddy Creek Watershed

Stream	No Buffer	< 25 ft	25—75 ft	> 75 ft	Total
Thompson’s Fork (N. Mud)	5,200 ft	87,750 ft	15,650 ft	149,400 ft	258,000 ft
Big Camp Branch (N. Mud)	4,700 ft	41,400 ft	300 ft	37,600 ft	84,000 ft
Caleb Branch (N. Mud)	1,600 ft	7,800 ft	4,000 ft	28,000 ft	41,400 ft
White Branch (N. Mud)	700 ft	10,600 ft	5,000 ft	10,600 ft	26,900 ft
Bledsoe Branch (N. Mud)	3,100 ft	9,700 ft	0 ft	3,900 ft	16,700 ft
Jacktown Creek (Youngs/N. Mud)	4,800 ft	14,500 ft	3,100 ft	12,800 ft	35,200 ft
Bobs Creek (N. Mud)	2,700 ft	13,600 ft	5,450 ft	62,150 ft	83,900 ft
Goose Creek (N. Mud)	3,600 ft	45,800 ft	17,500 ft	26,700 ft	93,600 ft
37 NUTR (N. Mud)	4,100 ft	8,700 ft	2,400 ft	14,200 ft	29,400 ft
2 SUTL (S. Mud)	3,400 ft	2,150 ft	950 ft	29,600 ft	36,100 ft
Long Branch (S. Mud)	1,000 ft	23,600 ft	7,900 ft	33,000 ft	65,500 ft
Magazine Branch (Hoppers/S. Mud)	800 ft	24,750 ft	2,950 ft	51,200 ft	79,700 ft
Reedy Creek (Mud)	3,450 ft	13,600 ft	1,100 ft	58,450 ft	76,600 ft
<b>TOTALS</b>	<b>39,150</b>	<b>291,710</b>	<b>66,300</b>	<b>508,600</b>	<b>866,610</b>

Creek drainage. There are three other small tributaries that lack an ample buffer for 51 - 100% of their drainage area. Sixteen additional streams are lacking an ample buffer for 27% or more of their drainage area. These are ideal candidate streams for riparian reforestation projects. On a positive note, five of the smaller tributaries currently boast 100% riparian forest cover for a minimum of 75 feet from the stream.

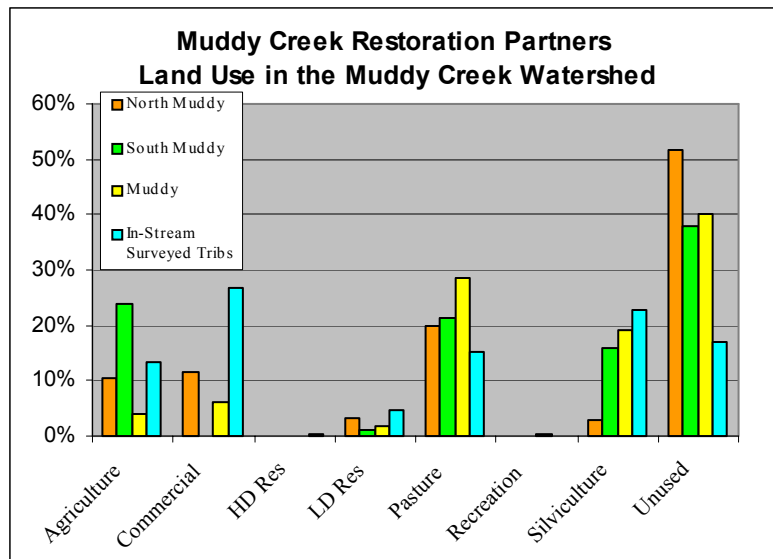
The Partners are convinced that incremental conservation successes in these smaller stream systems are critical to the ultimate attainment of project goals and the restoration of the broader Muddy Creek watershed. A steady accumulation of restoration and preservation projects on these 1st and 2nd order streams will increase the capabilities of the watershed to manage storm-flow surges that are so damaging to bank stability. In addition, the ecological benefits incurred and less turbid waters flowing from the smaller tributaries will flow downstream, joining with waters flowing from other enhanced tributaries to create better conditions in the main stems of North and South Muddy Creek.

On the larger streams, most of the areas having a minimal forested buffer occur adjacent to South Muddy Creek, though there is a substantial amount of riparian area with minimal buffer on North Muddy Creek between its headwaters and Highway 226. Corpening Creek (or Youngs Fork) lacks an adequate forested buffer along a majority of its length as suspected considering its proximity to the urbanized area of Marion. The lower section of Hoppers Creek also lacks an adequate buffer. Riparian forests in Muddy Creek downstream to the Catawba River remain largely intact.

Riparian Land Use

Most of the riparian lands that were assessed from the in-stream field survey are classified as “unused” or are forestlands that do not show any obvious signs of silviculture or other active use (Figure 16; Map G: Primary Land Use in the Riparian Zone Along Navigable Streams in the Muddy Creek Watershed). Unused land occurs often in association with riparian forest buffers greater than 75 feet wide. In many instances, this 75 feet wide riparian forest buffer may actually extend 300 feet or wider. Pasture and cropland agriculture are the next dominant land uses in the watershed. Commercial land use follows, which also includes transportation corridors such as highways and railroads that are adjacent to surveyed streams. Cropland agriculture, pasture, and commercial land uses are often associated with those areas where the riparian forest vegetation is less than 25 feet wide. There is very little high density residential land use, but low density residential land use is prevalent adjacent to streams throughout the watershed. Residential land use does occur close

Figure 16: Land Use in the Muddy Creek Watershed



to streams but is more often found 25 - 75 feet or further away from streams. These calculations are based only on in-stream field survey results and due to accuracy concerns do not include any results from the infrared photography analysis of smaller non-accessible streams in the watershed.

Pasture, agriculture, and commercial land use activities are proportionately more prevalent on tributaries than on the main stems of North and South Muddy Creeks. Some pastures provide direct access to creeks while others were observed to have adequate fencing to preclude cattle access. Cattle access to creeks was found at five sites along the larger accessible streams (Map H: Locations of Fenced and Unfenced Cattle). In addition, a quick random windshield survey of lands identified in pasture through the aerial analysis revealed 10 of 13 sites with unimpeded livestock access to the creek. Though this windshield survey lacks rigorous scientific controls, the Partners are confident in its ability to predict comparable results if randomly employed elsewhere in the watershed. Unchecked animal access to streams can be a major cause of streambank collapse and sedimentation, and coliform bacteria inputs. This land use practice is prevalent in the Muddy Creek watershed.

## Chapter 4: Conservation Priorities

This restoration plan recommends four primary conservation solutions to the sedimentation and nonpoint source problems plaguing the watershed; natural channel design stream restoration, riparian reforestation, livestock exclusion, and riparian buffer preservation. Each solution depends entirely on voluntary participation among landowners.

### A. Stream Restoration

Natural channel design stream restoration is recommended in those areas where the stream channel is entrenched and disconnected from the surrounding floodplain. Bioengineering solutions using appropriate excavation, root wads, and rock veins can be used to replicate a stream's natural inclination toward sinuosity and can re-establish a floodplain next to the existing channel elevation so water has a place to escape during high flow events. Currently in areas with high stream channel entrenchment, stormflow has nowhere to escape and instead scours and undercuts exposed and vulnerable creek banks. This serves as a primary source of sediment to the watershed.

It is not feasible to perform natural channel design restoration at all 886 bank erosion sites identified in the watershed. This would total over 8.5 miles of stream. At an \$85 per linear foot, that would require an estimated \$3.81 million investment, involve a multitude of private landowners, and require disposal of tens of thousands of dump truck loads of dirt. The Partners believe that natural channel design restoration should be employed only at those most needed locations. Most needed locations have been defined by 1) Barren Bank "Sites" most susceptible to stormflow scour; and 2) Stream "Reaches" that contain clusters of barren bank sites proven through bank pin measurements to be actively eroding. Most, but not all, of the barren bank sites most susceptible to stormflow scour are also included in the Priority stream reaches.

#### 1) Barren Bank Sites Most Susceptible to Stormflow Scour

The priorities in this section have been derived by applying the following assumptions:

- 1) Calculating the total barren bank area for each of the 886 erosion sites found in the field assessment (erosion length x erosion height), and selecting the top 100 sites with the largest area susceptible to erosive forces.
- 2) For each of these top 100 sites, adding together the corresponding metric for erosion length + erosion height + riparian forest buffer width + rooting depth + rooting density + the location of the bank in relation to the stream flow (Table 4).
- 3) Selecting as highest priorities the top 26 sites with the highest metric score.

The maximum score allowable for each barren bank site is 22. See Table 4 for the scoring and

Table 4: Criteria and Scoring for Factoring Stream Restoration Priorities

Erosion Length		Erosion Height		Buffer Width		Rooting Depth		Rooting Density		Erosion Location	
Condition	Metric	Condition	Metric	Condition	Metric	Condition	Metric	Condition	Metric	Condition	Metric
30-50'	1	1-5'	1	> 75'	1	Deep	1	Dense	1	Inside	1
51-150'	2	6-10'	2	25' - 75'	2	Shallow	2	Sparse	2	Straight	2
151-300'	3	11-15'	3	< 25'	3	None	3	None	3	Outside	3
301-500'	4	> 15'	4	None	4						
> 500'	5										

criteria applied in the prioritization process. See Table 5 for the highest priority barren bank sites.

These top 26 sites account for 12,392 linear feet of barren bank or 6.5% of all barren bank sites along the larger, more easily accessible streams in the Muddy Creek watershed. This top 26 list includes those longest, highest creek banks that have little or no deep rooted vegetation to hold the bank in place and that are more greatly exposed to erosive high water flows. Theoretically, these sites have the potential to deliver the greatest sediment loads to the watershed. However, this priority list does not calculate activity level of streambank erosion at each of these sites, nor does it factor in the erosive character of soil type - both crucial pieces of information needed before embarking upon any stream restoration design.

Table 5: Highest Priority Barren Bank Sites

Priority ID	Date	Creek Name	Bank (L/R)	From Wypnt	From Latitude	From Longitude	Area	Base (feet)	Height (feet)	Width	Root Depth	Root Dens	Location	Base (feet)	Height (feet)	Width	Root Depth	Root Dens	Location	Score
A	10/26/00	N. Muddy	L	8	35.63041	-81.95985	2,669.44	334	8	D	S	S	O	4	2	4	2	2	3	17
B	7/18/00	S. Muddy	R	1	35.62610	-81.85741	4,738.50	395	12	A	S	S	S	4	3	3	2	2	2	16
C	7/12/00	S. Muddy	R	4	35.67415	-81.85873	4,412.18	630	7	A	S	S	S	5	2	3	2	2	2	16
D	7/7/00	S. Muddy	L	5	35.66470	-81.85577	6,526.19	816	8	A	D	S	S	5	2	3	1	2	2	15
E	09/27/00	Muddy	L	58	35.72257	-81.83725	4,256.46	532	8	A	D	S	S	5	2	3	1	2	2	15
F	7/12/00	S. Muddy	R	9	35.67587	-81.85756	4,072.56	339	12	A	D	D	O	4	3	3	1	1	3	15
G	7/12/00	S. Muddy	L	2	35.67292	-81.85888	4,023.81	503	8	A	D	S	S	5	2	3	1	2	2	15
H	6/22/00	N. Muddy	L	25	35.69670	-81.86640	2,458.11	307	8	A	D	S	O	4	2	3	1	2	3	15
I	7/17/00	S. Muddy	L	19	35.64692	-81.85381	9,585.89	959	10	A	D	D	S	5	2	3	1	1	2	14
J	7/13/00	S. Muddy	R	24	35.68802	-81.85970	8,416.96	1052	8	A	D	D	S	5	2	3	1	1	2	14
K	7/7/00	S. Muddy	L	28	35.67051	-81.85685	7,058.96	706	10	A	D	D	S	5	2	3	1	1	2	14
L	07/28/00	Muddy	R	23	35.70354	-81.86330	5,724.68	382	15	B	D	D	O	4	3	2	1	1	3	14
M	7/13/00	S. Muddy	L	35	35.69279	-81.86190	5,103.90	510	10	A	D	D	S	5	2	3	1	1	2	14
N	7/18/00	S. Muddy	R	10	35.62948	-81.85388	4,638.24	580	8	A	D	D	S	5	2	3	1	1	2	14
O	6/15/00	N. Muddy	L	12	35.67326	-81.90702	4,488.01	561	8	A	D	D	S	5	2	3	1	1	2	14
P	07/31/01	Youngs Fk	R	39	35.64393	-81.94463	4,373.22	243	18	C	S	D	O	3	4	1	2	1	3	14
Q	7/18/00	S. Muddy	R	9	35.62832	-81.85496	4,220.08	528	8	A	D	D	S	5	2	3	1	1	2	14
R	06/04/01	Youngs Fk	R	13	35.65294	-81.96163	4,064.68	254	16	B	D	D	O	3	4	2	1	1	3	14
S	6/19/00	N. Muddy	L	4	35.64564	-81.94000	4,008.86	401	10	A	D	S	S	4	2	3	1	2	2	14
T	7/21/00	S. Muddy	R	10	35.62430	-81.85992	3,804.83	476	8	A	S	D	S	4	2	3	2	1	2	14
U	07/28/00	Muddy	L	33	35.70655	-81.85989	3,766.27	628	6	A	D	D	S	5	2	3	1	1	2	14
V	6/30/00	S. Muddy	L	40	35.65930	-81.85583	3,461.34	288	12	A	D	S	S	3	3	3	1	2	2	14
W	6/30/00	S. Muddy	L	37	35.65842	-81.85539	2,962.60	296	10	A	D	S	O	3	2	3	1	2	3	14
X	09/27/00	Muddy	L	55	35.72217	-81.83884	2,153.07	308	7	A	D	S	S	4	2	3	1	2	2	14
Y	12/11/00	N. Muddy	R	50	35.62653	-81.97869	1,984.72	198	10	A	S	S	S	3	2	3	2	2	2	14
Z	7/19/01	Hoppers	L	29	35.62536	-81.85157	1,664.61	166	10	A	S	S	S	3	2	3	2	2	2	14

## **2) Highest Priority Stream Reaches**

There are several locations in the watershed where more substantial barren bank sites are found clustered together. When determined to be actively eroding, these reaches are some of the more significant sources of sediment to the watershed. The reaches described below are ideal candidates for natural channel design stream restoration, being responsible for well over 350 tons of sediment delivered to the watershed, and most of that in the last year alone.

### Cluster 1: South Muddy/Hoppers Creek; Confluence

Both Hoppers and South Muddy Creeks warrant stream restoration from their confluence upstream for approximately 1.5 mile on South Muddy and 2 miles on Hoppers. There is one >500 feet barren bank site and three 301 feet - 500 feet barren bank sites in this stretch of South Muddy Creek, in addition to a multitude of less lengthy barren bank sites. Bank Pin Sites #28, #29, and #30 indicate a loss of 10 inches on average throughout the 30 feet long sample area adjacent to Sain Road over the last year during normal/above normal rainfall. The Partners estimate that this site has loaded 15 tons of sediment to the Muddy Creek watershed in just the last year alone. It is likely that this reach would have suffered more bank erosion had not the stream been dammed by Beavers soon after installation of the bank pins, which slowed stormflow surges and created a backwater pond on the creek. On Hoppers Creek, there are fewer long stretches of barren bank, but at least seven barren bank sites are 101 feet - 300 feet in length. Interspersed among these barren bank sites are clusters of 51 feet - 100 feet long sites. Measurements taken at Bank Pin sites #34, #35, #36, #37, and #38 indicate that this stream reach is one of the more active bank erosion areas in the entire watershed. Hoppers Creek has eaten over four feet of bank at site #34 and has eaten roughly 10 inches - 30 inches elsewhere. The Partners approximate that over 55 cubic yards, or approximately 70 tons, of soil has entered Hoppers Creek from bank erosion from just this 80 feet long bank pin sample area. This cluster contains highest priority stream restoration sites B, N, Q, T, and Z represented in Table 5.

### Cluster 2: South Muddy Creek; Pinnacle Church

Downstream from the confluence of Long Branch (at Pinnacle Church Rd), barren banks are omnipresent on South Muddy Creek, almost for its entire length to the confluence with North Muddy Creek. Cluster 2 begins at Long Branch and extends approximately 1/4 - 1/2 mile above Pebble Count site 4S downstream (Map C). There are four barren bank sites > 500 feet in length and five sites ranging from 301 feet - 500 feet long. Interspersed are 19 additional barren bank sites 101 feet - 300 feet long. Interestingly enough, only Bank Pin site #33 indicates any significant active erosion. At that nine feet long sample site, nearly four feet of bank has calved off and dropped into South Muddy Creek, delivering approximately 15 tons of sediment to the watershed. Bank Pin sites #31, and #32 indicate little or no active bank erosion. The soils appear to be comprised primarily of clay in this stretch of South Muddy which may explain the relative lack of bank erosion activity. More bank pins installed in this reach would provide a better picture of bank instability. This cluster contains highest priority stream restoration sites C, D, F, G, I, K, V, and W represented in Table 5.

### Cluster 3: South Muddy Creek; I-40

From the confluence of South and North Muddy Creeks upstream for approximately 1.5 miles on South Muddy, there are two barren bank sites > 500 feet and two barren bank sites 301 feet - 500 feet long. Interspersed throughout this reach are an additional seven sites 150 feet - 300

feet long. Of the four Bank Pin sites installed here, only #24 is indicating any significant active erosion. Approximately two feet of bank has been lost at this nine feet long sample sight, loading roughly nine tons of sediment to the watershed. This cluster contains highest priority stream restoration sites H, J, and M represented in Table 5.

#### Cluster 4: North Muddy Creek; Glenwood

North Muddy Creek flows for approximately 1.5 mile from Highway 221 to its confluence with Goose Creek, and in this reach there are at least 8 barren bank sites 101 feet - 300 feet long. Of three bank pin sites established here, only site #17 is indicating any significant active erosion. That bank has lost almost 40 inches in an approximately 26 feet long sample area in just the last year. This site is responsible for almost 26 tons of soil delivered to the watershed. This cluster contains highest priority stream restoration site Y represented in Table 5.

#### Cluster 5: North Muddy Creek; Bobs Creek confluence

North Muddy Creek flows for approximately 2 miles From Pebble Count site 33N downstream to just below the Bobs Creek confluence. There are 13 barren bank sites, each ranging from 101 feet - 300 feet in length. There are 20 additional barren bank sites 51 feet - 100 feet long. Bank pins established at sites #1, #2, #3, #4, #5 all indicate active bank erosion in this area, and most of it occurring in just the last year during normal/above normal rainfall events. Within just the 50 feet long sample site #1, roughly 94 tons of dirt has calved off the bank and dropped into North Muddy Creek. Almost 45 tons of additional sediment has entered the watershed from bank erosion from the other four bank pin sample sites. This cluster contains highest priority stream restoration site A represented in Table 5.

#### Cluster 6: North Muddy Creek; I-40

Just upstream from its confluence with South Muddy Creek, North Muddy is actively eating at several relatively short barren bank sites within a 1/2 mile stream reach. This stream section does not contain any of the highest priority stream restoration sites indicated in Table 5. However, the severity of active bank erosion here warrants attention. There are three barren bank sites ranging from 101 feet - 300 feet long. Bank pin site #23 indicates that within a 33 feet long sample area, one site has delivered at least 75 tons of sediment to the watershed in the last year alone.

### **B. Riparian Reforestation**

The physical assessment of the watershed has revealed numerous small tributaries that have little or no riparian forest buffer to filter the impacts of adjacent land disturbances. In many cases, these smaller streams do not pose a physical impediment to the property owner, so access through and across them has never been an issue. As a result, crops are raised, cattle are grazed, or houses and roads are built directly adjacent, through and across them with little regard for their impacts on water quality. Nearer to their confluence with North or South Muddy Creeks, many of these smaller tributaries are deeply entrenched and suffering from bank erosion and headcutting. Upstream on these smaller tributaries, bank erosion from stormflow does not appear to be as much of a problem as overland transport of sediment and bank trampling from cattle and other livestock. The cumulative sediment load from the sheer number of these smaller tributaries that have no buffer is not known, but observations during field surveys reveal

this problem to be widespread and perhaps equally as important as a contributor to the total sediment load in the watershed as bank erosion on the larger main stems of North and South Muddy Creeks. In many cases in the upper reaches of these smaller tributaries, simple revegetation of the riparian zone using native grasses, shrubs, and trees would provide multiple benefits such as temperature moderation, in-stream habitat, and filtration of sediment and other non-point source pollutants originating from adjacent lands.

First priorities must be focused on revegetating all of the streams known to have no riparian forest buffer at this time (Table 3). Small 1st and 2nd order tributaries account for 39,000 of the known 40,000 linear feet of creekbank having no buffer. The MCWRI can and should methodically approach riparian reforestation at each of these sub-watersheds. Second priorities should be given those streams or sub-watersheds that lack an adequate riparian forest buffer for 50% or greater of their drainage area. In the fall of 2002, two sites comprising approximately 5,000 feet of streambank were revegetated in this manner at the Coats and Allen sites on Goose Creek. In 2001, the Bobs Creek restoration project addressed 1,900 linear feet of this problem, which means 1/6 of the unbuffered problem has been solved.

**C. Livestock Exclusion**

There are at least 15 sites in the watershed where livestock have unencumbered access to creeks (Table 6; Map H). All sites combined, cattle or other livestock roam freely through 20,000 feet

Table 6: Priority Livestock Exclusion Areas

Site	Stream(s)/Location	Livestock Access
1: South Muddy; Pinnacle Church	South Muddy Creek 6 S Unnamed Tributary Left 7 S Unnamed Tributary Left	5,000 feet Unknown Unknown
2: Muddy; Bridgewater	Muddy Creek	3,000 feet
3: North Muddy; Stanfords Creek	Unnamed Tributary on Stanfords Cr	1,000 feet
4: South Muddy; Hoppers Creek	South Fork Hoppers Creek	1,500 feet
5: North Muddy; Bobs Creek	Bobs Creek	1,500 feet
6: South Muddy; Hicks Branch	Hicks Branch	1,200 feet
7: North Muddy; I-40	3 Unnamed Tributary Right	300 feet
8: North Muddy; Glenwood	37 Unnamed Tributary Left	500 feet
9: North Muddy; Caleb Branch	Caleb Branch	1,200 feet
10: North Muddy; Glenwood	North Muddy Creek (above Goose Cr)	1,300 feet
11: North Muddy; Glenwood	North Muddy Creek (above Goose Cr)	680 feet
12: Muddy; Bridgewater	Muddy Creek	180 feet
13: South Muddy Creek	South Muddy Creek	30
14: North Muddy; Glenwood	North Muddy Creek	30
15: North Muddy; Glenwood	Goose Creek	2,200 feet

or more of stream in the watershed. These calculations were derived from the in-stream field survey and a windshield survey based on assumptions generated through infrared aerial photo analysis.

Significant improvements in water quality can be made through the simple fencing of livestock from creek access and providing alternative watering systems. There are substantial state and federal dollars available to help farmers do this. Considering the drought over the last four years and the number of streams that went dry in the region during the summer of 2002, these practices should hold considerable appeal to livestock producers and holders. The preceding list, although not exhaustive, provides a starting point from which to build an effective livestock exclusion program. Other sites considered priorities for riparian reforestation in Section B of this chapter likely also hold cattle access.

#### **D. Riparian Forest Preservation**

Forever wild conservation easements, agricultural preservation easements, and working forest conservation easements can and should be employed to protect significant riparian lands. In addition, some sites also possess historical significance which could lead toward beneficial partnerships and greater public recognition of the value of conserving those landscapes. Large intact headwater landscapes are certainly high priorities for protecting the sources of Muddy Creek. In addition, there are five smaller tributaries currently 100% forested that deserve conservation planning before they succumb to forest clearing and residential development.

Since the project's inception, one of the highest priorities for riparian conservation along North Muddy Creek was sold and developed and now contains over 40 homesites - several with inappropriate slope construction and erosion from site clearing activities that are visibly delivering large sediment loads to the creek system. This once forested property contains over 3 miles of creek frontage on North Muddy Creek and along two tributaries. Just upstream, another forested property containing a mile or more of frontage along North Muddy Creek was sold and is in the process of being developed. Both of these developments are occurring within the once-heavily forested area along North Muddy Creek between Highway 221 and Highway 226. A priority intact forest adjacent to North Muddy Creek at Interstate 40 and the Highway Rest Area was recently clear-cut. Time is of the essence if the Partners are to be successful protecting existing intact riparian forest landscapes, as the conversion from forest to residential development or logging practices on these three large tracts demonstrate.

#### **Headwater Sites**

The benefits of downstream restoration could be nullified through decimation of upstream headwater areas. For that reason, headwaters must always factor in as a high priority for protection. In the Muddy Creek watershed, several clusters of headwater streams remain heavily forested and ironically are located in close proximity to each other in the Huntsville Mountains complex. This mountain range is an outlier to the Blue Ridge and is known to contain significant natural heritage elements. The vast majority of these lands are in corporate timber ownership. Many timber companies throughout the southeast are currently divesting themselves of large land holdings, though actual sales differ by corporate needs. Highest priority headwater sites in need of protection are listed below.

1) Bobs Creek Headwaters. Riparian forest protection here along 62,150 feet of creekbank, coupled with restoration at the Cochran site, would practically ensure the ecological integrity and clean water within the entire sub-watershed of Bob's Creek. This would result in both a tangible and powerful moral victory for watershed conservation here. There remains 800 linear feet of riparian land with no buffer and approximately 2,000 linear feet of 1st order stream on Bobs Creek which would benefit from a livestock exclusion project. Outreach is on-going with those landowners. These and past efforts to restore the lower sections of Bob's Creek could prove futile if the headwaters are not saved.

The largest tract contains approximately 2,426 acres and is in corporate ownership. Another landowner possesses 289 acres, while two other landowners are in possession of 42 and 45 acres. At least two of these property owners reside elsewhere.

2) High Shoals Creek/Baker Branch/Barnes Branch Headwaters. Riparian protection here would preserve intact forests along 25,000 feet of creekbank. The largest tract is in corporate ownership and totals 3,486 acres. The same 2,426 acres in corporate ownership in the Bobs Creek headwaters wraps around to include this drainage as well. The third largest landowner owns 280 acres.

3) Stanfords/Huntsville Creek Headwaters. Riparian preservation of these headwaters would protect intact 25,000 linear feet of forested creekbanks. The 3,486 acre tract containing the High Shoals Creek headwater cluster also wraps around to include the Stanfords Creek cluster of streams. Another private landowner owns 237 acres here.

4) South Muddy Creek Headwaters. One corporate timber company owns 5,664 acres of land in the South Muddy Creek headwaters subwatershed.

#### Other tributary sites

Protecting entire intact sub-watersheds will prove extremely powerful for water quality and ecological health. Individual successes are easily measurable and cumulatively they deliver tangible benefits. Each of the following priority sub-watersheds have at least a 75 feet wide riparian forest buffer on 100% of the riparian land.

1) 10 NUTL. There are 10,000 linear feet of streambank in this sub-watershed that feeds North Muddy Creek, and it is heavily forested. This stream is small and drains an area close to the confluence of North and South Muddy Creeks. There is currently no land use activity anywhere close to the creek that could pollute Muddy Creek, though aerial and topographic map analyses indicate that land development is occurring nearby. The topography in this area is moderately sloping. The parcels are relatively small and include a 3 acre, 5 acre, and 64 acre tract.

2) 32 NUTL. 14,800 linear feet of heavily forested streambank comprise this drainage emptying into North Muddy Creek just off of Old Glenwood Road. Some timbering and residential development is occurring nearby though an ample riparian forest buffer appears to be maintained. The primary parcel is 366 acres.

3) 1 UTL. 7,200 linear feet of heavily forested streambanks comprise this sub-watershed that feeds Hoppers Creek. Hoppers Creek empties into South Muddy Creek. The largest tract is 127 acres and is near the Hoppers Creek stream restoration priority reach.

4) Spruce Branch. 12,800 linear feet of streambank is heavily forested, though some timbering practices are occurring. This is the largest drainage area southwest of the Huntsville Mountains. It appears that adequate riparian forest buffers have been maintained adjacent to the creeks. In addition to the 3,500 acre tract draining the Huntsville Creek headwaters, another tract totaling 250 acres drains this area.

5) 39 SUTL. 12,800 linear feet of streambank is heavily forested with some timber practices occurring. This is part of the South Muddy Creek headwaters cluster. Two 125+ acre tracts are held by absentee owners.

6) 47 SUTL. 10,800 linear feet of streambank is heavily forested with some timbering practices occurring. It appears that ample riparian forest buffers are being maintained. This creek forms the southernmost drainage of the South Muddy Creek headwaters cluster. Riparian lands are in large corporate ownership. Fieldwork and aerial analysis indicates that this creek could potentially host some wetland type areas.

#### Floodplains and Upland Forests along North, South, and Muddy Creeks

1) South Muddy Creek headwaters. As a headwater area containing substantially forested tributaries and as a riparian area along the mainstem of South Muddy Creek, this region needs protection. Over 1 mile of stream is forested on South Muddy Creek, not factoring in adjacent tributaries feeding this subwatershed. Past gold mining has created bog/wetland type areas. Both upland forest and bottomland forests exist intact here. Though pines have been planted in a plantation type arrangement, native hardwood communities are scattered throughout and form a good primary buffer around this stream.

2) South Muddy Creek from the flood control dam downstream to Highway 226. For 3,400 feet, South Muddy Creek is buffered by mostly mature mixed hardwoods with moderate to steep terrain with a few possible wetland areas along the floodplain. Rock outcrops and bedrock are substantial in this section of the creek. An historic mill site is located along this section of creek.

3) South Muddy Creek one mile upstream from confluence with North Muddy Creek. One tract borders South Muddy Creek for approximately 2000 linear feet. In addition to being a priority riparian forest preservation site, this property also contains priority stream restoration sites. The owners have been very amenable to the project's need to access the creek through their property and have even furnished a key to their gate. They have in the past indicated that they would like any assistance possible to help re-establish a good quail population here. The landowner's wildlife objectives could potentially correlate nicely with the Partners large restoration goals.

4) Muddy Creek just before the confluence with the Catawba River. One tract comprised of 825 acres borders both sides of Muddy Creek for approximately 9,000 linear feet. Mostly mixed hardwood and planted pines occupy these long floodplains. A few large steep and rocky outcrops also exist along the creek. This property has also been deemed a priority for preservation in the Catawba River Riparian Corridor Conservation Design prepared by the Foothills Conservancy of North Carolina in September 1999. Considering the owners' earlier willingness to entertain riparian forest buffer plans for its other properties in the Catawba Basin - riparian forest preservation should occur here.

5) North Muddy Creek downstream from Sugar Hill Road. Four local landowners own approximately 2 miles of creek frontage paralleling Interstate 40. They include a 73 acre tract, 124 acre tract, 42 acre tract, and a 70 acre tract. One owner already indicated her interest in the project and would likely entertain the idea of an easement on her land. NC Department of Transportation possesses an easement through some of this land. Mix hardwood forests abounded on steep hillsides and in floodplains, but it appears that a large clearcut has recently occurred on some of this acreage.

6) North Muddy Creek from Bledsoe Branch to White Branch. Five local landowners possess approximately 300 acres of mixed hardwood and alluvial forest along approximately 6,500 linear feet of North Muddy Creek. They include a 92 acre tract, 16 acre tract, 59 acre tract, 85 acre tract, and 40 acre tract. This is the upstream component of the nearly 9 mile section of North Muddy Creek which flow through dense steep forests and bedrock between Highway 226 and Interstate 40.

7) North Muddy Creek from White Branch downstream for approximately 2.5 miles. This is the downstream section of the 9 mile forest adjacent to North Muddy Creek between Highway 226 and I-40. Mixed hardwoods on upland slopes combine with deep alluvial forested floodplains and plentiful exposed bedrock to make this one of the more picturesque and ecologically healthy areas in the watershed. Land has been somewhat fragmented by two large developments, but the riparian areas appear to be left alone. Property includes a 191 acre tract, 41 acre tract, and 70 acre tract. Because of tax advantages or amenities for residents, the developments might be amenable to permanent conservation of the historic mill and relatively intact riparian forest areas. In addition, the 41 acre tract is owned by one of the landowners in the Muddy Creek Restoration Partners.

## Chapter 5: Conclusion and Recommendations

All available physical, chemical, and biological data indicates that the Muddy Creek watershed is impaired. Restoration is warranted but successful attainment of the two project goals will be a difficult, time consuming, and costly endeavor. Considering the potential economic and ecological benefits to the region, the investment would be worthwhile. The Partners have established a substantial foundation of organizational, financial, and volunteer support and numerous project successes which are recognized as important assets that can be leveraged to take this project to a necessary higher level. To help the Partners fully capitalize on this momentum, the following six recommendations are provided.

Recommendation 1) Obtain more substantial local buy-in and commitment from landowners within the watershed and the elected leadership and administration of McDowell and Burke Counties and the Town of Marion. This recommendation has been a project objective since the Partners inception in 1998. Previous attempts have met with limited success. A tremendous constraint hindering local participation has been the controversy surrounding the State's proposed riparian buffer regulations for the Catawba River Basin. The Partners must quickly move beyond this obstacle if it ever hopes to achieve project goals. Each of the three strategies outlined below are vital components of Recommendation #1.

Strategy A - Turn the anti-buffer constraint into an opportunity. The Partners' voluntary approach to conservation should be marketed at every opportunity as an alternative to the State's proposed buffer regulations. Number of watershed participants and conservation projects on-the-ground could be touted by the anti-buffer constituency as proof positive that voluntary and local control measures work - thus negating the need for State mandates. However, until the project attains a critical mass of local participation, any arguments for local control and voluntary measures at conservation as a substitute for regulation will ring hollow. A disturbing reminder of the daunting task facing the Partners is that any gains made by the project over the last four years through voluntary means have likely been negated by the currently legal and widespread landowner clearing of once-buffered riparian areas. Efforts should begin immediately to engage the anti-buffer constituency and seek their support for and assistance with marketing the project throughout the watershed.

Strategy B - Enhance local government participation. The Town of Marion has never been involved at all in the project and they should be, considering that the watershed's only officially recognized 303(d) listed stream drains that urban area. McDowell and Burke County involvement has been adequate at committee meetings but financial investment or involvement in public events such as the Partners' watershed restoration tours or riparian reforestation projects has not been visible. As a result, many landowners view the project primarily as a program of an energy company from Charlotte who likely has ulterior motives, a State environmental agency who is likely to grab their land if given the opportunity, and a group of outside environmentalists - some of who put fish ahead of people. Greater exposure of the local counties' support for and investment in the project is critical to help landowners (their constituents) recognize the value of land and water conservation in the project area. If the local governments are not aware of this value, the Partners should expend the energy necessary to educate these leaders about the very real and tangible economic and ecological benefits of watershed restoration here.

In an effort to recruit greater local government investment, the Partners should recognize current government funding constraints in NC and examine innovative means of helping these cash-strapped entities meet their own internal needs when they overlap with Muddy Creek project objectives. Where feasible, tradeoffs could be made between the Partners and these local governments. As examples, the MCWRI could trade through its Coordinator or Partners a) grant writing assistance, b) GIS training and project specific services, or c) sedimentation and erosion control inspections for direct county investment in the form of dollars and improved visibility in the Partners different programs and media events. While it is important for the Partners to recognize the difficulty of local governments to provide funding in today's economic climate, it is also important for the local governments to recognize the \$1 million dollar plus investment that the Partners have already generated that, if successful, should enhance the economic potential of the region and quality of life of their citizens. Local government investment at the rate of \$12,000 - \$15,000 per year would basically fund project coordination duties.

Strategy C - Invest heavily in the Landowner Outreach Committee. The Partners have achieved some success in the latter months of 2003 at recruiting and obtaining the participation of four landowners in the Muddy Creek watershed to assume a role on this committee. This committee should also involve local government participation. The Partners need to secure the necessary funding to support the initiatives of this Committee in 2003 and beyond. The revised Outreach Committee needs to hold regular meetings to develop an active agenda of landowner education and outreach. Through this active committee, the Partners will model local level buy-in and participation.

Without demonstrably improved local interest and participation within the next year, the Partners must recognize that its uphill battle will continue and successful attainment of project goals is questionable.

Recommendation 2) Implement measures to more accurately gauge sediment loads in the watershed and entering the Catawba River. To date, the project is still relying on "guesstimates" of the sediment load entering the Catawba River and does not have a verifiable method of tracking this pollutant or measuring its impact on salmonids in the tailrace fishery. An up-front investment in a sound sediment tracking system may actually save on costs long-term due to its ability to help the project determine when sediment delivery to the Catawba River drops to a satisfactory threshold. If broad enough, such a system will even help determine where major sediment sources are located so that restoration projects can be targeted more effectively. A good system would also help the Partners evaluate the effectiveness of site-specific restoration projects. A good sediment tracking system might be comprised of a StreamsideSystems™ bedload removal and the strategic reinstallation and monitoring of suspended sediment samplers throughout the watershed.

Recommendation 3) Fully utilize existing agricultural conservation programs. In the current economic climate of state budget deficits and declining foundational support, the 2002 federal Farm Bill appears to offer a great deal of potential funding. The Muddy Creek watershed is primarily rural and has numerous bottomlands currently in crop or cattle production. Many of the conservation priorities outlined in this plan involve reforesting streamsides and fencing out livestock or even protecting existing critical riparian forest buffers - all achievable through the

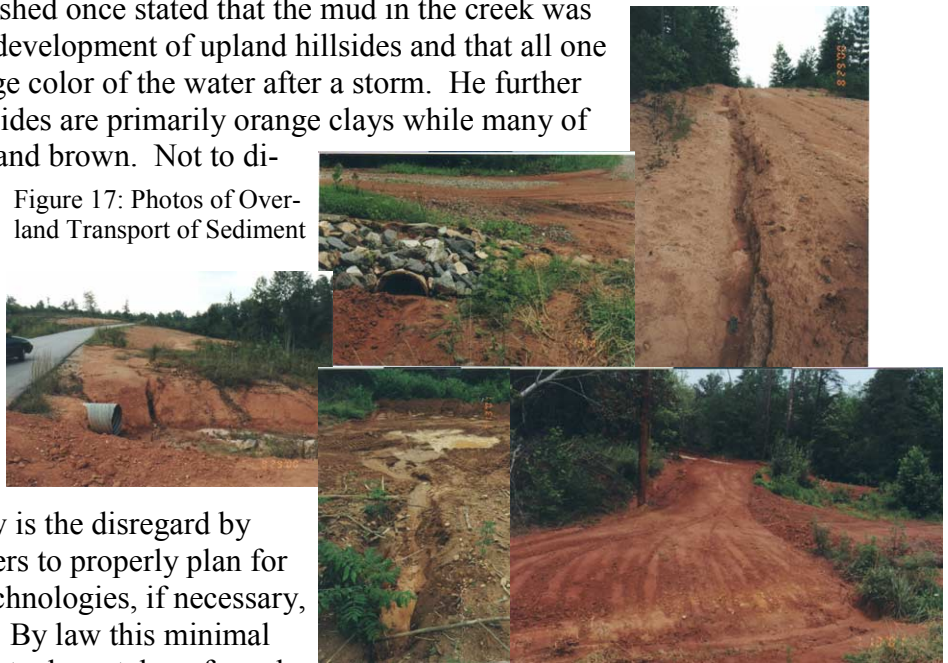
Farm Bill programs. The USDA Natural Resources Conservation Service is the federal agency in charge of these programs and has been a valuable partner in the Partners since its inception.

This plan recommends a greater role for this agency in the coming year(s) to help acquire funding for conservation practices and implement them on-the-ground. Albert Moore, the current District Conservationist for McDowell County, has indicated his interest to promote more conservation in the project area and has stated that adequate funding should be available to implement a number of programs which would help restore watershed health. These programs are available on-demand via landowner application. Albert indicates that he could use assistance from the MCWRI helping to market the programs and service the demand in McDowell County. In the fall of 2003, the Partners began providing this service through Duke funding.

Recommendation 4) Combat overland transport of sediment with equal fervor as bank erosion.

A farm landowner in the watershed once stated that the mud in the creek was coming from the clearing and development of upland hillsides and that all one had to do was look at the orange color of the water after a storm. He further stated that the soils on the hillsides are primarily orange clays while many of the floodplain soils are loamy and brown. Not to diminish the significance of streambank erosion as a primary sediment source, this landowner's observation is accurate to some degree as evident by the photographs in Figure 17. Two years of general observations during field inventories suggest that a major problem with overland flow is the disregard by some landowners and developers to properly plan for and install sediment control technologies, if necessary, during development activities. By law this minimal measure is required, but it is not adequately enforced.

Figure 17: Photos of Overland Transport of Sediment



The State does not have the organizational capacity to monitor and enforce the Sediment and Erosion Control Act of 1974 and McDowell County does not employ anyone to help. The Partners should see to it that someone - even if that be the Coordinator of the Muddy Creek Restoration Partners - monitors the project area for the presence of appropriate sediment and erosion control measures, reports these findings to the State and County leaders, and ensures that existing laws are enforced. If overland transport of sediment is not addressed, sediment loads from these sources will nullify gains from other stream and riparian restoration projects.

Recommendation 5) Build restoration projects upon priority lists. The determination that the Muddy Creek watershed is impaired has been based upon a comprehensive analysis of data involving biological, chemical, and physical parameters of watershed health. A successful reversal, or restoration, of this condition will depend upon implementation of the four different conservation strategies - natural channel design stream restoration, riparian reforestation, livestock

exclusion, and riparian forest protection. Each of the strategies is of equal importance. Natural channel design stream restoration is imperative at those highest priority stream reaches where prominent bank erosion sites are clustered. These areas are responsible for an extraordinary 350 tons of sediment delivered to the watershed over the last year or so. Riparian reforestation must occur on especially the smaller 1st and 2nd order tributaries to help infiltrate stormwater runoff such that storm flow surges through this watershed are mitigated. By slowing runoff, the Partners will in effect slow stormflow velocities and decrease its souring potential on vulnerable barren banks. Livestock exclusion will allow currently degraded areas to heal. These type of projects are cost-effective and can actually increase the health and poundage of a herd of cattle. Cattle exclusion should also help reduce coliform concentrations. While these restoration strategies are worthwhile and necessary if the Partners hope to reach their goals, they will be to no avail if currently intact riparian areas become degraded. Protection of existing good water supplies is imperative, especially in headwater areas.

The priority lists generated by this plan are not confining but appear to provide the Partners with a critical mass of potential projects such that implementation should not be held up due to landowner dis-interest. In other words - there are plenty of places to work. Implementation should begin immediately, starting with active outreach of those landowners of priority sites. That being said, this plan also recognizes the occasional need for the Partners to step outside of the bounds of the priority lists to service demand from landowners whose needs may not have been recognized by the various prioritization processes. This plan emphasizes that anyone who requests restoration assistance be serviced if it can be determined through a site visit that their property contains bonafide restoration need. This value is predicated on the notion that the more on-the-ground successful projects the Partners can design and install, the more they will lead to additional restoration opportunities. Word of the mouth from satisfied customers will be the best advertisement for all restoration strategies.

Recommendation 6) Budget adequately to pay for a quality project that will attain its goals. Restoration is a costly undertaking. The Partners should prepare themselves for a 10 year time commitment and expect to invest at minimum \$2.021 million , excluding land preservation costs (Table 7). Factoring land preservation into the equation creates an additional \$15 million cost in the budgetary requirements.

A. Budget Calculations - At \$85 per linear foot, natural channel design stream restoration at the 26 highest priority barren bank sites will cost an estimated \$1,053,320. At \$7 per linear foot, riparian reforestation at a width of 35 feet on the remaining 32,000 feet of streambanks that have no buffer will cost an estimated \$224,000. Costs for livestock exclusion and alternative watering systems on just the 15 projects identified in this plan would likely require a \$140,000 investment for fencing, wells, and plumbing. Those costs are difficult to predict due to their contingency upon site specific conditions. At \$2,000 - \$5,000 per acre for land acquisition, the Partners should expect to invest at minimum \$30 million if it hopes to purchase in fee simple the 15,000 acres or so of intact riparian forestlands that comprise the priority headwaters, sub-watersheds, and key bottomlands identified in this plan. Purchasing conservation easements on these properties could lessen that expense to roughly \$15 million. Staffing to coordinate the project and recruit landowners into restoration projects would likely total \$350,000 over a ten

year period, with an additional \$100,000 earmarked for land preservation outreach. The benchmarks given for these four restoration strategies could conceivably be achieved in ten years provided the Partnership is well coordinated, funding is readily available, and each Partner assumes responsibility for and efficiently implements its responsibilities for its relevant tasks.

Table 7: Muddy Creek Restoration Partners Forecasted Program Budget

<b>Program Costs</b>	<b>Benchmark (10Yr)</b>	<b>Ideal (20YR)</b>
Natural Channel Design Stream Restoration	\$1,053,320	\$1,053,320
Riparian Reforestation	\$224,000	\$2,127,650
Livestock Exclusion	\$140,000	\$280,000
Landowner Outreach and Recruitment - Restoration	\$200,000	\$400,000
Program Coordination	\$150,000	\$300,000
Sediment Monitoring System	\$125,000	\$125,000
Grants Administration (7.5% of Total Expenditures)	\$142,749	\$321,447
<b>Sub Totals</b>	<b>\$2,035,069</b>	<b>\$4,607,417</b>
<b>Budget Including Land Preservation Costs</b>		
Riparian Forest Preservation	\$15,000,000	\$30,000,000
Landowner Outreach and Recruitment - Preservation	\$100,000	\$200,000
<b>Total Budgetary Requirements</b>	<b>\$17,135,069</b>	<b>\$34,807,417</b>

Additional restoration needs exist beyond the benchmark levels identified in this section, and are factored into this budget under the Ideal (20YR) column. There are 3 sub-watersheds where riparian forest buffers are less than 25 feet for over 50% of their drainage areas. There are 16 additional sub-watersheds where the riparian forest buffer is inadequate for 27% -50% of its drainage area. There are likely double the number of livestock exclusion projects needed in the watershed than stated as priorities. Ideally, restoration would encompass these areas, which would likely add another 10 years to the total program duration. Fee simple costs for land preservation of the 15,000 estimated acres have been inserted into the ideal budget as a means of accounting for increasing land values over time.

B. Funding Opportunities - The forecasted budget needs are daunting. However, innovative partnerships and creative channeling of regulatory requirements and State dollars could spread the costs in a more manageable context. Already, the Partners are teaming with the USDA Natural Resources Conservation Service to market livestock exclusion and buffer enhancement projects, taking advantage of existing Federal and State agricultural programs to pay design and installation costs. This partnership removes a \$140K fundraising burden. Recent communications with the NC Wetlands Restoration Program indicate that they are willing to provide the financial investment and personnel to produce the designs, coordinate all contracting, and oversee the construction on natural channel design stream restoration projects. If this relationship with NCWRP is established, a huge fundraising burden (\$1.053M) will be lifted from the

Partners. On a similar note, the State's newly established Ecosystem Enhancement Program could pay substantial dividends toward the permanent preservation of priority headwater and bottomland areas. The NC Department of Transportation needs to fulfill a backlog of stream, wetland, and species mitigation requirements and is emphasizing "protection" of functionally intact aquatic areas as a means of addressing that backlog. This plan identifies a number of properties that meet EEP criteria and qualify for preservation funding. As part of the dam relicensing process, Duke Energy will likely be required to mitigate some disturbances. As founding member and staunch supporter of the Muddy Creek Restoration Partners, Duke has expressed its interest in seeing mitigation investments go directly into the Muddy Creek watershed. Duke's mitigation dollars would be most effective if regulatory authorities allowed them to be used for project coordination and landowner outreach activities. These are the more difficult program areas to fund, but without the staffing to make the connections with landowners, on-the-ground conservation does not occur. In addition - the Partners must fulfill grant reporting requirements; budgeting and fundraising needs; committee coordination; restoration project supervision; and restoration project evaluation. These work tasks, some of which are required by funders, require personnel - and personnel costs money. The Partners need to stress this truth to potential funders. The land preservation and riparian reforestation restoration strategies would also benefit from Duke's cash outlays. In summary, it appears that money can readily be found for on-the-ground conservation projects but may prove difficult to raise to pay for the staffing to make those conservation projects a reality. This predicament begs Partner attention.

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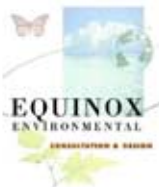
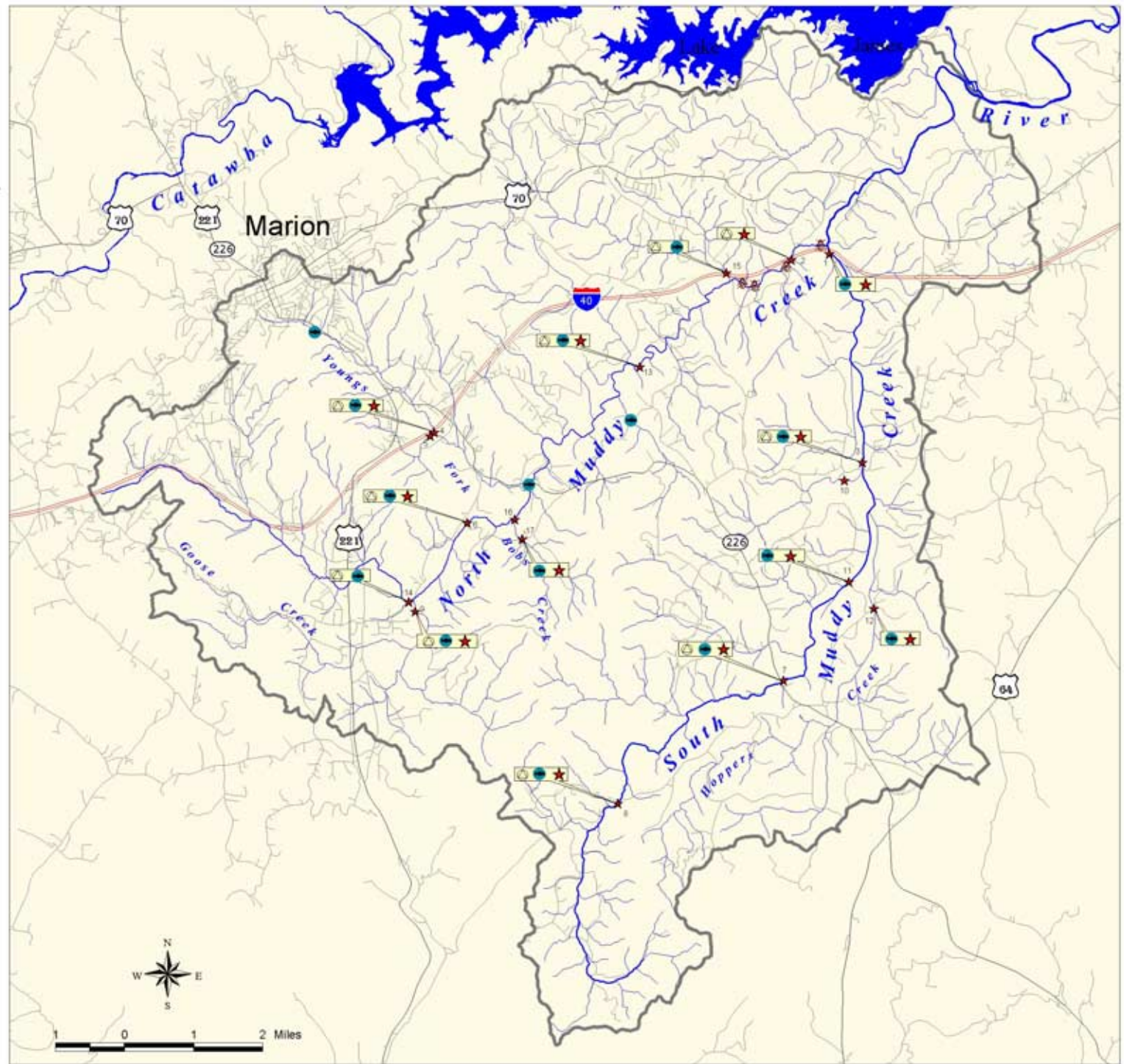
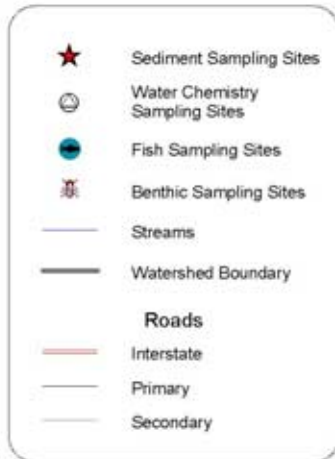
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## **Appendix A: Maps of Muddy Creek Watershed**

- Map A: Locations of All Data Stations in the Muddy Creek Watershed
- Map B: Physical Survey of Streams and Their Banks in the Muddy Creek Watershed
- Map C: Bank Pin and Pebble Count Locations
- Map D: Location of Barren Banks and Their Corresponding Length
- Map E: Riparian Forest Buffer Widths of Accessible Streams in the Muddy Creek Watershed
- Map F: Riparian Forest Buffer Status on 2nd Order and Above Streams
- Map G: Primary Land Use Within the Riparian Survey Area
- Map H: Locations of Fenced and Unfenced Livestock in Phase I and II Survey
- Map I: Locations of Conservation Priorities: Natural Channel Design Stream Restoration, Riparian Reforestation, Livestock Exclusion, and Riparian Forest Preservation

**Muddy Creek  
Restoration Partners**

**Map A:  
Locations of All Data  
Stations in the Muddy  
Creek Watershed**



The Muddy Creek Watershed Restoration Initiative is comprised of Citizens in McDowell & Burke Counties, McDowell County Soil & Water Conservation District, NC Cooperative Extension Service, USDA Natural Resources Conservation Service, NC Wildlife Resources Commission, Trout Unlimited, Duke Energy Corporation, Foothills Conservancy of North Carolina, McDowell & Burke Counties

Funding Provided By: NC Division of Water Resources, NC Clean Water Management Trust Fund, National Fish & Wildlife Foundation, Trout & Salmon Foundation, Trout Unlimited and Duke Energy Corp.

December, 2003

**Muddy Creek  
Restoration Partners**

**Map B:  
Physical Survey  
of Streams & Their  
Banks in the Muddy  
Creek Watershed**

**Streams**

**Field Survey**

- Phase I
- Phase II
- Unsurveyed Areas

**Aerial Analysis**

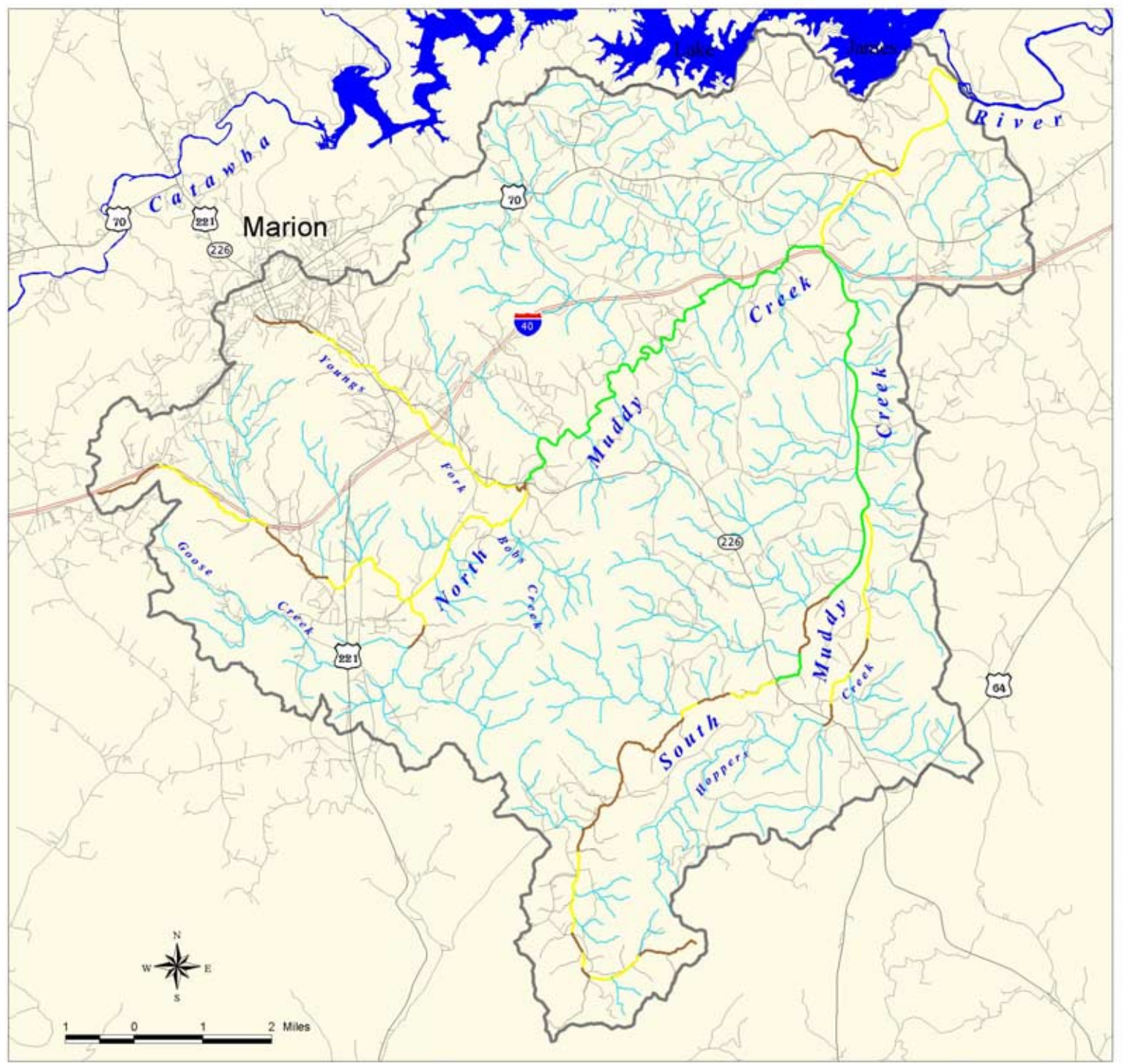
- Phase III

**Watershed Boundary**

- Watershed Boundary

**Roads**

- Interstate
- Primary
- Secondary




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**Muddy Creek  
Restoration Partners**

**Map C:  
Bank Pin and Pebble  
Count Locations**

 Bank Pin Locations  
(Number 6 and 7 removed)

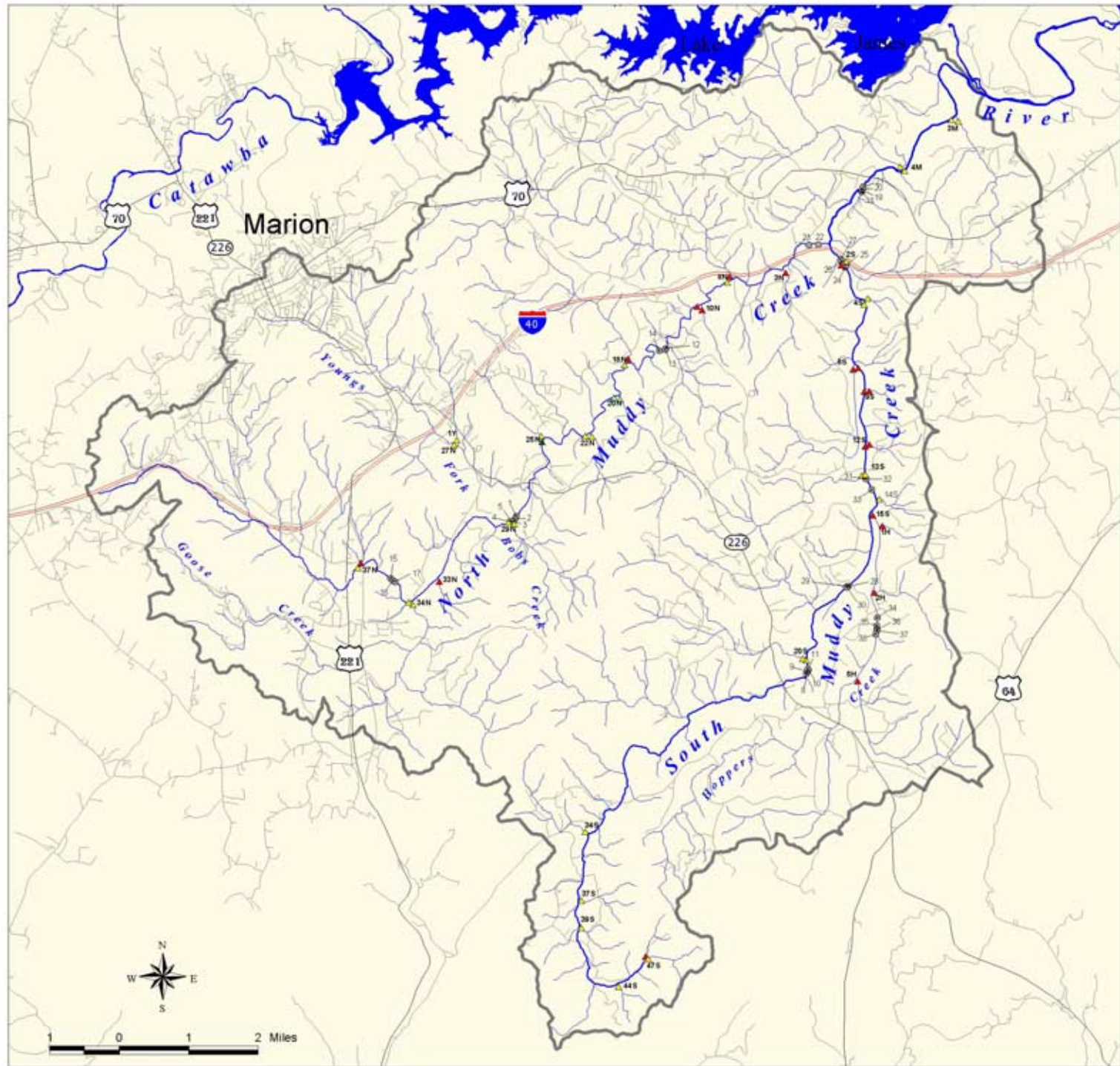
**Pebble Count D50**

-  Sand/Silt
-  Gravel
-  Cobble
-  Boulder

 Streams  
 Watershed Boundary

**Roads**

-  Interstate
-  Primary
-  Secondary



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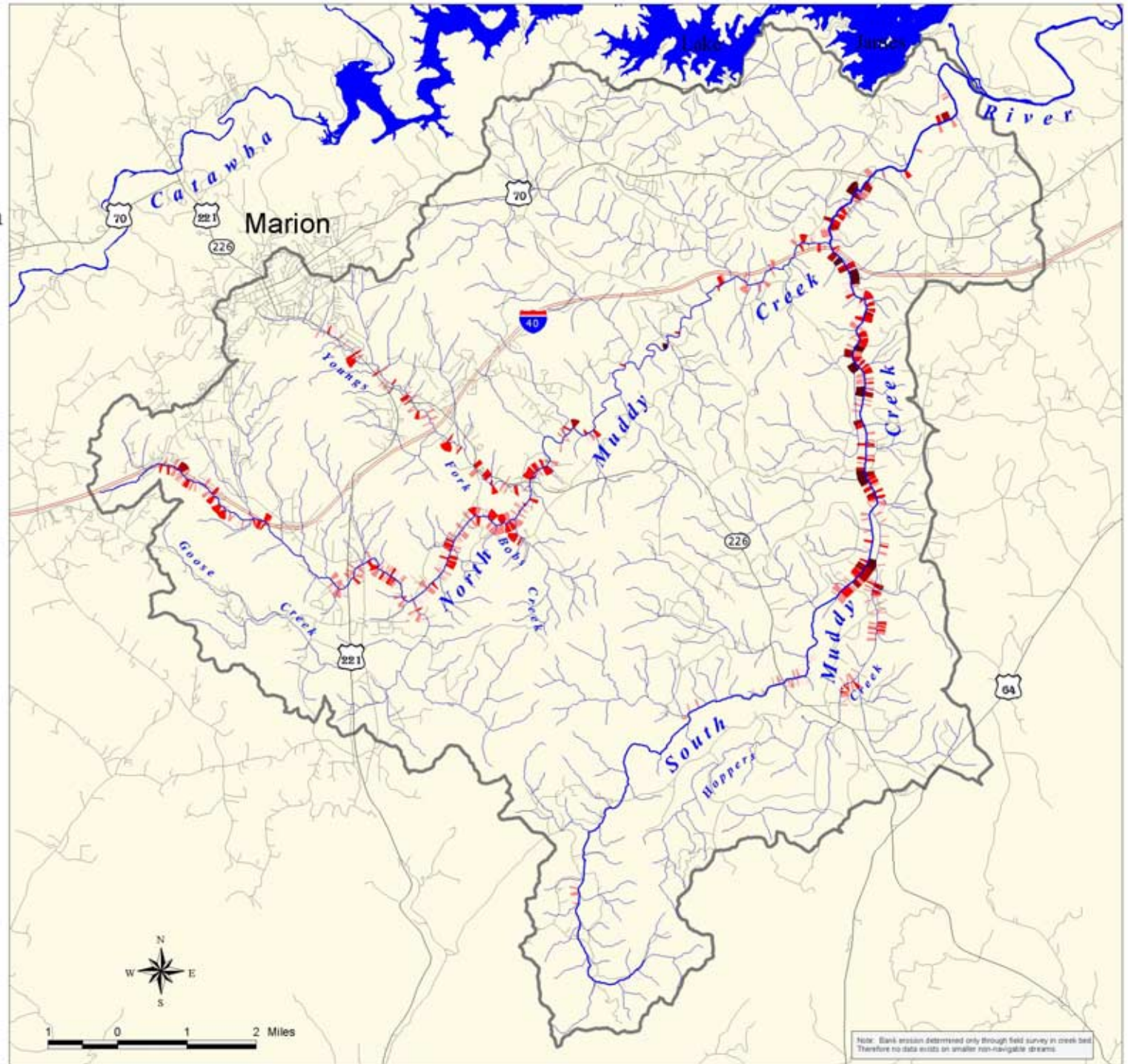
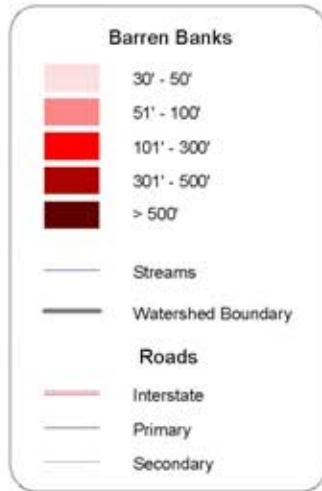
December, 2003



**Muddy Creek  
Restoration Partners**

**Map D:  
Location of Barren  
Banks and Their  
Corresponding Length**

Survey of Accessible Streams



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Funding Provided By: NC Division of Water Resources, NC Clean Water Management Trust Fund, National Fish & Wildlife Foundation, Trout & Salmon Foundation, Trout Unlimited and Duke Energy Corp.

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Note: Blank erosion determined only through field survey in creek bed. Therefore no data exists on smaller non-navigable streams.

**Muddy Creek  
Restoration Partners**

**Map E:  
Riparian Forest  
Buffer Widths of  
Accessible Streams  
in the Muddy Creek  
Watershed**

Phase 1 and 2 Survey Areas

Buffer Widths (feet)



 Streams

 Watershed Boundary

**Roads**

 Interstate

 Primary

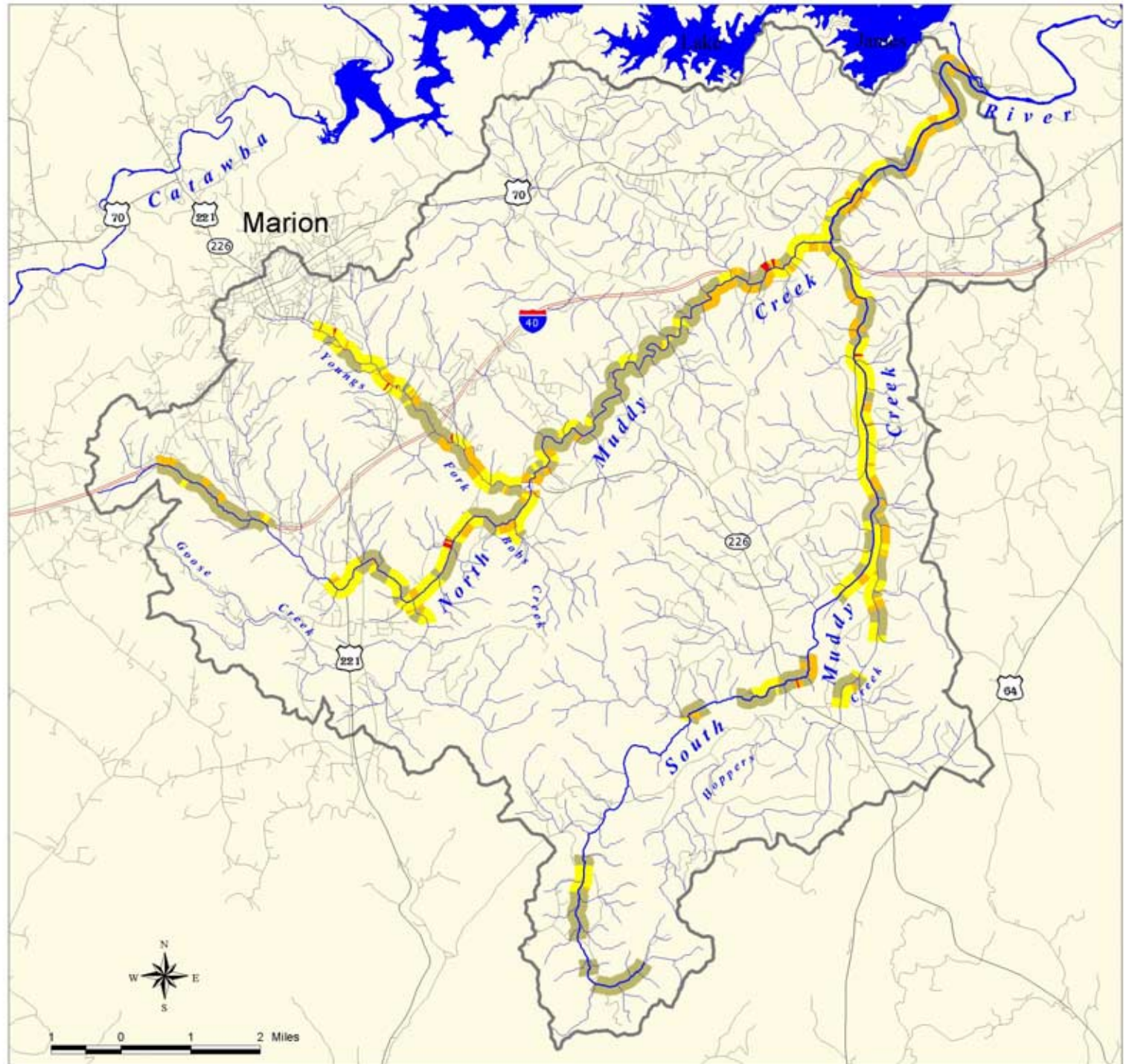
 Secondary



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**Muddy Creek  
Restoration Partners**

**Map F:  
Riparian Forest Buffer  
Status on 2nd Order &  
Above Streams**

Sub-watersheds with < 25 ft  
Riparian Forest Buffer

- 51 - 100 % of Stream
- 27 - 50 % of Stream

Sub-watersheds with > 75 ft  
Riparian Forest Buffer

- 100 % of Stream

— Streams

— Watershed Boundary

**Roads**

— Interstate

— Primary

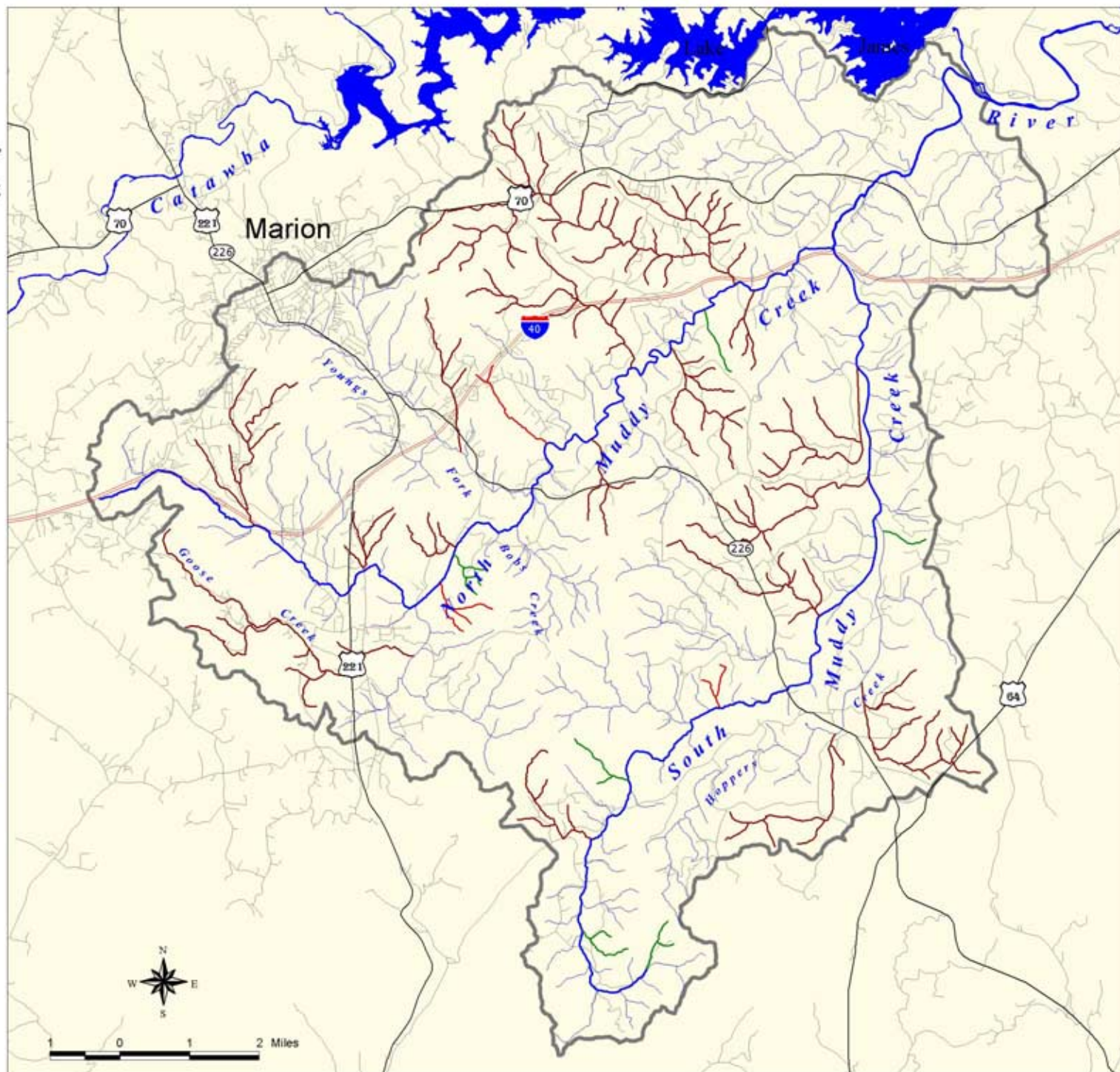
— Secondary



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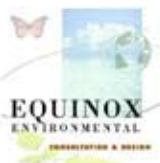
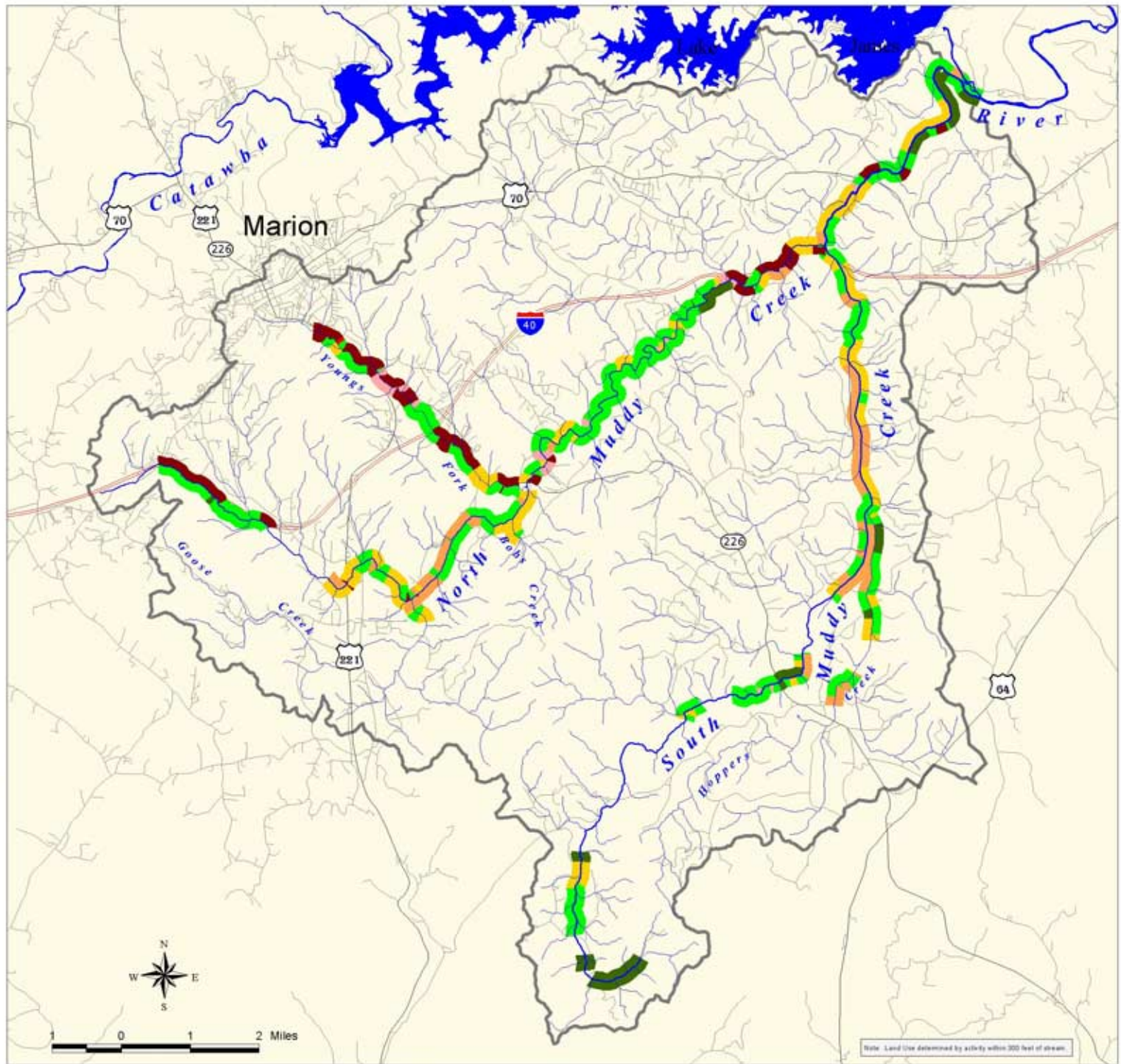
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**Muddy Creek  
Restoration Partners**

**Map G:  
Primary Land Use  
Within the Riparian  
Survey Area**



The Muddy Creek Watershed Restoration Initiative is comprised of Citizens in McDowell & Burke Counties, McDowell County Soil & Water Conservation District, NC Cooperative Extension Service, USDA Natural Resources Conservation Service, NC Wildlife Resources Commission, Trout Unlimited, Duke Energy Corporation, Foothills Conservancy of North Carolina, McDowell & Burke Counties

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December, 2003



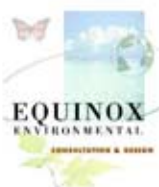
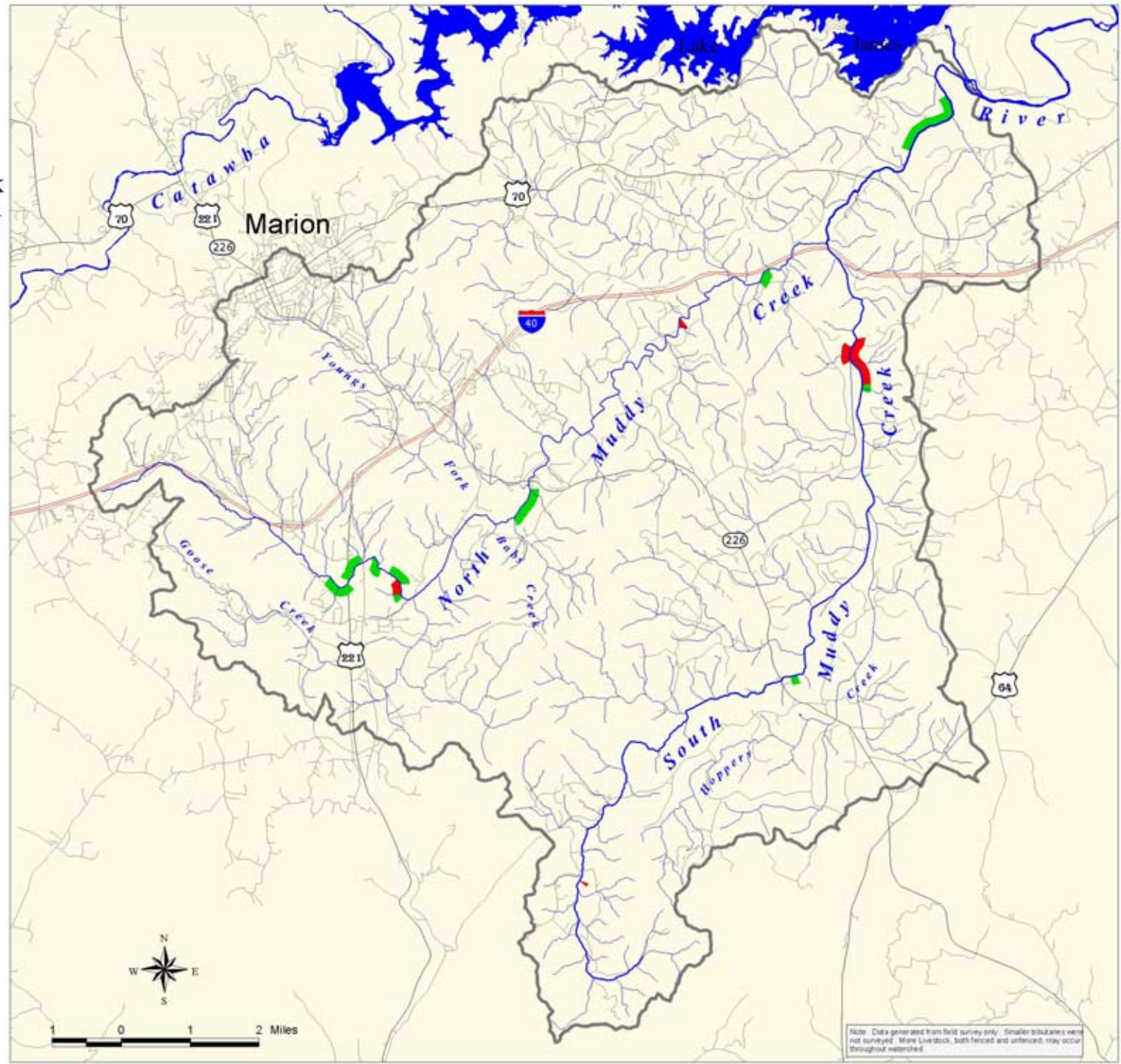
Note: Land Use determined by activity within 300 feet of stream.

**Muddy Creek  
Restoration Partners**

**Map H:  
Locations of Fenced  
& Unfenced Livestock  
in Phase I & II Survey**

**Cattle Locations**

- Fenced Livestock
- Unfenced Livestock
- Streams
- Watershed Boundary
- Roads
- Interstate
- Primary
- Secondary



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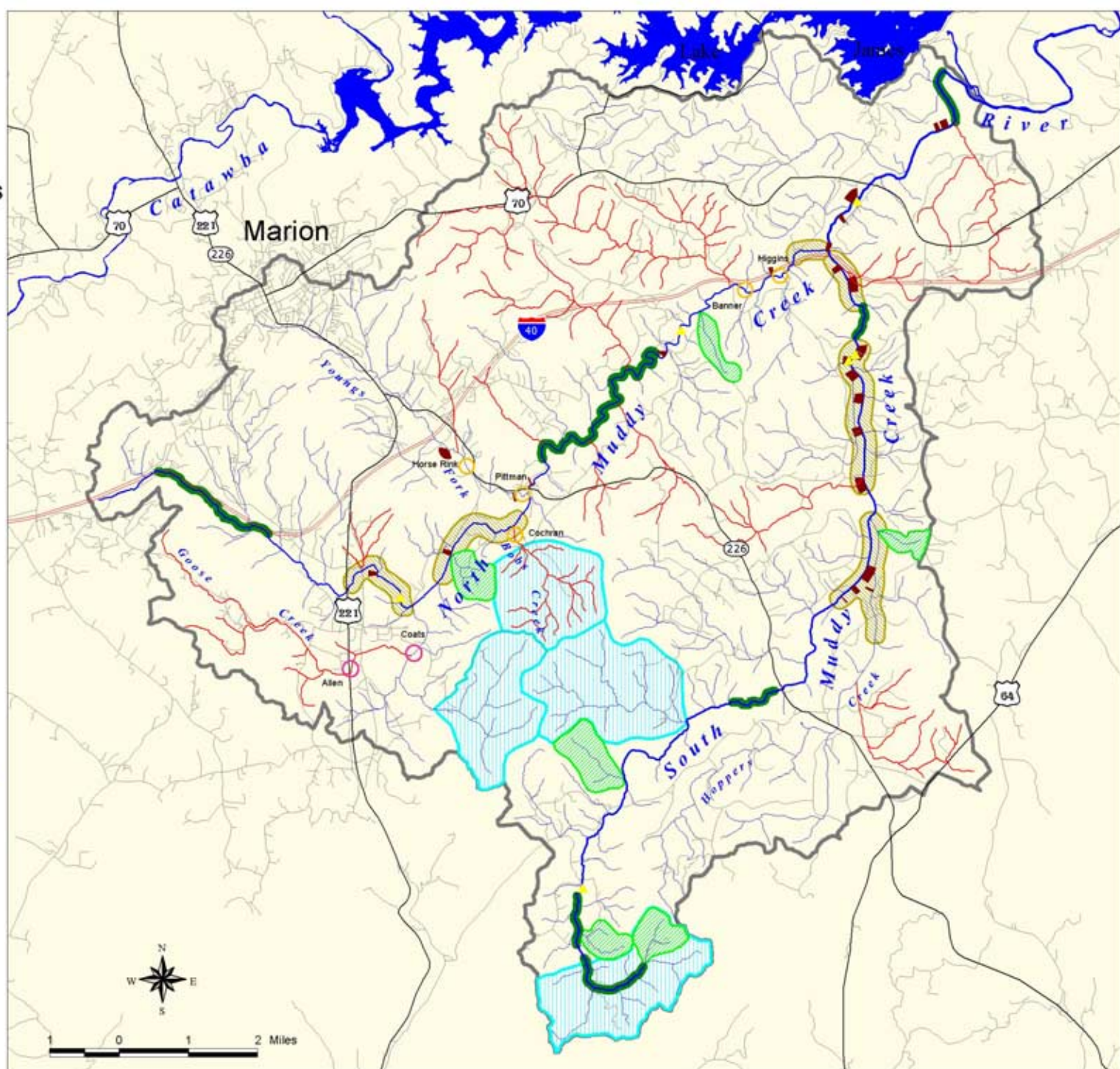
December, 2003

Note: Data generated from field survey only. Smaller tributaries were not surveyed. More Livestock, both fenced and unfenced, may occur throughout watershed.

# Muddy Creek Restoration Partners

## Map I: Locations of Conservation Priorities

- Natural Channel Design  
Stream Restoration**
- Highest Priority Stream Reaches
  - Highest Priority Barren Bank Sites
- Riparian Reforestation**
- Highest Priority Reforestation Streams
- Livestock Exclusion Sites**
- Livestock Access
- Riparian Forest Preservation**
- Headwater Sites
  - Other Tributaries
  - Main Stem Sites
- Completed Restoration Priorities**
- Stream Restoration Sites
  - Riparian Reforestation Sites
- Streams**
- Watershed Boundary
  - Roads
  - Interstate
  - Primary
  - Secondary



The Muddy Creek Watershed Restoration Initiative is comprised of Citizens in McDowell & Burke Counties, McDowell County Soil & Water Conservation District, NC Cooperative Extension Service, USDA Natural Resources Conservation Service, NC Wildlife Resources Commission, Trout Unlimited, Duke Energy Corporation, Foothills Conservancy of North Carolina, McDowell & Burke Counties

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December, 2003

