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EXECUTIVE SUMMARY

Local Watershed Plans are management tools initiated by the North Carolina Ecosystem Enhancement Program (EEP) to identify factors contributing to water quality degradation within a watershed and provide strategies to address non-point sources of pollution. The plans are used to identify wetland, stream, and riparian restoration projects that can be utilized to help meet compensatory mitigation needs as well as address problems associated with non-point source pollution and stormwater runoff.

The challenge of watershed restoration is in determining the sources of water quality and habitat degradation and deciding what management practices should be implemented to address the problems. The EEP has adopted a phased approach to efficiently focus the resources necessary to meet these challenges. As a first step, a watershed characterization is developed to assemble and analyze existing information, to identify potential problems and water quality issues, and to develop analytical tools and metrics for more detailed analyses. WK Dickson & Co., Inc. (WKD) has been retained by the EEP to perform the Phase 1– Watershed Characterization of the Little River watershed and Laurel Branch sub-watershed.

The Little River Watershed (HUC 0505001030020) was selected by the EEP due to its abundant mitigation opportunities that conserve water quality by restoring riparian habitat on unforested stream buffers. Also, the watershed contains rare bog habitat and High Quality Waters. This study includes the Laurel Branch sub-watershed of Brush Creek (HUC 0505001030030) located to the southeast of Little River. The study area covers approximately eighty (80) square miles within Alleghany County, North Carolina, which includes slightly over three (3) square miles of catchment drained by Laurel Branch.

To perform the watershed characterization, WKD first assembled the most current GIS information available for this project. EEP provided various data sets for the project as well as GIS files from the Conservation Fund and Resource Data, Inc. Furthermore, data were obtained from CGIA and the Alleghany County GIS Department. Following the data compilation and evaluation, various map documents were created that were utilized to aid in the analysis of physiography, land cover, soils, hydrology, historical trends and habitat of the Little River and Laurel Branch watersheds. Additional data and information were obtained through windshield surveys, interviews with local habitants and agency members, and from existing documents.

The windshield survey of the study area showed nothing unexpected from what is typical of the region, and largely verified much of the remote sensing analysis. The study area consists mainly of small and medium sized farms that have existed for several generations. There is a long history of dairy and cattle farming, although only a few dairy operations remain today. In various areas throughout the watershed, the upper slopes have been cleared and planted with either Christmas trees or white pines for timber. The introduction of these practices to the area has increased the number of steep dirt and gravel roads, which are also a major feature of most of the remaining farms.

Through office and field analyses, three problems that contribute to the degradation of water quality and habitat have been identified. The two most significant problems are riparian habitat and sediment. Many of the streams in the area have unforested buffers that are heavily grazed, and stream banks are trampled by cattle. These conditions provide high amounts of fine sediment to the streams. The third problem is the unmanaged stormwater in and around the town of Sparta that has adverse effects on in-stream habitat and causes an increase in pollutant

loadings. The assessment of watershed problems indicates that there are many activities on very steep slopes (e.g. road building, development and Christmas tree farming) that take place with little regard to surface water run off.

The visual assessment of the watershed and meetings with local citizens indicated an abundance of typical stream and wetland restoration sites within the Little River Watershed. Several landowners have worked with the NRCS in the past and may be willing to consider conservation easements for stream and wetland projects contingent on the economic benefits. Additionally, the County has the basic beginnings of a development plan; however, there is no clear path to implementation. Increased funding and guidance within the context of a watershed plan could improve county management of stormwater through the application of Stormwater Treatment Practices (STP's).

Before action can be taken to address the identified water quality and habitat issues, a more detailed study is necessary to accurately assess the problems within the Little River watershed and Laurel Branch sub-watershed. After evaluating the available information and in consideration of the overall Local Watershed Plan objectives, eleven (11) sub-watersheds have been identified as focus areas for more detailed study. To provide a more thorough analysis of the existing conditions, a two tiered riparian corridor survey should be executed to evaluate the physical and biological conditions in the streams and riparian habitats. The first level would include more thorough reconnaissance and GIS analyses of the eleven sub-watersheds. The additional "windshield surveys" would provide additional ground-truthing of inconsistent mapping information and also allow the most effective data collection sites to be identified. The second level of investigation would acquire qualitative data on a representative sample of riparian corridors and initiate quantitative assessment strategies. Examination of the resulting data can be used to identify discrete restoration sites and develop a matrix for project ranking and prioritization. Additional efforts are recommended to evaluate the following watershed characteristics:

- Sediment
- Water quality
- Benthos
- Mussel survey
- Bog turtle survey and inventory of species of concern
- Verification of hydric soils
- Riparian vegetation
- Stream stability

Results of a concerted application of the proposed methods will provide a basic data set for extrapolation across the Little River watershed and Laurel Branch sub-watershed. The assessment tools provide a systematic approach to evaluate the scope and magnitude of water quality problems and restoration opportunities. Furthermore, the resulting data will provide the basis for the development of a plan containing practical conservation initiatives supported by a broad consensus of resource professionals, local officials and residents of the watershed.

INTRODUCTION

Local Watershed Plans are management tools that help the North Carolina Ecosystem Enhancement Program meet habitat restoration and water quality improvement objectives throughout the state. The Little River Watershed (HUC 0505001030020) has been selected by the Ecosystem Enhancement Program (EEP) for plan development. This hydrologic unit was selected due to the abundance of opportunities to conserve water quality by restoring riparian habitat on unforested stream buffers. The Laurel Branch sub-watershed of Brush Creek (HUC 0505001030030) was added to the study. Brush Creek is the adjacent hydrologic unit and flows into the Little River from the east. The Laurel Branch sub-watershed has a history of water quality problems related to illicit sediment discharges.

The study area covers approximately eighty (80) square miles within Alleghany County, North Carolina, which includes slightly over three (3) square miles of catchment drained by Laurel Branch. Figure 1 shows the location of the study area within the state; more detailed maps are provided herein as Appendices I and V.

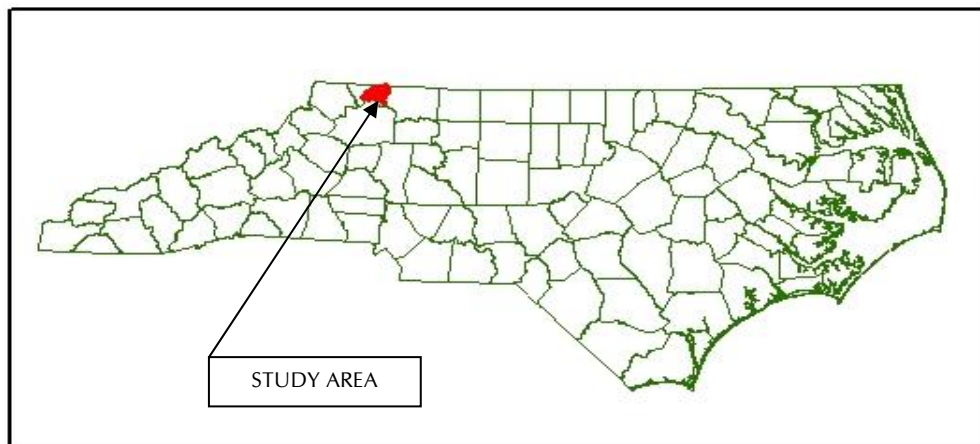


Figure 1. General location map of the Little River Watershed study area in North Carolina.

Local Watershed Plans identify factors contributing to water quality degradation within a watershed and provide strategies to address non-point sources of pollution. They are used to identify wetland, stream, and riparian restoration projects that can be utilized to meet compensatory mitigation needs as well as address non-point source pollution problems. The plans include three key components:

- An inventory of the specific causes of water quality degradation identified through a detailed watershed assessment;
- A plan which links water quality problems with specific restoration strategies that are supported by local stakeholders and/or the community;
- A strategy for implementing restoration projects and other water quality initiatives identified in the plan.

PURPOSE AND OBJECTIVES

The challenge of watershed restoration is in determining the sources and causes of water quality degradation and deciding what management options should be applied to solve the problem.

SECTION 1

INTRODUCTION

Another challenge with watershed restoration is that each watershed is unique—both naturally (weather patterns, soils, vegetation) and in the anthropic impacts (development history, land use, hydrologic modifications). The EEP has adopted a phased approach to efficiently focus the resources necessary to meet these challenges. As a first step, a watershed characterization is developed to describe, based on existing information, that unique combination of watershed characteristics and potential causes of water quality impairment.

The purposes of the Watershed Characterization are to thoroughly assemble and analyze existing information, to identify potential problems and water quality issues, and to develop analytical tools and metrics for more detailed analyses. WK Dickson & Co., Inc. (WKD) has been retained by the EEP to perform the Phase 1– Watershed Characterization of the Little River watershed and Laurel Branch sub-watershed. This document summarizes the findings of extensive records research, GIS-based spatial analyses, interviews with resource professionals and local residents, and a cursory visual assessment.

Included with this report is an electronic copy of an ArcView 3.2 project (.apr) file and all associated data on compact discs. The data are in the form of ArcView shapefiles, tables, and digital photos, and reside in clearly labeled folders. Hardcopy maps of GIS data are provided in Appendices I and V. Additionally, a spreadsheet describing all of the data (metadata) is included with the GIS files and provided herein as Appendix III. Other discs contain images of aerial photography taken at approximately ten year intervals from 1941 to 1998.

REGIONAL GEOLOGY, PHYSIOGRAPHY, AND DRAINAGE

The study area is located entirely within the Blue Ridge Physiographic province. The Blue Ridge escarpment forms the continental divide, separating the Little River from adjacent catchments in the Yadkin Basin. The region is believed to be composed of crystalline thrust sheets of allochthonous Precambrian basement rocks and late Precambrian to early Proterozoic metasedimentary and metavolcanic rocks. The thin-skinned overthrust sheets around the Little River watershed typically consist of slope and rise sequences originally deposited on both continental and oceanic crust (Horton and Zullo, 1991).

The structure and lithologies document the complex Appalachian orogenic sequences, during which a large Precambrian supercontinent separated into discrete land masses, including the North American paleocontinent of Laurentia. Initial rifting resulted in the formation of the Iapetus Ocean, and subsequent cycles of convergence, rifting and associated volcanics created the complex of tectonostratigraphic terranes.

The watershed is underlain by rocks of the late Proterozoic age. These units are typically amphibolite and greenschist metafacies, and are comprised of muscovite-biotite gneiss, mica schists, amphibolites and metamorphosed extrusive and intrusive igneous rock. Metasedimentary rocks, particularly granule conglomerate with schist and phyllite are also common. Sulfide deposits are locally significant within the mapped units, but their occurrence in the study area is doubtful.

There are two reasons these geologic complexities are of interest for the present study. First, the NC Geological Survey (Carpenter and Reid, 1993) has collected extensive data on stream and groundwater, and stream sediments. These data largely reflect water chemistry that results from the geologic conditions, and may be helpful in sorting out water quality issues that may be discovered in the future. Secondly, the New River watershed is generally believed to reflect a

SECTION 1

INTRODUCTION

superposed drainage pattern, one in which the general channel locations of the drainage system predate the development of contemporary physiographic features. This would be an important consideration for any stream restoration project.

The eastern and southeastern limits of the Little River/Laurel Branch study area are the continental divide. The Little River flows north-northeast and enters the New River a few miles over the state line in Virginia. The New River flows generally northward to the Kanawa River in West Virginia, which in turn flows into the Ohio River and ultimately the Gulf of Mexico. Detailed statistics including number of channel segments, stream orders and drainage densities are provided in Appendix II.

LAND USE/COVER

The study area lies entirely within the New River Plateau section of the Blue Ridge Mountains Ecoregion. By using 1999 GIS land cover data obtained from the Clean Water Trust, land use trends were determined for the study area. Approximately half of the eighty square mile study area is covered by forest, predominantly mixed hardwoods. Most of the remaining land is covered by pasture, with only 632 acres cultivated for row crops and burly tobacco. Most of the larger forested tracts are up on the hilltops, in areas too unproductive for grazing or too difficult to access for other uses. Forest covers about 70 percent of the three square mile Laurel Branch catchment, with the remaining area used for pasture and three golf courses. Throughout the study area, and particularly in the southern portion, Christmas tree production has become an increasing land use.

Sparta, the Seat of Alleghany County, is situated in the north-central part of the watershed. Sparta and adjacent unincorporated areas comprise the only portion of the watershed that could be considered urban. Besides several government offices and a downtown commercial district, Sparta has a few manufacturing and warehouse facilities and strip-malls. The watershed is predominantly covered with small and medium size family farms that have been worked for several generations. There had been a long history of dairy farms, which declined years ago and are now limited to a handful of operations. Additional information on land cover and habitat is included in Section 5 of this report, and in the sub-watershed statistics provided in Appendix II.

GEOGRAPHIC INFORMATION SYSTEMS

DATA COMPILATION

WKD met with EEP staff and assembled the most up to date GIS information for this project. EEP provided various data sets for the project as well as GIS files from the Conservation Fund and Resource Data, Inc. (see Appendix III). WKD obtained BasinPro from CGIA and GIS files from the Allegheny County GIS Department to augment data provided by EEP. Additionally, data layers, tables and digital photos were created by the project team during the course work.

After compilation, the data were analyzed to assess any critical data gaps that would affect the project. No gaps were found and the data layers were cataloged and metadata was created for each layer (see Appendix III).

DATA MANIPULATION

Following the data compilation and evaluation, various ArcGIS documents (.mxd) were created and all relevant data layers were integrated. Spatial analysis was conducted on the layers generating information about the impact that each layer has on one another. Working maps utilized in the field and office were created to assist project staff with the initial watershed characterization.

All spatial analysis and map production for this project occurred within the ArcGIS environment. ArcView 8.3 was used due to advanced spatial analysis, editing and cartographic capabilities that ArcView 3.2 does not have. The finished GIS product has been converted from ArcView 8.3 into ArcView 3.2 for delivery to EEP.

QUALITY CONTROL

Quality control has been performed throughout the GIS portion of the project. The finished digital ArcView 3.2 GIS model has been rigorously evaluated to ensure that it fully complies with the requirements set out by EEP. The program and all dynamic links to various data sources (tables, hyperlinked documents) have been checked and consistently operate properly.

HYDROGRAPHIC DISCREPANCIES

Differences were noted between the hydrographic layers derived from USGS 1:24,000 maps and that included in the Allegheny County data as viewed in GIS. There were streams that appeared in only one of the two layers, and the locations and planform geometry of several stream reaches differed substantially between the two data sources. In most cases, the Allegheny County hydrography showed streams that were not evident on the USGS mapping, and in several locations the headward extent of channels was significantly greater in the Allegheny County data. The Allegheny County stream mapping appeared more recent than the USGS mapping that was photo revised in 1991 for the Sparta East and West quadrangles, 1977 for Cumberland Knob, and 1968 for White Head and Glade Valley. Because the Allegheny County mapping generally provided higher resolution coverages, EEP staff determined it should be used for the project. Therefore, all stream inventories, GIS project data and spatial analyses are based on hydrographic information derived from the Allegheny County GIS data.

SECTION 2

GEOGRAPHIC INFORMATION SYSTEMS

During visual inspections of the watershed, six streams that were mapped by only one hydrographic data source were checked. The streams were selected from throughout the study area and were conveniently located near roads. In all cases, flowing streams were observed, indicating more streams may be present than are currently mapped by either the USGS or Allegheny County.

SUB-WATERSHED DELINEATION

The Little River watershed was divided into sub-watersheds to break the study area down into more manageable units. Sub-watersheds were delineated upstream from a confluence point or a road crossing for all major tributary systems (greater than second order) entering the Little River. The delineation of sub-watersheds along the Little River itself included tributaries of either first or second orders only. Land use/cover was also considered when selecting end points for the sub-watersheds. After finalizing the sub-watersheds, the boundaries were imported into the GIS project where the stream segments were inventoried by stream order and apparent Rosgen stream type. Thirty-three sub-watersheds (including Laurel Branch) were defined having drainage areas of 0.45 mi² to 5.44 mi². In addition to the stream inventories described below, other data were compiled for each sub-watershed including: land cover, wetland types and associated acreage, buffer area, drainage densities and hydric soil information. Tabulated summaries of these data are hotlinked to each sub-watershed in the GIS project.

STREAM CHANNEL INVENTORY

Stream order was determined for each stream and inventories tabulated for each sub-watershed. Stream order is a measure of the position of a stream in a hierarchy of tributaries (Leopold et al, 1964), and usually reflects regional tendencies in relative channel size. First order streams have no tributaries. Second order streams receive only first order streams as tributaries; when two second order streams flow together the resultant is a third order stream. This progression continues and several significant relationships such as drainage densities and bifurcation ratios can be determined between the lengths, orders and drainage areas of streams. The cumulative linear footage of each stream order in each sub-watershed is provided in the data table hotlinked to each sub-watershed in the GIS project.

The streams within the Little River and Laurel Branch watersheds were also assigned preliminary classifications according to the Rosgen classification system (Rosgen, 1996) using remote sensing methods. This hierarchical methodology categorizes streams based on measurable geomorphic features that describe channel geometry in the three dimensions of planform, cross-section and longitudinal profile.

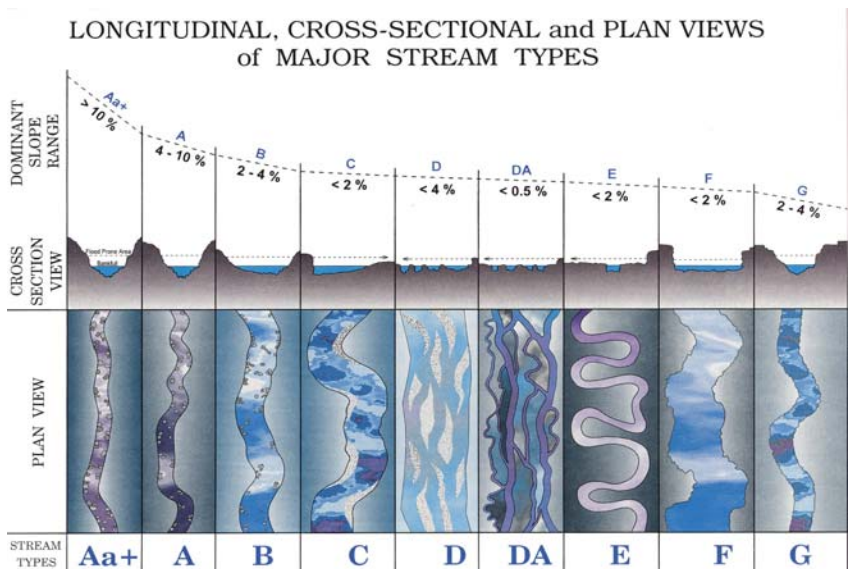


Figure 2. Stream classification scheme (from Rosgen, 1996).

SECTION 2

GEOGRAPHIC INFORMATION SYSTEMS

The Rosgen classification method was applied because, since it is routinely used throughout the state, some test of its utility in the study area is warranted. The method is also intended to provide a means of extrapolation of data between sites based on stream type. Most of the parameters, with the notable exception of channel slope, are expressed as dimensionless ratios such as width/depth, and sinuosity. The use of dimensionless ratios allows categorization and comparison of streams of varying sizes. Another parameter in the scheme is the average size of the sediment particles (sand, gravel, cobble, etc.) on the streambed. The system includes nine broad categories shown in Figure 2.

Classification of the streams within the project area was derived from USGS 1:24,000 topographic mapping and the GIS project. Topographic contours were used to identify valley forms and determine channel slopes, and sinuosity was evaluated to discern channel pattern. The majority of the streams throughout the watershed were assumed to have channel beds comprised of cobble and gravel based on an initial visit to the area and the geologic characteristics of the region.

During visual inspections, streams were randomly picked around the watershed for field verification of stream types. Measured channel widths, combined with ocular estimates of mean depth, slope, and bed materials were used to determine stream types and then compared to the initial desktop classifications of those streams. Results from the field verification of classifications are presented in Table 1.

Table 1. Classification comparison.

STREAM	INITIAL CLASSIFICATION	FIELD VERIFICATION
Unnamed Tributary to Glade Creek near Hudson Road	A3	B3
Unnamed Tributary to Little River near Tayson Rd	C3	E3
Pine Swamp Creek near Cahn Rd	C3	C4
Unnamed Tributary to Little River near Todd Rd	B3	E3b
Unnamed Tributary to Little River near Osborne Rd	B3	E4b
Vile Creek near Napco Rd	B3	B3
Downstream portion of Little River	C3	C3

Of the stream segments visited, twenty-nine percent received the same classification as initially determined through remote sensing. Another twenty-nine percent had been classified as having a cobble substrate, but upon visual inspection were found to be gravel. Overall, classification via remote sensing was erroneous for 57 percent of stream reaches observed. This discrepancy can be attributed to the utilization of the USGS topographic mapping during the initial classification of the streams. Because the mapping displayed contours in 40-ft intervals, channel dimensions and related entrenchment and width to depth ratios could not be determined; all of which are criteria for classification. Accordingly, since both “C” and “E” type streams have very similar slope constraints, a stream could not be classified one over the other with certainty without measured hydraulic geometry data. Slope was therefore the basis for which many stream types

SECTION 2

GEOGRAPHIC INFORMATION SYSTEMS

were determined. Only one of the incorrect stream types showed an erroneous initial estimate of slope. This too can be attributed to 40-ft contours and the proximity to the receiving stream.

The utilization of remote sensing techniques to determine classifications does not appear to be useful for lower order streams. However, by combining remote sensing with more field verifications, trends could be established that would produce more accurate classification predictions. The trend that appears to be developing from a very limited sample is that B3 or B4 channels are actually E3b or E4b for lower order streams. This is significant, especially for those streams running through pastures or other open areas. The "E" streams are more likely to be in close proximity to wetland systems sustained by groundwater which may support bog turtles and other species of concern.

SOILS

GIS maps and the Soil Survey of Alleghany County were initially reviewed to provide an overview of soils information in the study area. Mr. Jasper Cave of the NRCS stated in interviews that he believes the soil survey is very accurate, especially when compared to soil surveys from other surrounding counties. He further stated that the typical hydric soil areas in the study area are relatively flat floodplains located along rivers and streams. These areas are, and always have been, highly sought by farmers for use as pasture. He stated that from his past experiences in attempting to create stream buffers, people are very reluctant to lose any of this land. Mr. Cave also noted that he didn't believe there were very many tile drains in these hydric areas, but people relied more on swales and ditches to drain the land.

A field check of available soils mapping was devised to focus on hydric soil units, due to their importance in wetland restoration. Potential verification sites were identified to be areas mapped as Alluvial land or identified as wet in the Soil Survey, mapped as wetlands on the National Wetland Inventory (NWI) maps, and shown as cleared in the Soil Survey. A brief field review was conducted on October 9, 2003.

The primary source of data for this portion of the study was the Soil Survey of Alleghany County, North Carolina (1973). There are two soil types mapped in the county which are considered hydric, Alluvial land, wet (Ad) and the Codorus complex (Cx). They are described in the Soil Survey as follows:



Alluvial Land, Wet

Alluvial land, wet (Ad) consists of poorly drained, nearly level soils that are variable in texture and subject to very frequent flooding. These soils are on flood plains and in upland draws and depressions. The soil material is unconsolidated alluvium, fairly recently deposited. Bedrock is at a depth of more than 5 feet, and a seasonally high water table is at or near the surface. The surface layer, 6 to 10 inches in thickness, is dominantly very dark grayish brown, but ranges from grayish brown to black. It ranges from silt loam to fine sandy loam in texture. The underlying layer ranges from dark-gray to black loamy sand to silty clay loam, 30 to 48 inches in thickness, underlain by stratified sandy material, gravel, or stones. Alluvial land, wet is generally low in natural fertility and organic-matter content.

The acreage is about equally divided between forest and pasture or meadow. Only a small acreage is cultivated. The soils are fairly well suited to pasture and hay, particularly fescue.

Very frequent flooding of very brief duration and wetness are major hazards, and adequate drainage is needed if these soils are cultivated or used for pasture or hay. (Capability unit IVw-1; woodland suitability group 2; wildlife suitability group 4).

CODORUS SERIES

The Codorus series consists of somewhat poorly drained, nearly level soils on flood plains. These soils are subject to very frequent flooding.

In a typical profile the surface layer is dark-brown silt loam about 9 inches thick. The subsoil is loam and silt loam to a depth of about 40 inches. It is dark brown to brown in the upper part and is mottled grayish brown, dark grayish brown, and strong brown in the lower part. Below the subsoil, to a depth of about 64 inches, is stratified sand and gravel.

The Codorus soils are low in natural fertility and organic-matter content and are high in available water capacity. These soils have a moderately deep to deep effective root zone. Permeability is moderate, and the shrink-swell potential is low. The seasonally high water table is at a depth of about 1 to 1.5 feet.

Most of the areas are cleared and are in pasture, hay, or row crops. Unless drained, these soils have a rather narrow range of suitability for row crops. Drained areas are suited to corn, hay, and pasture grasses. The major limitations to the use of these soils are wetness and very frequent brief flooding.

CODORUS COMPLEX (Cx)

This complex consists of somewhat poorly drained to poorly drained, nearly level soils on flood plains. These soils are subject to very frequent flooding.

The Codorus soil has a dark grayish-brown to dark-brown silt loam surface layer 8 to 15 inches thick. The subsoil is dark-brown to brown to yellowish-brown, friable silt loam, loam, or silty clay loam 30 to 45 inches thick. Grayish mottles appear within 20 inches of the surface.

The somewhat poorly drained Codorus soil makes up about 50 percent of the complex, and a soil that is wetter and grayer than the Codorus soil makes up about 30 percent. Included in mapping were areas of Alluvial land, wet, which make up about 20 percent of the acreage.

Infiltration is moderate, and surface runoff is slow. The soil is fairly easy to keep in good tilth and can be worked throughout a fairly wide range of moisture contents.

Most of this complex is in pasture or cultivation. If drained, the soils are well suited to corn, hay, and pasture. Flooding is very frequent, but generally of extremely brief duration; crop damage can be expected about one year in three. (Capability unit Illw-1; woodland suitability group 1; wildlife suitability group 4).

Based on these descriptions, the study focused primarily on those soils mapped as Alluvial lands, wet. This soil unit is Poorly Drained, which by definition is a hydric soil. The Codorus complex ranges from Somewhat Poorly to Poorly Drained. By definition, Somewhat Poorly Drained soils can be hydric or non-hydric. However, the majority of these soils are typically NOT hydric. Nevertheless, the Codorus complex should not be completely ruled out since there are undoubtedly areas in which a majority of the soils will be hydric.

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The NRCS defines hydric soils as “soils formed under conditions of saturation, flooding, or ponding for long enough during the growing season to develop under anaerobic conditions in the upper part.” The concept of hydric soils also includes soils developed under significantly wet conditions to support the growth and regeneration of hydrophytic vegetation. This concept can also include soils that are sufficiently wet because of artificial measures taken to induce such conditions.

In order to further refine the hydric soils criteria so they are more representative of the field indicators of a particular region, the NRCS (1996) has divided the United States into Land Resource Regions (LRR). The Little River Watershed falls in LRR “N”. Some of the hydric soil field indicators are applicable to all soil types, while others are based on the soil texture. Sandy soils have one set of indicators while Loamy and Clayey soils have another.

Seven locations were selected for field verification (Figure 3). As expected, the land use of the selected areas was predominately active cattle pasture. There were also forested sections and some maintained lawns. Many of the sites were not accessible (i.e. people’s back yards, gated community). The soils in accessible areas were evaluated via a hand auger mainly to determine if they were hydric or non-hydric.

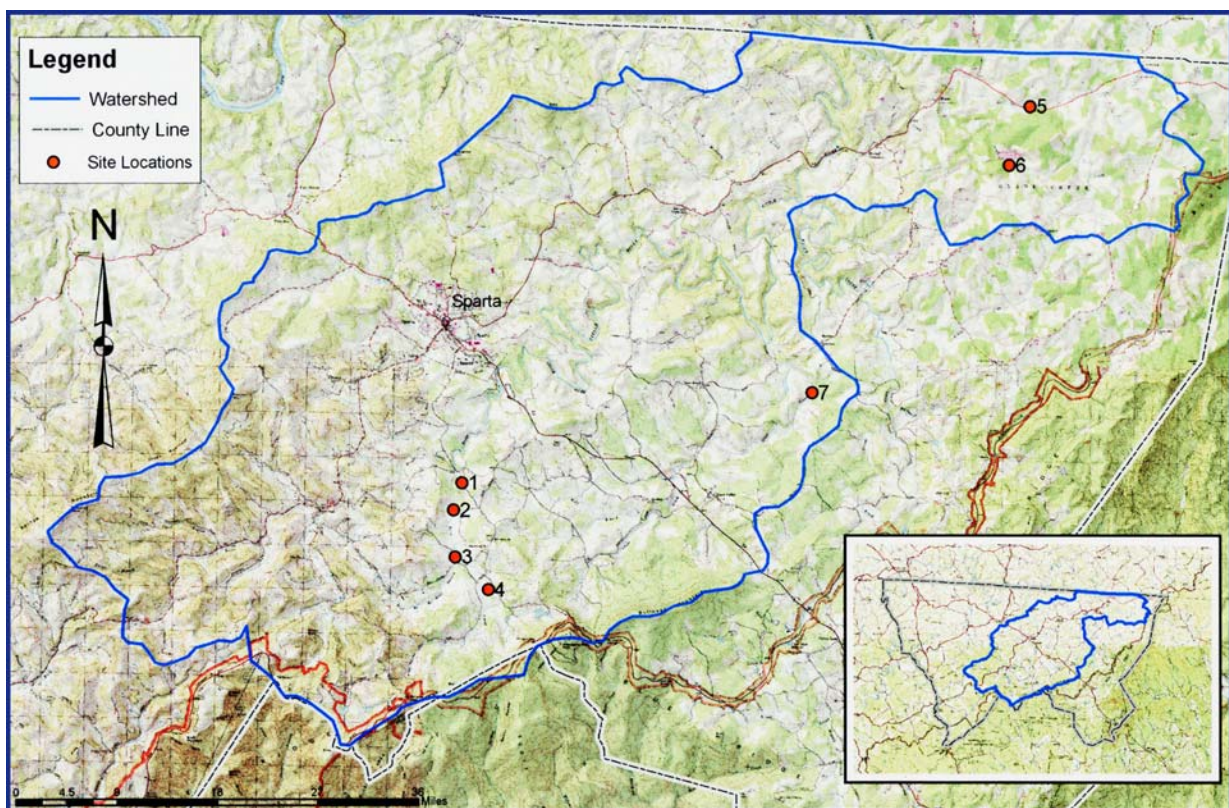


Figure 3. Field verification locations for hydric soil indicators and soils mapping.

Areas that were not accessible were visually surveyed. They often exhibited the same vegetation growth as that found on the hydric soils in the accessed area. They also were found in the same general landscape position and appeared to have the same catena as the accessed soil, thereby instilling a strong belief that they are also promising mitigation sites.

SECTION 3 SOILS

The first site visited was a forested area off of SR 1900 (site 4 on Figure 3). This site was chosen in order to examine a soil in a “natural state” for comparison to the disturbed, pastured areas. Hydric soils appeared to comprise approximately 60% of the floodplain. The main hydric soil indicator in these soils was F5 - Thick Dark Surface which is described as follows:

A layer at least 15 cm (6 in) thick with a depleted matrix that has 60% or more chroma 2 or less (or a gleyed matrix) starting below 30 cm (12 in) of the surface. The layer(s) above the depleted or gleyed matrix have hue N and value 3 or less to a depth of 30 cm (12 in) and value 3 or less and chroma 1 or less in the remainder of the epipedons.

The non-hydric areas were typically Somewhat Poorly Drained soils that often showed evidence of alluvial deposition.

The remainder of the field review looked at “disturbed” lands, which were primarily pastures. The areas that could be accessed (see Table 2) appeared to have a large component of the soil classified as hydric and met the F5 – Thick Dark Surface criteria. In some cases, these areas supported a different vegetation community than the non-hydric areas.

There are many areas in the Little River Watershed that contain a majority of hydric soil and have good potential for wetland restoration. The available soils information appears to be reliable and a valuable source to identify these sites. Based on conversations with Mr. Cave, acquisition of many sites will likely prove difficult since they are highly valued, mainly as pasture land.

Table 2. Site Accessibility.

SITE NUMBER	ACCESSIBLE	INACCESSIBLE
1	✓	
2		✓
3		✓
4	✓	
5	✓	
6		✓
7		✓

HYDROLOGY

USGS GAGE DATA ANALYSIS

Three USGS gage stations in North Carolina and five in Virginia contiguous to the study area were identified for the preliminary study. The criteria for selecting the sites were drainage areas between 0.5 and 40 mi², location within HUC 05050001 (New River), and close proximity to the Little River watershed. Table 3 lists those sites chosen for analysis.

Table 3. USGS gage site information.

Gage Site	Site Number	Period of Record (years)	Drainage Area (mi ²)
Old Field Creek, NC	3160610	1955-1971	2.40
Buffalo Creek, NC	3162110	1940-1970	21.8
Vile Creek, NC	3162880	1955-1971	2.10
Wallen Creek, VA	3162700	1966-1975	2.23
Mill Creek, VA	3162800	1950-1976	5.32
Chestnut Creek, VA	3165000	1940-2002	39.4
Mira Fork Trib, VA	3167300	1967-2002	0.62
Beaverdam Creek, VA	3167700	1971-1995	4.75

The suitability of the eight stations for use in creating a regional flood-frequency curve was determined using the Dalrymple homogeneity test (Dalrymple, 1960). The homogeneity test determines if the variations in slope of the flood-frequency curves for the individual stations are significant. Only those stations which exhibit insignificant differences are determined to be sufficiently homogeneous for use in constructing a single regional flood-frequency curve. After this analysis on the aforementioned gage sites, the Wallen and Mill Creek sites located in Virginia were determined unsuitable for use in a flood-frequency analysis.

For the hydrologically homogeneous sites, annual peak flow data were acquired from the USGS website for each site's period of record. Detailed hydrographer's records could only be obtained for one station from the USGS website – Chestnut Creek, VA. Both the Virginia and North Carolina USGS offices were contacted in an effort to gather any other information USGS may have that was not available through the web. The Virginia office had no supplementary information regarding the stations. A visit was made to the NC USGS office in Raleigh to examine the existing hard copy information for the three gage stations. The only information on record was the same as that found on the web.

Annual maximum peak discharge data mined from the USGS website for the six suitable gages were used to generate a regional flood-frequency curve. In order to create the regional curve, flood-frequency curves were first developed for each site. The average curve for each station was used to produce a table consisting of discharges for various recurrence intervals (T-year flood) including the mean annual flood. A graph was then created relating the mean annual flood to drainage area (Figure 4.) A second table was formed displaying the ratios of the T-year flood to the mean annual flood. The regional flood-frequency curve was thus formed as a relationship between the ratio of the T-flood to the mean annual flood versus the recurrence interval (Figure 5.) The two graphs can be utilized to produce discharge estimates for Little River and its tributaries by using the recurrence interval to read the mean annual flood off Figure 4 and then reading the ratio of the T-flood to the mean annual flood off Figure 5.

Mean Annual Flood vs. Drainage Area

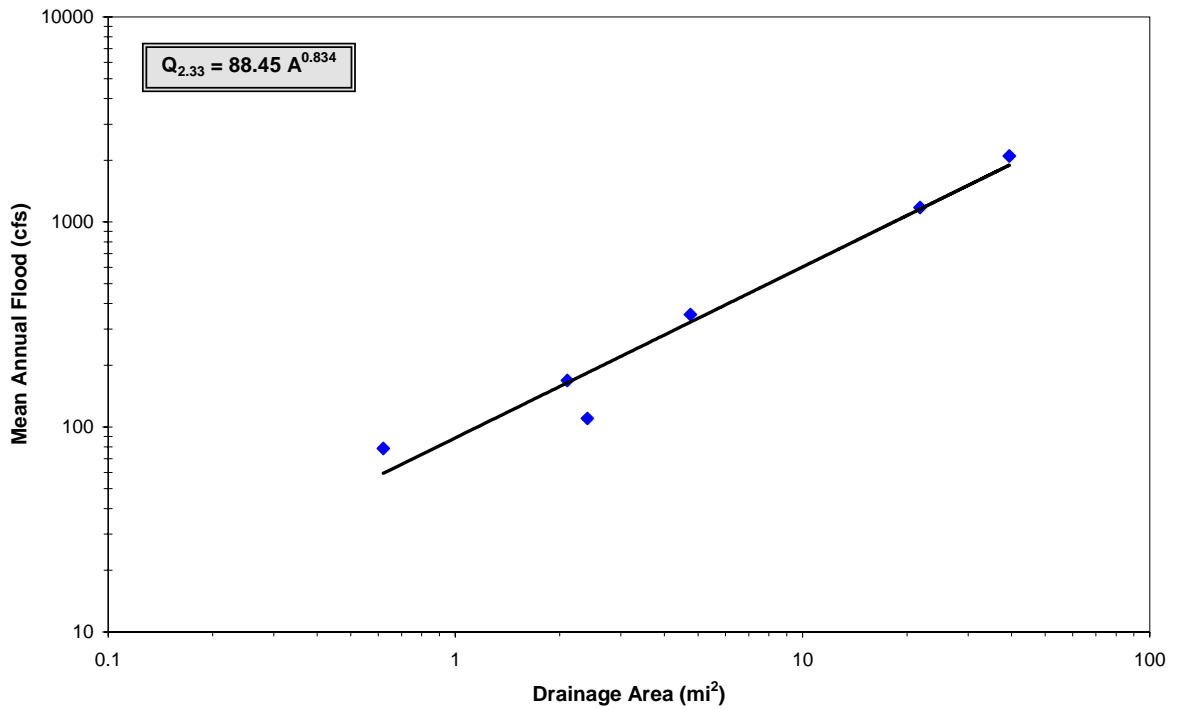


Figure 4. Mean annual flood vs. drainage area graph.

Ratio of T-flood to $Q_{2.33}$ vs. Recurrence Interval

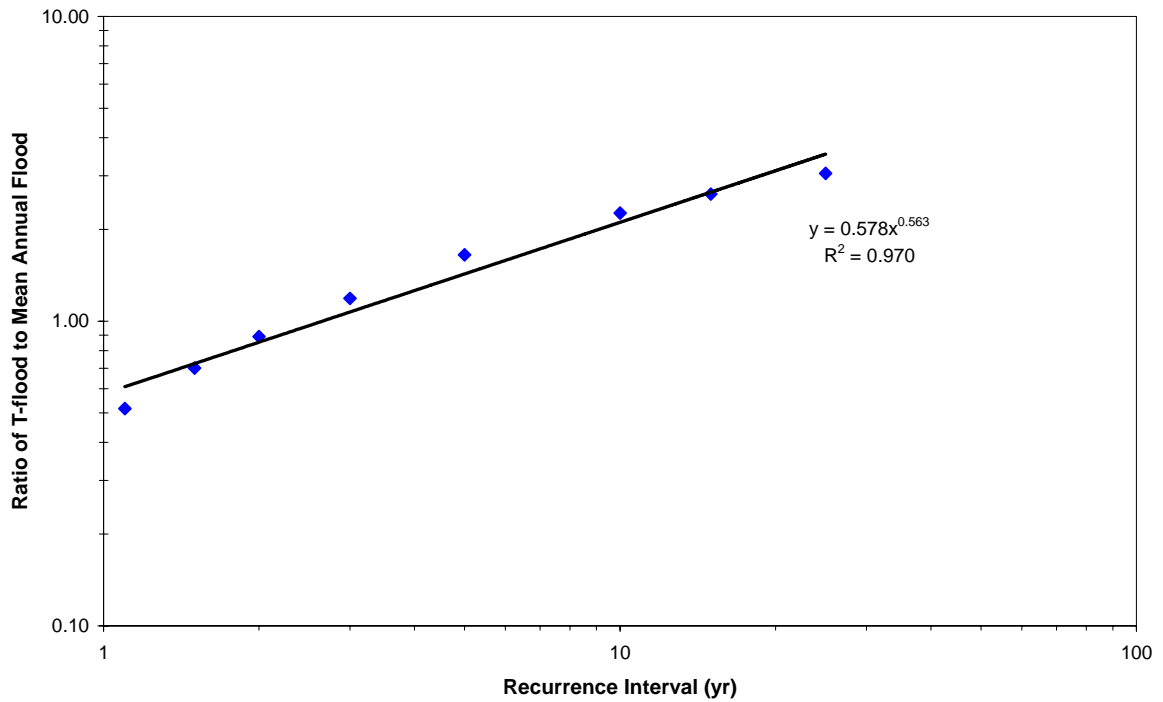


Figure 5. Ratio of T-flood to $Q_{2.33}$ vs. recurrence interval graph.

SECTION 4 HYDROLOGY

To further analyze the regional flood-frequency curve developed for the project area, graphs were created comparing the NC Blue Ridge-Piedmont Regional Regression equations, the VA Blue Ridge Regional Regression equations, and the regional curve developed from Figures 4 and 5. The graphs formulated show the relationships between discharge and drainage area for the three curves for the 2-, 5-, and 25-year recurrence intervals. Regional Regression equations used to create the graphs were obtained from USGS Water-Resources Investigations Reports. The NC equations used are (Bisesse 1995):

$$Q_2 = 135 (DA)^{0.702} \quad (1)$$

$$Q_5 = 242 (DA)^{0.677} \quad (2)$$

$$Q_{25} = 476 (DA)^{0.645} \quad (3)$$

where Q is discharge in ft³/sec and DA is drainage area in mi². The VA equations used are (Pope 2001):

$$Q_2 = 95 (DA)^{0.760} \quad (4)$$

$$Q_5 = 201 (DA)^{0.726} \quad (5)$$

$$Q_{25} = 450 (DA)^{0.695} \quad (6)$$

In addition to the Regional Regression equations, the 2-year regional curve was also plotted against the NC Mountain Regional curve represented by equation (7) (North Carolina Stream Restoration Institute 2003).

$$Q_{BF} = 100.64 (DA)^{0.76} \quad (7)$$

The results of the comparison as applied to several Little River sub-basins and the analyzed gage sites are presented in the following three graphs. See Figures 6, 7, and 8.

2-YR: USGS Regional Regression vs. Regional Curve

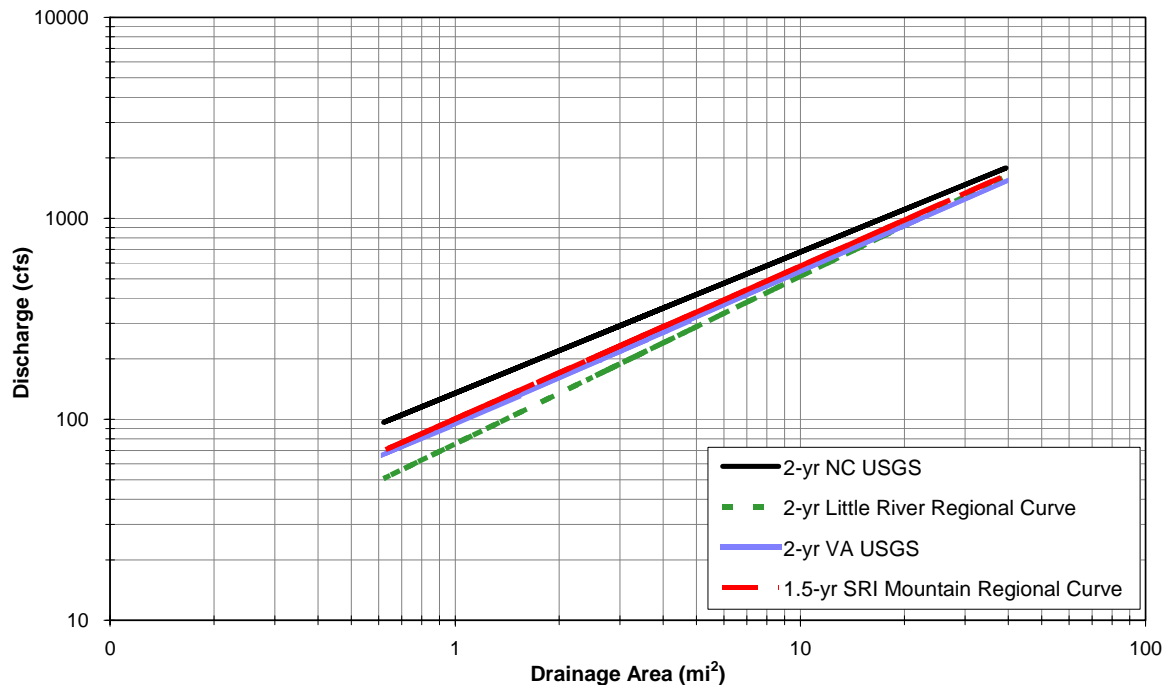


Figure 6. 2-year regional curves.

5-YR: USGS Regional Regression vs. Regional Curve

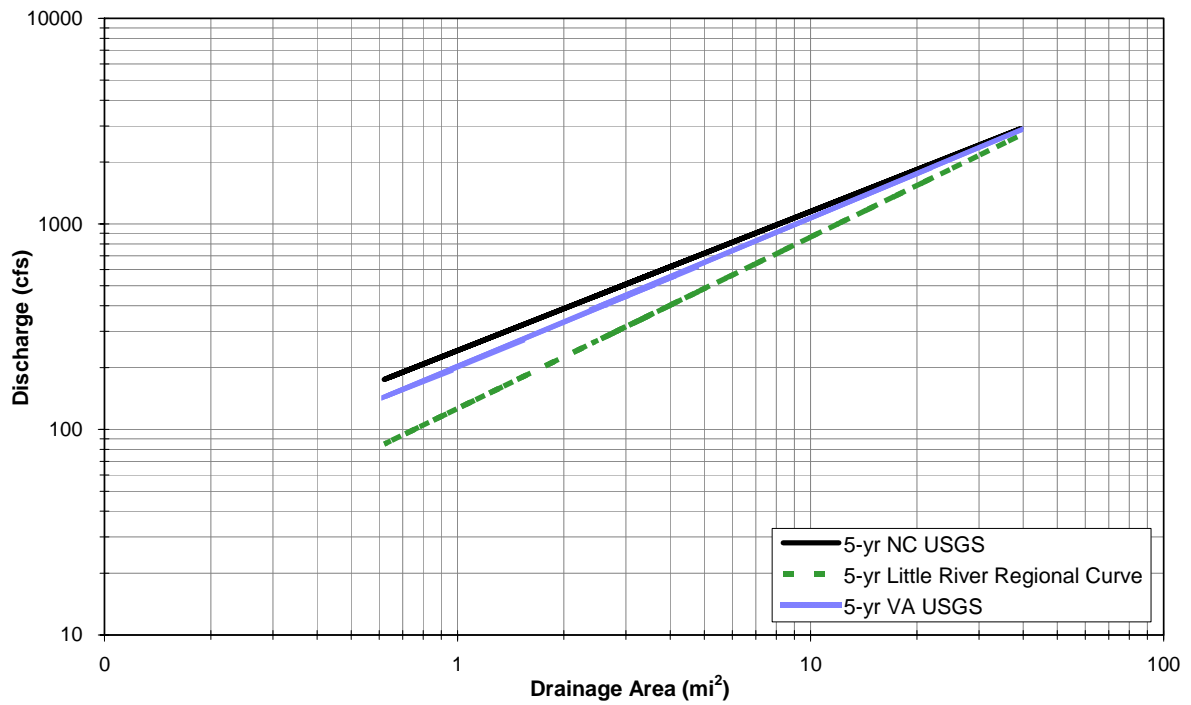


Figure 7. 5-year regional curves.

25-YR: USGS Regional Regression vs. Regional Curve

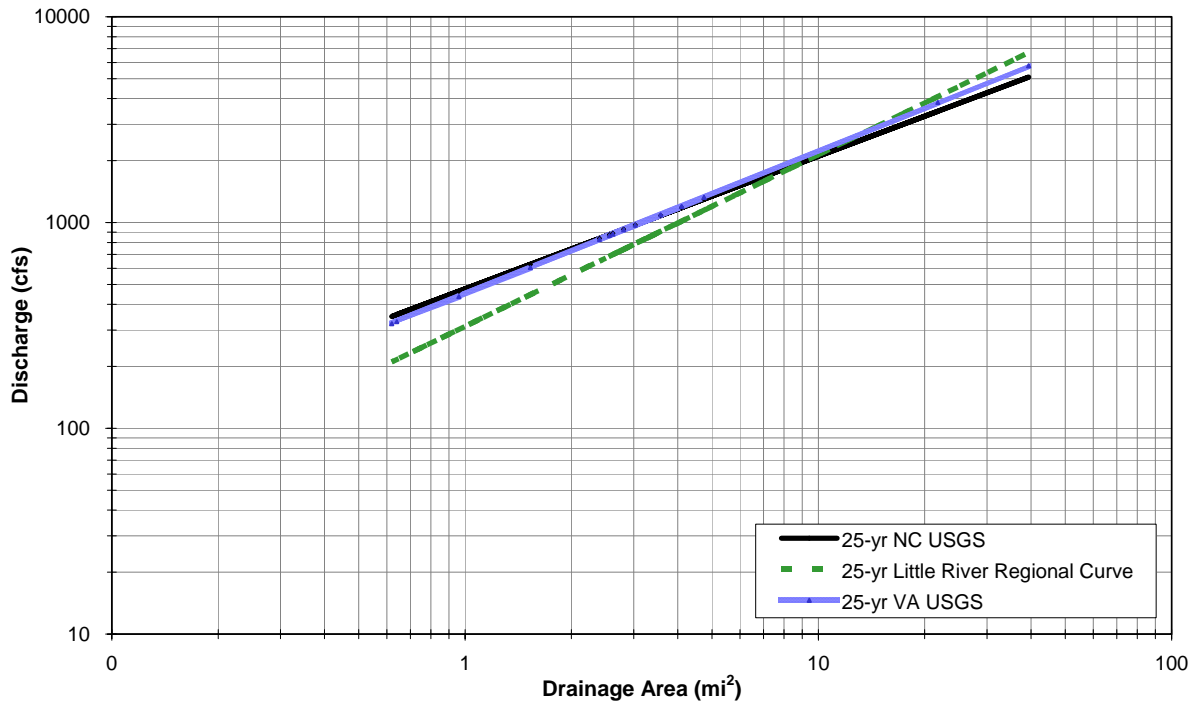


Figure 8. 25-year regional curves.

Analysis of the graphs relating the three different curves shows several significant trends. An overall observation of the graphs shows that the regional curve developed for Little River presents a steeper relationship and lower intercept between drainage area and discharge as compared to the regional regression equations. Because the developed regional curve is steeper, the lines tend to converge for watersheds having larger drainage areas. For example, the 2-year regional curve results in flows forty-seven percent smaller than those produced by the NC Rural Regression equation for a drainage area of 0.62 mi² as compared to nine percent for a drainage area of 39.4 mi².

Another observed trend shows a closer relationship between the developed regional curve for the project area to the Virginia regression equation than with the North Carolina equation. For the 2-year discharge, the difference between the regional curve and Virginia curve flows range from zero percent to twenty-three percent. This range is explained by the slightly steeper nature of the regional curve.

The relationship between the developed regional curve and the Virginia curve demonstrates a greater degree of significance that can be attributed to the formulation process of the regional regression equations for North Carolina as compared to Virginia. The equations for North Carolina were derived from a data set of gages located throughout the Piedmont and Blue Ridge hydrologic regions. The Virginia equations were derived solely from gages within the Blue Ridge region. The utilization of a set of equations, which incorporates characteristics of both the Piedmont and Blue Ridge, is likely to provide less accurate results when applied to the Little River watershed.



Mira Fork Gage at US-221, Carroll County, VA.

Four gage sites were visited in order to obtain rough cross-section measurements and classification data due to the limited amount of hydrographer information obtained from USGS. The four sites visited were: Old Field Creek, NC; Buffalo Creek, NC; Mira Fork Tributary, VA; and Beaverdam Creek, VA. However, no cross-sectional measurements were taken at Buffalo Creek. These sites were chosen based on criteria concerning drainage area, period of record, and convenient location. Since the majority of the streams within the Little River watershed are of first and second orders, data collected from stations having small

drainage areas are preferred to those with large areas. Also, those stations with the most recent and longest periods of record would provide more meaningful data when making comparisons to the present-day project area. In order to gather more detailed information for gages within NC, the Old Field and Buffalo sites were visited despite that their periods of record ended in 1970 and 1971, respectively.

During the field visits, cross-sectional area was measured by stretching a fiberglass tape across the stream at bankfull indicators near the location of the USGS gage. A pocket rod was then used to

SECTION 4 HYDROLOGY

measure the distance down from the tape to the ground/channel bed at intervals necessary to pick up significant breaks in slope. The classifications and cross-sectional areas determined during the field visit are presented in Table 4.

Table 4. Classification and cross-sectional area of USGS gage sites.

GAGE SITE	CROSS-SECTIONAL AREA (ft ²)	CLASSIFICATION
Old Fields Creek, NC	17	E3b
Buffalo Creek, NC	----	B3
Mira Fork Tributary, VA	8.3	E4
Beaverdam Creek, VA	46	B3

The measured cross-sectional areas were compared to the North Carolina Mountain Regional curves as seen in Figure 9. All of the areas measured fall below the regional hydraulic geometry curve; only the Beaverdam site plots close to the curve. The Mira Fork gage is located at the confluence of Mira Fork and an unnamed tributary, and the stream is over-widened and in poor condition at this point. As a result of the poor stream conditions, there were no good bankfull indicators near the gage. However, a rough area was measured using the best indicator observed based on experience.

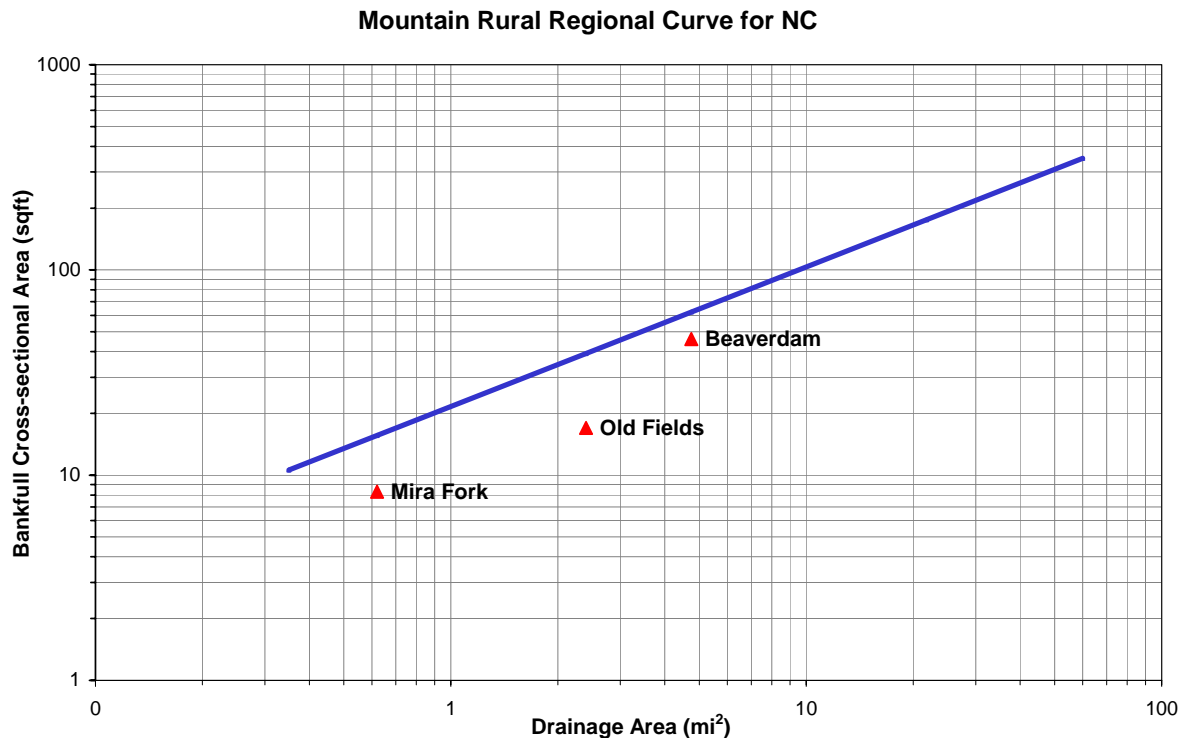


Figure 9. Mountain Rural Regional Curve.

Since each gage site visited plotted below the regional hydraulic geometry curve, the data set the Stream Restoration Institute utilized to construct the graph was reviewed. The average mean annual rainfall of the data set was 72 inches, while the Little River watershed and surrounding area receives 46 inches per year on average. Also, only three of the fourteen gages had mean rainfall data of 50 inches or less. This difference in rainfall demonstrates the potential inapplicability of the Mountain Rural Regional Curve to the project area. Therefore, the gage

sites visited are expected to plot below the curve because a channel receiving 72 inches of rain a year may prove to be significantly larger than that receiving 46 inches.

As another comparison, the Mountain Rural Regional curve relating discharge to drainage area was added to the 2-year graph comparing the regional regression equations for North Carolina and Virginia to the regional flood-frequency curve developed for the project area. See Figure 6. The Mountain curve fell very close (slightly higher) to the Virginia curve on the graph. However, the recurrence interval for the Mountain curve is 1.5 years, not 2 years. This observation provides further evidence to support the conclusion that the Mountain curve produces results that may be too high for the Little River watershed.

HABITAT

The Little River Watershed is situated in the New River Plateau section of the Blue Ridge Mountains Ecoregion. Despite the long agricultural history and more recent development of Christmas tree farming, the area retains substantial and diverse ecological resources. Forest covers over 25,500 acres of the study area, almost exactly half of the 51,270 acre total land area. In the Laurel Branch sub-watershed, forest covers about 1,375 acres, or about 70% of the 1,940 acre catchment.

Mixed upland hardwoods account for most of the forest; other common forest cover types include mixed pine-hardwood and mountain conifers. Deer, turkey, squirrel, raccoon and other forest mammals are abundant throughout the watershed. In addition, since the early 1970's black bear (*Ursus americanus*) have moved northward from Wilkes County into the southern and eastern portions of the study area. While about one third of the Little River Watershed is now part of the bears' occupied range, NC Wildlife Resources Commission (NCWRC) data indicate that their occupied range has not increased in the study area since the early 1990's.

Seventeen wetland types (after Cowardin) are mapped in the study area, covering 308 acres. Many of the known occurrences of the thirty-two state and federally listed species live in these diverse wetland systems. Several discussions with Chris McGrath (NCWRC), Ann Somers (UNCG) and Dennis Herman (NCMNS) indicated that most of the wetlands along creek channels in the Little River Basin have been and may still be used by meta-populations of bog turtles. The Bog Turtle (*Clemmys muhlenbergii*) is a Piedmont and Mountain province endemic species that lives in small wetlands that cluster along the narrow valleys of the region. It is a small and secretive turtle living in areas that have constant moisture and deep mud year round.



Bog Turtle

Recent work has indicated that these small turtle travel long distances in their annual cycles of foraging, nesting mating and hibernating. These travels are mostly along creek corridors with nodes of small wetlands, which have the required elements of wetland habitat for the turtles' needs. However, they also use upland areas and road kill have been collected on ridge-top roads miles from the nearest suitable habitat. The turtles use a larger portion of the watershed than just the limits of the wetland in which they were born. The species is in serious trouble in some portions of its range (MD and NC) due to wetland habitat loss and the conversion of many wet meadows to residential and forestry land uses. In addition, the meta-population individual exchange can be interrupted if the turtle travel corridor is destroyed or altered by development. This leaves isolated populations which are much more prone to extirpation.

The good news is that the turtles exist well with contemporary cattle grazing practices and occur in sites that are otherwise marginal for development. Additionally, new populations are being found every year. The Little River watershed has many creek corridors and wetlands that have not been adequately investigated for the presence of bog turtle or other significant wetland species, but from a distance appear to have suitable habitat. It is important to consider that the mountain wetlands that support the bog turtle are also home to a wide array of other animals and plant species of concern that require similar conditions.

Dennis Herman, the Curator of Living Collections at the North Carolina Museum of Natural History, provided a nice set of hand drawn maps and notes about the current status of the bog turtle in the Little River Watershed. Herman is a major proponent of the meta-population protection scheme for the turtles, and has conducted extensive surveys throughout the project area. His maps also include the locations of “surprise” turtles like road kills and sites that have not yet been searched and are suspected of having good potential. These occurrences are contained in the GIS project. Mr. Herman would be a valuable part of the EEP team on the ground, helping to improve landowner relationships and supporting conservation efforts for bog turtles and other sensitive species in the watershed planning process.

Many in the bog turtle research community and other naturalists and wetland scientists would like to see some management of Sparta Bog. This site supports nine state or Federally listed rare plant species, two NC or Federal Candidate animal species, three NC Watch List plant species and five plant species which are regionally rare (Smith, 1993). The property was purchased by NCDOT, who commissioned a stream restoration design that has not been built. The proposed channel may have destroyed much of the existing wetlands. Since that time, no management has taken place at the site, which has grown shrubby and will eventually succeed to a closed tree and shrub canopy. The natural old field successional processes are detrimental to both the bog turtle, Gray's lily (*Lilium grayi*), and the other listed wetland plants known to exist in Sparta Bog.

NC Wildlife Resources Commission: Fisheries Biologists

NC WRC fisheries biologists Joe Mickey, Shannon Deaton, Fred Harris, Kin Hodges and Kevin Hining also provided input for this study. This group includes some people who have worked in the Little River watershed in the past as well as the current field biologists. The consensus of fisheries biologists is that there is a lot of potential for watershed improvement based on the location, topography, climate and land use. Given their knowledge of the watershed several themes recurred in these conversations.

First, the northern part of the watershed is heavily impacted by cattle grazing operations that are adversely impacting water quality in the main channel and major tributaries. There is tremendous potential for cattle exclusion and riparian buffer enhancements, and some opportunities for stream and wetland restoration. Many such projects would be enhancements on the headwaters of trout streams. It was suggested that watershed improvement projects offered great potential for business development if they could be related to trout fishing.

Second, the Sparta area and especially Bledsoe Creek are heavily impacted by residential/commercial/urban developments. This opinion was supported by Mr. Jim Siegfried, a lifelong resident and local fishing guide. Mr. Siegfried stated that Bledsoe Creek still holds some nice trout, but not as many as even just a few years ago. He believes the decline of this fishery is caused by fine sediment in-filling of pools. The fisheries biologists believe that additional storm

water BMP's are required in the Sparta area to mitigate for the watershed impairments in the Bledsoe Creek sub-basin.

Bledsoe Creek is unique in the Little River Watershed in that its headwaters are intensively used for agriculture and forestry, as are the other headwater areas in the study area, but then the middle reaches of the creek are residentially impacted and the lower stretch is densely urbanized. This combination of major impacts makes for a cumulative stress level that exceeds the assimilation capacities of the natural systems. This also provides the potential for EEP to implement a wider range of mitigation projects to achieve watershed stability and enhance ecological function. Visual assessments by the project team found several places where stream restoration could be beneficial within the urban area, as well as the upper portions of the sub-watershed.

HISTORICAL TRENDS ANALYSIS

Historical trends that can be gleaned from windshield surveys, discussions with locals and a basic familiarity with the area indicate a long history of small farms covering the landscape of almost the entire basin. These small farms were once more productive and profitable than they are currently. Many causes converge here, as in the larger Appalachian Region, to limit current economic vitality. The dramatic topography that makes the region scenic and a wonderful place to live and work also limits transportation routes and produces thin soils of low productivity. The elevation that makes the region attractive as a summer getaway also makes for cold and long winters compared with the adjacent Piedmont. Combine this with a poor ability to compete against nearby growing urban centers in an increasingly global market and the mountain region continues to be a population of people land rich and cash poor.

One expanding land use that has occurred in the current generation is Christmas tree farming. Well suited to the climate, soils and topography, Christmas tree plots have proliferated widely in the region. During the early years of the development of this industry, many forested areas were cleared and replanted with Christmas trees. Currently, there are approximately 200 Christmas tree growers with farms averaging in size from ten to fifteen acres. Full-time farms generally exceed 100 acres.

Because the preferred species, Fraser fir (*Abies fraseri*), grows best at higher elevations, seedlings are established around and on the tops of the highest hills, areas typically too rocky, steep or unproductive for crops or pasture, but capable of supporting fine hardwood forests. Conversion to Christmas trees removes the resisting forces that stabilize the landscape in just that position where slope length, gradient, and freeze/thaw – all major elements in hillslope processes – are all maximized. The result is a major disturbance to the landscape that might be expected to greatly accelerate erosional processes. In addition there are a significant number of very steep dirt roads that service these tree plantations and these roads may contribute more sediment on a continuing basis.

However, observations at established tree farms noted dense grass and herbaceous vegetation between the rows of trees, and discussions with the Alleghany County Christmas Tree Association revealed a shift in management practices to leave the stumps of harvested trees in place. When the standard geomorphic disturbance parameters of rate, intensity, duration and aerial extent are evaluated, conversion of hardwood forest to Christmas trees can be considered a rapid, very intense, short term perturbation of modest extent. This type of disturbance can be expected to generate a major episode of sediment loading to the watershed that gradually translates through the fluvial system. In short, the activity may appear catastrophic at first, but the modest extent and limited duration leave little lasting impact on the larger system.

The dirt and gravel roads that provide operational access to the Christmas tree farms present a more persistent problem. In a plantation or other forest managed for timber production, most access roads are seldom used and often support vegetation. The frequent and intense management practices applied at Christmas tree farms necessitate a more dense network of heavily used roads. Observations in the study area found many such private roads to be poorly maintained and deeply rutted. They are likely a significant source of sediment and should be quantitatively assessed.

SECTION 6

HISTORICAL TRENDS ANALYSIS

HYDROMODIFICATIONS

Aerial imagery of the project area was obtained from USGS for the years 1950-51, 1964, 1976, and 1982-83. Coverage from 1941 was acquired from the National Archives and Record Administration; 1993 black and white imagery and 1998 color infrared coverage were provided by EEP at the outset of the project.

A combination of the aerial images and GIS maps were used to identify stream reaches that appear to have been relocated or straightened. Several dozen streams appear unusually straight (given their respective landscape positions and channel slopes) on GIS hydrography, and fourteen were selected for analysis. The sample was intended to provide spatial diversity across the study area, but was otherwise random. These reaches were then located and compared on the aerial images for the years 1950-51 and 1964 using imaging software. If the stream had been altered during that time span, the type of modification, location, and time period were documented. If the stream showed no signs of alteration during that time, the aeriels for 1964 and 1976 were compared. The 1941 and 1950-51 images were studied if the stream segment in question looked as if it had been modified on both the 1950-51 and 1964 photos. This process was repeated for each reach that was selected from the GIS maps until the time periods of channel modification could be identified for each reach. (The 1941 and 1950-51 images were not initially compared because the 1941 images were the last set to be received). However, there were some reaches that appeared to have been altered before 1941; and therefore, it is not possible to confidently determine the reason for their modification. Additional trends analyses were performed with the images and parcel and land cover data in GIS. Results are provided in Table 5.

Table 5. Stream modifications

STREAM	TIME PERIOD	MODIFICATION	APPARENT PURPOSE
Unnamed Trib to Crab Creek near Delhart Rd	1950-1964	straightened & split – runs along and parallel to property boundary	maximize managed and/or cultivated lands
Unnamed Trib to Crab Creek North of NC-18	1950-1964	straightened through property	maximize managed and/or cultivated lands
Moccasin Creek along SR 1412	1950-1964	straightened – runs parallel to SR 1412	maximize land usage
Unnamed Trib to Glade Creek along US-21	1950-1964	straightened along property boundary then parallel to the road	maximize managed and/or cultivated lands
Glade Creek along Dewitt Rd	1950-1964	straightened through managed lands and runs along property boundary	maximize managed and/or cultivated lands
Unnamed Trib to Wolf Branch near Mahogany Rock Rd	1950-1964	straightened	road crossing
Wolf Branch near Mahogany Rock Rd	1950-1964	straightened through property	maximize managed and/or cultivated lands
Pine Swamp Creek East of Fraser Rd	1950-1964	straightened along property boundaries	maximize managed and/or cultivated lands
Bledsoe Creek along Sparta Pkwy	1950-1964	straightened along property boundaries	maximize managed and/or cultivated lands
Bledsoe Creek along US-21	1950-1964	straightened along property boundaries	maximize managed and/or cultivated lands
Glade Creek East of Ridge Glen Rd	before 1941	straightened through properties	maximize managed and/or cultivated lands
Unnamed Trib to Pine Swamp Creek near Raspberry Ln	before 1941	straightened	road crossing
Unnamed Trib to Little River along Tayson Rd	before 1941	straightened parallel to road	road construction
Moccasin Creek along NC-18	before 1941	straightened parallel to road	road construction

SECTION 6

HISTORICAL TRENDS ANALYSIS

Historic imagery confirmed that ten of the fourteen streams analyzed had indeed been straightened or relocated. Anthropogenic manipulation of four additional streams could not be dated, but the correspondence of straight channels to roads and property lines suggests the alterations occurred prior to 1941, the oldest year for which images were available.

Throughout the watershed, the most common motive behind straightening a stream segment appears to be to maximize land usage. Those streams that have been altered are typically located on farms supporting crops and/or livestock. By relocating a stream along a property boundary or straightening a stream through a pasture, farmers are able to increase their available lands and efficiency of use. Based on this limited sample, major stream modifications seem to have ceased during the past 30 to 40 years.

SOCIAL, ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

Over the past 40 years, Allegheny County has incurred significant population increases of 18 percent and 11 percent during the 1970's and the 1990's respectively. Table 6 shows the population trends for the county since 1960.

Table 6. Population trends.

YEAR	POPULATION
1910	7745
1960	7734
1970	8134
1980	9587
1990	9590
2000	10,677
2001	10,763

Analysis of construction permitting information obtained from the Allegheny County Inspection Department shows that the number of new houses being built represents a declining trend. The number of new home permits issued over the past 5 years is as follows (Allegheny 2003):

- 7/1/98 to 6/30/99 – 155
- 7/1/99 to 6/30/00 – 130
- 7/1/00 to 6/30/01 – 101
- 7/1/01 to 6/30/02 – 102
- 7/1/02 to 6/30/03 – 70
- 7/1/03 to 10/20/03 – 34

However, if the number of permits continues to increase at the same rate as from July to October of this year, the trend may begin to show an increase in new homes.

Recent losses of major employers in the region combined with declines in the dairy and burly tobacco farm economies have led to and increased dependence on extractive uses of the land like forestry and expansion of marginal pasturage for beef cattle. Currently many of the landowners in the watershed are looking for ways to use their land to increased financial advantage. Some do this by selling lots and subdividing marketable property. In other cases they are trying to increase cattle grazing or Christmas tree production while at the same time cutting costs. This leaves many landowners willing to listen to offers of financial assistance in exchange of an easement or to pay for watershed BMP's on their land.

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HISTORICAL TRENDS ANALYSIS

Allegheny County is aggressively pursuing business development and economic growth. They have also been working on plans to develop additional water supply resources to supplement the current system of wells. One option is to capture water from the New River in Virginia, and another is a dam on the Little River in Sparta.

NATURAL RESOURCE CONSERVATION

Existing Programs and Organizations

North Carolina Natural Heritage Program (NHP)

The details of the element occurrences in the GIS database were supplied by John Finnegan, who along with Judy Ratcliff provided some older reports of the bog surveys conducted in the Little River by an NHP contractor (Alan Smith) in the early 1990's. There are other researchers that are known to have worked in the Little River, mostly on the bogs and related wetlands. Some of this information is in old reports that would take time to find, but have likely been incorporated into other documents. Other work was done more recently and has not been entered into the NC NHP database, nor even submitted, (i.e. Patrick McMillan in the late 1990's did some rare plant surveys of bogs in the Allegheny County area).

Allegheny Soil and Water Conservation Service/ NRCs

Multiple interviews with Jasper Cave and Linda Hash found a recurring theme: EEP stream and wetland restoration projects would require landowners to give up large areas in the riparian bottoms, which is the most productive land on most farms. In most cases, this will be difficult to accomplish without substantial compensation to the landowners. A key issue with implementing existing agricultural cost-share programs is reliable funding. There have been several instances where landowners have become interested in conservation projects, but the deals have fallen through during the protracted interval between project approval and the allocation of funds.

Despite such complications, the agricultural service agencies have several successful projects on the ground and a list of several substantial landowners that would be interested in

implementing additional conservation measures. If agricultural BMP's can be utilized for mitigation credits as the Stream Mitigation Guidelines imply, several significant water quality improvement projects could be completed in the study area.



Fenced out stream and alternative water source along tributary to Wolf

SECTION 6

HISTORICAL TRENDS ANALYSIS

New River Community Partners

This group focuses on natural resource management in the New River Basin, mostly in the area of the state park properties and the national river designated section of the New River. Patrick Woodie is the Executive Director of the organization and also an Allegany County Commissioner. Hollis Wilde, who works part time for this group as a natural resource consultant, was also interviewed. Both were quite wary of the EEP and cited past problems with NC WRP. As a group the New River Community Partners seeks to apply a holistic and pragmatic approach to environmental protection. They appear to be a strong and experienced organization that might benefit from inclusion in the watershed planning process. They can be expected to contribute to the plan in a way that makes it more acceptable to the public.

Blue Ridge Rural Land Trust

The BRRLT is one of the success stories of the North Carolina land trust movement. Founded in 1998, they have already helped preserve over 4000 acres of farm land in the counties of Alleghany, Ashe, Wilkes and Watauga. They have a small but strong membership base in the Little River watershed and have several farmland preservation easements already in place. James Coman, BRRLT Executive Director, was interviewed and stated that he hopes to close on 8-10 easements by the end of the year, covering an additional 2000 acres. He said they have no specific plan other than to work with willing landowners and encourage them to talk to their neighbors and thereby form clusters of protected farms. They have several protected farms in the Little River Basin and may consummate some other projects in the near future.

Mr. Coman's assessment is that its "easy pickings" to find farmers who need some financial help and are willing to sell an easement to reduce their debt load and increase their chance at profitability. He said 49% of the landowners in this region own more than 25 acres, and 10% have farms larger than 300 acres. He also lamented that he did not have the population base of the larger land trusts in which to raise money and memberships. His only limitation to protecting more farmland is money. However, Mr. Coman is also wary of EEP, and fears another bureaucracy with rigid policies may develop. He mentioned, as have others, how the 100-foot wide buffer requested by WRP is a difficult issue for most farmers. He also thinks most farmers in the area will not even consider stream restoration and cattle exclusion. He is, however, very interested in implementing a program of dirt and gravel road BMP's as mitigation. He said he likes this idea and thinks that it might be a way to address a major sediment problem in the mountain region. Mr. Coman is looking forward to participating in the local watershed planning and implementation process for the Little River and can be a valuable partner.

DEVELOPMENT AND LAND USE PLANNING

The 3-4 year old Alleghany County Planning Office is headed by Jack Conaway, who has broad experience in Mecklenburg County, North Carolina. Some of the recent activity includes re-evaluating the FEMA flood maps and instituting a subdivision ordinance that increased road construction requirements to meet NCDOT standards. In addition, a Land Development Plan was approved by the county commissioners in 2000. The plan gathers much of the basic data on natural resources from various sources into one nice document and makes some generic recommendations on growth, development, conservation and quality of life.

One of the key objectives of the "Alleghany County and Town of Sparta Land Development Plans: A Land Development and Growth Management Resource Manual" (Alleghany County, 2000) is to provide for the long-term management and protection of the County's significant natural resources. Alleghany County is aware of the need to maintain and protect their community resources and have established a 20-year plan to address these concerns. More specifically, the purpose of the plan is to provide a mechanism in which land use planning and environmental protection are coordinated in an effort to preserve water quality and natural resources.

Listed within the plan are a series of goals, objectives, and suggested policies concerning land development planning and water quality management. Selected goals, objectives and policies relating to water quality are listed below.

- Goals:*
- 1) Coordinate and integrate land development and environmental planning such that the County's land and water resources are protected.
 - 2) Promote effective stormwater management and the implementation of the New River Basinwide Water Quality Management Plan.
 - 3) Improve water quality through the preservation and enhancement of the County's wetlands.

- Objectives:*
- 1) Protect water quality through effective and coordinated land development planning.
 - 2) Future land use will be based upon the suitability of the land for development as it affects areas of environmental concern.
 - 3) Protect High Quality Waters (HQW), Outstanding Resource Waters (ORW), Water Supply Waters (WS), and all other surface waters by informing the public of the State's stormwater and land development requirements.
 - 4) Participate in the NCWRP where feasible.

- Policies:*
- 1) Promote sound environmental planning.
 - 2) Direct intense urban and agricultural development away from environmentally sensitive areas.
 - 3) Promote on-site implementation of stormwater management measures and soil conservation BMP's in an effort to mitigate a development's impact to water quality.
 - 4) Work with DWQ and DENR to distribute pertinent information to the public concerning stormwater regulations and to implement the New River Basin Plan.

SECTION 7 DEVELOPMENT AND LAND USE PLANNING

Throughout the plan, the County has clearly pointed out objectives and goals that recognize the importance of the New River Basin Plan. The County has also stated an interest in participating in the New River Basin Plan and a need to work with agencies involved with environmental issues such as NCDWQ, NCDENR, and EEP.



While this plan has thoroughly covered the relationships between development and conservation and the means necessary to meet their goals, the County has yet to put into motion the policies stated within the plan. To achieve the preservation of water quality and natural resources, the County must establish stricter rules and regulations needed to enforce conservation policies. Specific resource areas need to be identified and protected. Growth areas need to be defined, and the broad community consensus necessary for implementation must be built. Local citizens must act on

their collective cognizance of the intrinsic values provided by their natural environment.

There is currently no stormwater management plan for the Town of Sparta (which is not covered by NPDES Phase 2 requirements) and only minimal large lot zoning throughout the county. Individual home sites continue to be developed with no apparent regard for resource protection, and observations during this study noted several active sites without soil erosion and sediment controls; other recently completed homes had very poor vegetative stabilization on the disturbed areas. Finally, inadequate stream crossings were observed at several driveways and private roads leading to newer home sites, and the resulting channel erosion was substantial.

A priority of the Local Watershed Plan should be to work with Alleghany County and Town of Sparta staff to establish and enforce meaningful environmental protection measures. Local stormwater management regulations would be a good start, and ordinances that encourage low impact development should also be considered.



WATER QUALITY

The New River Basinwide Water Quality Plan (NCDWQ, 2000) indicates that all the streams in New River Sub-basin 05-07-03 (Little River) are fully supporting their intended use and no streams are considered impaired. The portion of Little River between the bridge at NC HWY 18 and the Virginia border is classified as High Quality Waters (HQW), and the report recommended that more of the upper reaches of the Little River be reclassified as HQW. All other streams in the planning area are generally classified as C (aquatic life, secondary recreation, fresh water) and many are trout waters (TR). Laurel Branch was previously listed as impaired due to sediment impacts from 1980's golf course construction. Sediment removal and stream restoration activities (including North Carolina's first applications of natural channel design concepts) occurred through a court order. While the extent to which these remedial measures contributed to recovery is not documented, Laurel Branch is now classified as C TR. The basin wide assessments have rated the water quality in the Little River sub-basin as Good to Excellent based on benthic macroinvertebrate data. The only decline in water quality indicated by benthos data was a drop in Bledsoe Creek from Good in 1993 to a lower score of Good-Fair in 1998. This is thought to indicate the watershed impacts of urban development around the town of Sparta. See Table 7 for a list of sampling sites and their ratings.

Table 7. Bioclassification

Site	Date	Bioclassification	Site	Date	Bioclassification	
Little R. (NC18/SR 1141)	May-98	Good	Laurel Br. (SR 1105)	Aug-98	Good	
	Aug-98	Good		Sep-92	Fair	
Little R. (SR 1128)	Jul-93	Excellent		Aug-89	Fair	
	Mar-89	Good		Dec-88	Fair	
Little R. (SR 1424)	Aug-98	Excellent		Aug-88	Good-Fair	
	Jul-93	Excellent		Laurel Br. (NC 21)	Aug-88	Fair
	Mar-89	Fair		Laurel Br. (NC 21)	Sep-92	Poor
Little R. (NC 18)	Aug-98	Excellent		Laurel Br. (NC 21)	Aug-88	Poor
	Jul-93	Excellent		Little Glade Br. (Parkway)	Sep-92	Excellent
	Jul-90	Excellent		Little Glade Br. (NC 21)	Sep-92	Excellent
	Mar-89	Excellent	Pine Swamp Cr. (SR 1128)	Aug-98	Good	
	Jul-88	Excellent		Jul-93	Good	
	Aug-86	Excellent	Bledsoe Cr. (SR 1172)	Aug-98	Good-Fair	
	Aug-84	Excellent		Jul-93	Good	

The ambient water chemistry from the Little River has been analyzed at only two stations: at NC 18 from 1973 to 2000 and at SR1433 from 2000 to the present. The Little River samples exceeded the 20mg/l suspended solids standard in 13% of the samples collected between 1994 and 1998. The mean value of bacteria in the samples was below the 200 colonies / 100ml standard; however, several very high readings (10,000 colonies/ 100ml) indicate that the most common pollutant in the watershed attributed to runoff could be a result of cattle access to streams and, historically, straight pipes and failing septic systems (NCDWQ, 2000).

Julie Jackson, the New River basin Planner for DWQ, and Trish McPherson of the DWQ Bioassessment Unit, were contacted about any additional information that might be available on

the Little River since the publication of the last basinwide plan. DWQ staff stated that an additional round of water quality monitoring data was to be collected in 2003. That data is currently available and included herein as Appendix VII. No other data on the Little River have been collected since the last basin report was presented in 2000.



NCDWQ fish community analysis was also conducted at two locations within the study area. Data from the fish communities suggest that sedimentation and nutrient enrichment are still significant problems in the basin. Fish tissue samples collected from two sites did not exceed standards for metals and were not tested for pesticides.

DOMESTIC WASTEWATER

The Sparta wastewater treatment plant (WWTP) is the largest facility permitted through the National Pollutant Discharge Elimination System (NPDES) within the Little River watershed with a capacity of 0.6 MGD. Over the past four years, only one violation has been reported against the plant which involved an exceedance of fecal coliform limits. However, of the four NPDES permitted facilities located in the Laurel Branch sub-watershed, the OGBP Company has had five violations since 2001. For a complete list of the NPDES listed facilities discharging to the Little River and Laurel Branch, see Table 8. (NCDWQ, 2003)

Table 8. NPDES facilities.

FACILITY	RECEIVING STREAM
Sparta WWTP	Little River
High Meadow Inn	Laurel Branch
OGBP Company	Laurel Branch
Parkway Heritage Inn	Laurel Branch
Roaring Gap Club Inc.	Laurel Branch

The *New River Basinwide Water Quality Plan* postulated that "straight pipe" sewage disposal and failing septic systems contribute to water quality problems in the New River Basin. Alleghany County has recently addressed these water quality issues through the *Ashe/Alleghany Straight Pipe Elimination Project*. The program focused on both Ashe and Alleghany Counties and received funding from the Appalachian Regional Commission, Community Development Block Grants, and the North Carolina Clean Water Management Trust Fund. In addition to funding, the Appalachian District Health Department performed the survey, while the North Carolina Waste Water Discharge Elimination program provided technical assistance. The purpose of the project was to repair or replace straight pipes or failing septic systems identified by an extensive survey performed on the areas surrounding Little River. Any sites that were found to have straight pipes or failing septic systems were repaired or replaced.

At the outset of the project, fewer problem areas were found than initially anticipated. This allowed for the expansion of the study area to cover a greater percentage of the Little River watershed. More than 450 straight pipes were eliminated or failing systems replaced by the end of the project. Of these, 325 were fully funded by the project and 150 systems were corrected by homeowners at their own expense.

INITIAL WATER QUALITY MODELING

Nutrient enrichment frequently ranks as one of the top causes of water resource impairment. Systems are impaired when water quality fails to meet the designated use criteria. The EPA has reported that of the systems surveyed and considered impaired, 40 percent of rivers, 51 percent of lakes and 57 percent of estuaries are listed primarily because of nutrients. Therefore, nonpoint source pollutants and their affect on stream water quality were considered in the course of this study. The Environmental Protection Agency’s (EPA) modeling program PLOAD (version 3.0), a subprogram of BASINS (version 3.0), was used to estimate nonpoint source pollutant concentrations and loads. PLOAD is a simple GIS-based spreadsheet model that was designed to calculate pollutant loads for watersheds and sub-watersheds. The fact that the modeling can be performed in a GIS environment allows visualization of the watershed, adding the dimension of sight to the model. It was designed to be a general screening tool for decision-making analysis related to watershed planning and management. Annual average non-point source loads are estimated based on the following user specified information: annual precipitation, land uses and watershed area. PLOAD can be classified in the family of spatially distributed, lump parameter models. In the model there are two options for non-point source loads: (1) the “Export Coefficient” method and (2) EPA’s “Simple Method Approach”. The Simple Method was selected based on industry acceptability and availability of constituent concentration rates for North Carolina.

Allegany County’s land use GIS data and sub-watershed runoff areas were used in combination with pollutant Event Mean Concentrations (EMC) for land use types for North Carolina found in the Appendix IV of the PLOAD user manual. The following sub-watershed areas where selected for evaluation because they represent the physiographic diversity and land uses in the study area:

Table 9. PLOAD sub-watersheds and land uses.

SUB- WATERSHED	LAND USE/COVER TYPES
Upper Bledsoe Creek	mixed hardwood forest, hay/pasture
Lower Bledsoe Creek	forest, hay/pasture, med. density residential, urban
Waterfalls Creek	mixed hardwood forest, hay/pasture
Laurel Branch	forest, hay/pasture, golf courses

The results from the PLOAD modeling program are shown below in Table 10. The pollutants are listed in pound/acre/year.

Table 10. PLOAD results.

SUB-WATERSHED POLLUTANT LOADING				
Pollutant (lbs/ac/yr)	Lower Bledsoe Creek	Waterfalls Creek	Upper Bledsoe Creek	Laurel Branch
Biochemical Oxygen Demand (BOD)	4.81	1.99	2.10	1.98
Chemical Oxygen Demand (COD)	28.05	14.08	14.66	13.77
Total Suspended Solids (TSS)	19.48	9.11	9.54	8.97
Total Dissolved Solids (TDS)	37.28	24.28	24.97	23.21
Total Nitrogen (TN)	1.10	0.51	0.54	0.50
Nitrate and Nitrite Nitrogen	0.36	0.19	0.19	0.18
Ammonia Nitrogen	0.13	0.05	0.05	0.05
Organic Nitrogen	0.48	0.23	0.24	0.23
Total Phosphorus	0.16	0.09	0.10	0.09
Dissolved Phosphorus	0.09	0.05	0.05	0.05

Model output was analyzed using the following three approaches. First, a comparison of the calculated loading results to published export coefficients for similar land uses was performed. It would have been preferable to compare the results to loads calculated from actual water quality monitoring data collected in a watershed with similar physiography and land uses. Unfortunately those data were unavailable. However, North Carolina State University's Water Quality Group (Line et al, 2003) recently published export coefficients of an impaired watershed in the Piedmont region of North Carolina. For the present analysis it was determined that nitrogen and phosphorous would be the two constituents compared to the published export coefficients. These nutrients are often of the greatest concern when evaluating in-stream water quality related to pollutant loading.

Table 11. Comparison of Little River and Upper Neuse River Basin (UNRB) loading rates.

	PLOAD RESULTS	UNRB STUDY	PLOAD RESULTS	UNRB STUDY
	Phosphorus (lbs/yr/ac)	Phosphorus (lbs/yr/ac)	Nitrogen (lbs/yr/ac)	Nitrogen (lbs/yr/ac)
Upper Bledsoe Creek	0.10	0.90	0.54	10.22
Lower Bledsoe Creek	0.16	1.04	1.10	11.25
Waterfalls Creek	0.09	0.89	0.51	10.11
Laurel Branch	0.09	0.85	0.50	9.59

Comparison of the NC State study to our results readily shows that the loading rates generated by the PLOAD model are well below those found in the Upper Neuse River Basin (UNRB) as shown in Table 11.

These findings are not surprising given that the Neuse River Basin is known for high nitrogen levels due to urbanization while the subject watersheds are not urbanized and are rated High Quality Waters.

Second, an analysis of time series trends of ambient water quality data for total nitrogen and total phosphorus was performed. The data were obtained from NC DWQ Ecosystem Unit. This analysis revealed that between 1974 and 2002 with at least one sample per year, no substantial increases in pollutant loading have occurred. The only increase noted was in total nitrogen and it was from 0.45 mg/l in 1974 to 0.9 mg/l for 2000-2002.

Finally a comparative analysis of the watersheds modeled was performed. The most readily apparent result is the elevation of pollutant loadings in the Lower Bledsoe sub-watershed compared to the other areas studied. That the loadings for each parameter modeled would be 50 to 100% higher coming off the Lower Bledsoe catchment is to be anticipated because this is the most intensely developed portion of the Little River watershed, and includes the downtown urban center and several older residential areas of Sparta.

The results of these evaluations clearly indicate that at a screening level no hot spot areas were immediately determined and that the overall pollutant loadings are generally low. However, it should be considered that no two watersheds are quite the same, and despite many similarities in land use they may differ significantly in their assimilative capacities for various pollutants and associated ecologic response. Further, the results of the PLOAD model were based solely on off the shelf Event Mean Concentrations (EMCs) published for North Carolina as a whole and not specifically for the Little River Watershed. Accurate pollutant loadings can only be determined through a twelve month sampling and analysis program specifically developed for the land use types within the subject watersheds. The PLOAD model could then be revisited using EMC's determined through such monitoring, and the utility of more extensive water quality studies could more accurately be assessed.

Therefore it is recommended to establish a 12 month monitoring plan to obtain loading data by landuse type within the subject watersheds. Based on the EMC's obtained from the monitoring plan the model should be revisited to determine what loads would actually be generated based on project specific loading rates. Based upon these results the need to perform a more extensive water quality model such as BASINS HSPF or SWAT could be determined.

UNPAVED ROAD EROSION MODEL

Dirt and gravel roads have been identified as major sources of sediment to streams, particularly those draining mountainous watersheds (PA Center for Dirt and Gravel Roads). Dirt and gravel roads are abundant throughout the Little River and Laurel Branch watersheds, including NC DOT-maintained state routes and private farm roads. These roads are often built along streambanks where there is generally very little or no riparian buffer present to aid in pollutant removal (NCDWQ, 2000). Sediment-laden runoff was observed in roadside ditches



during visual inspections in the study area, prompting further investigation.

The road soil erosion model contained in the Water Erosion Projection Project (WEPP) (USDA, 2003) was applied to generate estimates of sediment supplied by unpaved roads. WEPP represents the latest generation of USDA computer simulations of watershed processes, and was designed for small watersheds and individual hillslopes. In addition to hydrologic analysis, WEPP allows the user to evaluate spatial and temporal variations in sediment production. The ROAD SOIL EROSION MODEL is a web-based program developed for the USDA Forest Service to determine annual sediment run off from gravel road segments. It should be noted that, while WEPP's erosion prediction tools have been validated for small catchments and individual hillslopes, validation studies are on-going for the road erosion module.

To perform a desktop calculation for a typical unpaved road in the study area, a hypothetical set of conditions were defined. It is important to note that the segment of road analyzed by WEPP for this work was created to represent common factors of a road near a stream. Input values were based on conditions frequently observed during reconnaissance drives through the project area; road gradient, buffer length and buffer gradient were determined by averaging random measurements using project topography in the GIS. Table 12 shows the characteristics used for model input:

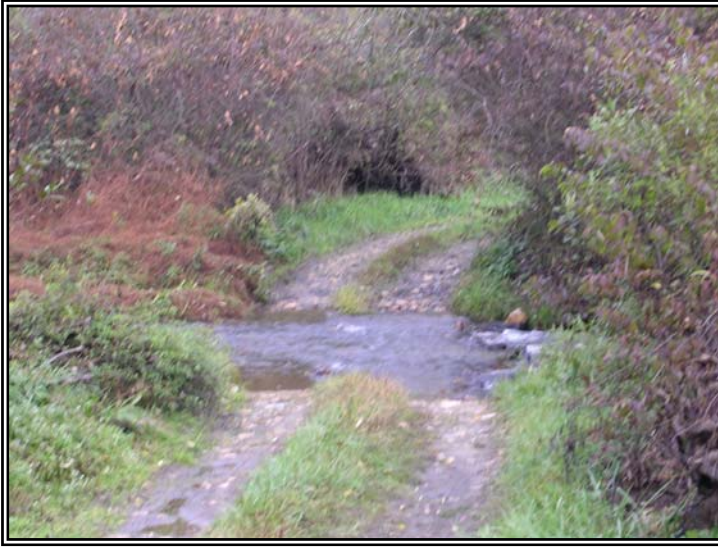
Table 12. WEPP road soil erosion model input.

PARAMETER – DESCRIPTION	INPUT VALUE
<u>ROAD</u>	
LENGTH- the distance between road segments where water crosses the road via culvert, water bar, or other means	500 ft
GRADIENT- slope of the road in percent	5%
WIDTH- the average road width of the segment	12 ft
DESIGN TYPE- (selected from menu)	outsloped
DESIGN SURFACE CONDITION- (selected from menu)	unrutted
MATERIALS- (selected from menu)	sandy loam
<u>FILL</u>	
LENGTH- the horizontal distance from edge of road to bottom of fill	4 ft
GRADIENT - slope of the fill from the edge of road to ditch	100%
<u>BUFFER</u>	
LENGTH - the distance from the road to stream	25 ft
GRADIENT- the slope of the buffer path in percent	18%

Climate data can be selected from several source locations in a pull down menu and modified as needed, or a custom climate data can be entered by the user. For this exercise, Banner Elk, NC was selected from the pull-down menu; total annual precipitation was modified from 49.96 inches to 46 inches.

The WEPP Roads program indicated that the typical segment of unpaved road outlined in Table 10 should be expected to yield 395.42 pounds of sediment per year to receiving streams.

SECTION 8 WATER QUALITY



Spatial analysis of GIS road coverage determined that there are approximately 293 total miles of public roadways in the project area. A conservative estimate would put unpaved roads at 15 % of the total, or about 45 miles. In addition, there are many tens of miles of undocumented private roads on farms and woodlots throughout the study area. While many of these roads obviously have characteristics that would result in lower sediment production and greater assimilative capacities on buffers, it should be assumed that there is a substantial amount unpaved roadway supplying equal or greater

amounts of sediment to the area streams as described in the model. If only five miles of unpaved road produces an equivalent amount of sediment (400 lbs/yr), they would cumulatively yield over 21,000 pounds of sediment per year to receiving streams.

WATERSHED PROBLEMS AND POTENTIAL SOLUTIONS

WATERSHED PROBLEMS AND POTENTIAL SOLUTIONS

INITIAL VISUAL ASSESSMENT

The windshield survey of the study area showed nothing unexpected or unusual that is not typical of the region, and largely verified much of the remote sensing analysis. The area is basically the home to many small and medium size family farms that have been worked for several generations. There is a long history of dairy and cattle farming, although only a few dairy operations remain in the entire county. The upper slopes which were once forested and served as occasionally managed woodlots have now been partly cleared of native forest and planted with either Christmas trees or white pines for timber. In addition, the Little River watershed is heavily dissected with narrow stream valleys, often with notably narrow floodplains and steep adjacent slopes. The landowners in this area are quite used to finding ways to access this topography and are skilled at cutting roads into small valleys and to the top of steep slopes. This makes steep dirt and gravel roads a major feature of most farms.

The lasting impression from driving through the area is one of cattle pasture, and it may appear as if nearly every stream is trampled by the cattle that graze all riparian vegetation to the nub. Hay and pasture land cover half of the Little River watershed and about one fourth of the Laurel Branch sub-watershed, and since most roads are down in the valleys where the most productive grazing occurs, bovine impacts are overwhelmingly apparent. It is also common to spot new shoots of rushes (*Juncus spp.*) and sedges (*Carex spp.*) growing in many active riparian pastures. However, even ungrazed buffers are often in poor condition, with only a narrow stretch of alder or willow along the banks and adjacent fields. Visual assessments also provided confirmation of many instances of stream relocation and channel straightening identified via remote sensing.

A brief tour with Mr. Jasper Cave of the USDA Natural Resource Conservation Service afforded the opportunity to observe some successful conservation projects, where cattle had been fenced out of the streams and alternative water sources developed. Several similar projects were also noted in the northern part of the Little River Watershed. Examples of these conservation efforts are documented with image links in the GIS project.

As previously described, Christmas tree farming causes severe short-term impacts during initial establishment, and one such instance was observed. On a site at the southern end of the Little River Watershed, logging slash from a clear-cut hardwood forest was piled in a windrow parallel to topographic contours about two-thirds of the way up a very steep slope. No other sediment and erosion control devices were in evidence. The good herbaceous cover between Christmas tree rows was also notable at several large, established plantations nearby.

As indicated above, potential restoration, preservation and agricultural BMP opportunities are abundant. Representative examples were cataloged in the field and photo-documented. Information on the location, type of project, and probable cause of impairment is included with images of each example in Appendix IV, and captioned images are linked in the GIS project.

SUMMARY OF WATERSHED PROBLEMS

Three types of problems that adversely impact water quality and degrade habitat have been identified. The first two problems are related: degraded riparian habitat and sediment. The map in Appendix V highlights unforested riparian 100-ft buffers greater than 1500 feet in length. The total is approximately 1300 acres in area, and there are many more areas that do not constitute

WATERSHED PROBLEMS AND POTENTIAL SOLUTIONS

1500 continuous linear feet. The vast majority of these unforested buffers are heavily grazed, and stream banks are trampled by the cattle, which in turn provides excessive amounts of fine sediment to the streams.

While there is a general lack of ecologically functional riparian buffers along most of the headwater streams and tributaries of the Little River, habitat degradation is not limited to areas immediately adjacent to channels. Nearly 3100 acres of hydric soils are mapped in the study area, and many of these areas are also heavily grazed. Accelerated sediment delivery to receiving streams also occurs from new home sites and other construction, and from the hundreds of miles of unpaved roads, public and private. The assessment of watershed problems indicates that there are many activities on very steep slopes like road building, development and Christmas tree farming that take place with little regard to surface water run off.

Finally, the unmanaged stormwater in and around Sparta increases pollutant loadings and degrades in-stream habitat. This problem will only compound with growth and development.



Eroding banks within a pasture along Glade Creek.

IDENTIFIED POTENTIAL SOLUTIONS

The visual assessment of the watershed and meetings with local citizens indicated an abundance of typical stream and wetland restoration sites within the Little River Watershed. Currently many of the landowners in the watershed are looking for ways to use their land to increased financial advantage. Some do this by selling lots and subdividing marketable property. In other cases they are trying to increase cattle grazing or Christmas tree production while at the same time cutting costs. This leaves many landowners willing to listen to offers of financial assistance in exchange of an easement or to pay for watershed conservation practices on their land.

Our discussions with the NRCS staff indicate that there are several landowners who have worked with that agency in the past and may be willing to consider conservation easements and stream and wetland projects on their property, if the price is right. James Coman of BRRLT said that he currently knows several landowners who have nice wetlands on their farm and these could become the target of farmland conservation easements. He was also interested in the idea of a dirt and gravel road BMP program that could be implemented in this mountainous topography. He thinks that this would be a good program that might attract attention from some landowners who would not otherwise be interested in working with the state. It is readily apparent that public agency and nonprofit staff can be of tremendous assistance in the development and implementation of a Local Watershed Plan.

SECTION 9

WATERSHED PROBLEMS AND POTENTIAL SOLUTIONS

The Bledsoe Creek watershed presents more challenges and also more opportunities. Urban areas are places in a watershed with a multitude of small impacts from lots of sources, all of which may need to be addressed to restore the ecological function of the watershed. The County has the basic beginning of a development plan, with lots of resource friendly goals that are well articulated but not implemented. They could use additional funding and technical guidance to change the way they manage their stormwater. Development of a watershed plan and implementation of Stormwater Treatment Practices (STP's) should also generate mitigation credits.

Fortunately, Sparta is relatively small and of manageable size in a watershed of relatively good quality. The County Planning Director, who just spearheaded a subdivision ordinance and a farmland protection ordinance (establishing agricultural districts), has now turned his attention to watershed issues, starting with FEMA and a new water supply. He should be brought into the watershed planning process at the soonest appropriate time. More detailed land use planning, mixed-use zoning, riparian buffer regulations, and storm water management requirements can all be important in this watershed, but are not likely to occur without his avid participation. In addition, stricter enforcement of state soil erosion and sediment control within Alleghany County needs to become a top priority, but success will require local government support.

Similarly, the people who have been dedicated to bog research and preservation for several decades can be tremendous assets in the preservation of bog turtles and their habitat. The preservation of good bog turtle habitat is more complicated than just land acquisition because the bogs require management, which is best accomplished by seasonal grazing. The members of Project Bog Turtle have cultivated relationships with landowners in the area and only lack the resources to conduct wider surveys and work with more landowners. Implementing management practices at the NC DOT-owned Sparta bog may be a good first start.

Ambient water quality monitoring based on specific land use type (i.e. light urbanization, pasture, cropland, Christmas tree farm) would be useful to develop EMC's for the Little River watershed and provide better water quality modeling results.

ASSESSMENT STRATEGIES

FOCUS AREAS

After evaluating the available information and in consideration of the overall Local Watershed Plan objectives, eleven (11) sub-watersheds have been identified as focus areas for more detailed study (Table 11.). Criteria used to identify these areas are shown in the table below; selections are intended to efficiently generate data on the identified problems of eroding stream banks, unforested buffers, previously straightened reaches, mountain bogs, and sediment supply as a result of dirt and gravel roads. Spatial variation across the study area, land use (e.g. Christmas tree farms, downtown Sparta), and diverse combinations of issues within the respective sub-watersheds were also considered. These areas should provide a representative data set from which watershed-wide solutions can be developed.

To effectively identify basinwide trends, general assessments should be applied to representative areas in each of the 11 sub-watersheds. Such assessments include the use of GIS analysis to quantify dirt/gravel roads, qualitative stream and riparian evaluations, and analysis of bank erosion and other channel processes by various metrics. The focus areas are further prioritized by those areas where more intense analyses can be applied to a variety of common watershed conditions with some expectation that findings can be applied throughout the entire study area. The recommended sub-watersheds are Pine Swamp, Lower Bledsoe, Middle Glade, UT01, and Laurel Branch highlighted in Table 13. The five basins have been selected for detailed assessments contingent on their habitat features, buffer conditions and potential restoration opportunities.

Table 13. Focus areas.

SUB-WATERSHED	REASON
LR5	<ul style="list-style-type: none"> • Headwaters of Little River • Christmas tree farms • Unforested buffers
Pine Swamp Creek	<ul style="list-style-type: none"> • Wetlands/Bog turtle habitat • Christmas tree farms • Dirt and Gravel roads • Unforested buffers
Upper Bledsoe Creek	<ul style="list-style-type: none"> • Unforested buffers • Wetlands • Animal Operation
Lower Bledsoe Creek	<ul style="list-style-type: none"> • Urban stormwater issues • Straightened channel segments • Bog habitat • Unforested buffers
Wolf Branch	<ul style="list-style-type: none"> • Unforested buffers • Dirt and Gravel roads
Middle Glade Creek	<ul style="list-style-type: none"> • Wetlands/Bog turtle habitat • Straightened channel segments • Unforested buffers • Stream restoration opportunities
Lower Glade Creek	<ul style="list-style-type: none"> • Wetlands/Bog turtle habitat • Unforested buffers • Trout waters
Moccasin Creek	<ul style="list-style-type: none"> • Straightened channel segments • Unforested buffers
LR1	<ul style="list-style-type: none"> • Unforested buffers • Dirt and Gravel roads
UT01	<ul style="list-style-type: none"> • Straightened channel segments • Dirt and Gravel roads • Wetlands/Bog turtle habitat • Unforested buffers
Laurel Branch	<ul style="list-style-type: none"> • Wetlands/Bog turtle habitat • Unforested buffers • Sub-watershed history

RECOMMENDATIONS FOR ADDITIONAL DATA

The following items describe data acquisition activities which, except as noted, are recommended for all of the eleven sub-watersheds previously identified as focus areas.

1. There is no Alleghany County Natural Heritage Inventory, or other comprehensive survey to characterize and rank the natural resource base. Such an inventory puts the Element Occurrences and other land use into context and allows systematic evaluations of land planning alternatives.
2. There is a need for additional bog turtle survey and inventory of the other species of concern known to exist in the wetlands and stream corridors in the Laurel Branch and the Little River systems. The expert consensus is that the Little River basin might be home to the largest population of turtles in North Carolina, and additional verification would be helpful given the federal listing.
3. It appears that sediment is the major water pollutant in the study area. As pool in-filling is an early indicator of stability problems, sediment monitoring, especially in Laurel Branch and Little River tributaries, would support identification of sediment sources and allow a quantitative evaluation of the magnitude of the problem.
4. Water quality monitoring would be useful in the Bledsoe Creek sub-watershed as proposed in the *New River Basinwide Water Quality Plan*. If water quality modeling should become important in the future, such as to support stormwater quality management around Sparta, then real monitoring data will be necessary for more accurate results. Most major land uses occurring within the study area (with the notable exception of the golf course around Laurel Branch) are found in the two Bledsoe Creek sub-watersheds. Including fecal coliform or *e.coli* in the suite of analytes may also provide a more persuasive data set to use in convincing farmers to limit cattle access to creeks.
5. The benthic monitoring done by NCDWQ for the watershed basin plans is typically minimal and does not provide enough data to discriminate water quality problems in the various tributaries. Currently, monitoring has occurred in six of the eleven previously identified focus areas. Even a one-time survey with increased sample density to include at a minimum the focus areas would be helpful to assess the sub-watersheds and build a more detailed picture of the entire basin.
6. No data were available on freshwater mussels in the study area. Several species of concern are known to exist in the New River Basin. A valuable prioritization tool could be developed if listed species are documented in the Little River system and/or Laurel Branch.
7. Verification of hydric soils on a larger scale will support identification of potential wetland restoration sites and bog habitat identification.
8. Riparian vegetation inventories at both unforested and forested sites will provide field verification of buffer mapping and documentation of vegetative communities. The vegetation inventories can be used in restoration planning and management (e.g., a pasture with a substantial presence of herbaceous hydrophytes is more likely to colonize with similar species than a pasture that has been meticulously maintained in cool season grasses).
9. Stream stability assessments should be completed to identify, inventory and evaluate physically degraded stream reaches.

METHODS

A comprehensive stream and riparian corridor survey is probably the most valuable data set that should be generated by the next level of investigation, and can be designed to efficiently encompass several of the other additional data recommendations shown above. This comprehensive survey should evaluate the physical and biological conditions in the streams and riparian habitats. The survey will identify and thoroughly describe existing conditions. GPS would be used to locate disturbances, type localities, data points, etc. in the field to integrate survey findings into the GIS project. The survey data can be used to identify discrete restoration/preservation project sites and develop a matrix for project ranking and prioritization.

Methods for detailed stream and riparian corridor assessments are described below. Specific applications would be based on characteristics of individual sites such as threats to water quality, habitat value, stream physical condition, and mitigation opportunities. These methods were selected with the expectation that findings can be extrapolated to other parts of the watershed for management purposes.

River Corridor Assessment

To begin a more thorough analysis of the existing conditions, a two tiered riparian corridor survey should be executed to evaluate the physical and biological conditions in the streams and riparian habitats. The first level would include more thorough reconnaissance and GIS analyses of the eleven sub-watersheds. GIS efforts can correlate extensive unforested buffers with large land ownerships to focus preliminary Riparian Corridor Assessments toward identifying potential mitigation sites. The second level of investigation would acquire qualitative data on a representative sample of riparian corridors and initiate quantitative assessment strategies. GIS would be utilized at this stage to determine sampling densities and allow the most effective data collection sites to be identified.

The River Corridor Site Analysis form (Figure 10) compiles a series of primarily qualitative observations onto a single worksheet. This method was originally developed for an NC Cleanwater Management Trust Fund study, and has since been applied to twenty (20) different watershed studies in North Carolina. The riparian corridor assessment will identify locations where more detailed inventory work should be pursued. The River Corridor Assessment was selected because it relates basic observations that integrate riparian habitat and water quality. The form is simple and rapidly completed, and includes a space to follow-up with landowner interest in conservation/restoration work.

The Stream Reconnaissance Record Sheet provided in Appendix VIII is a more rigorous inventory method that should be applied to potential project sites, particularly those opportunities on streams that have been straightened or relocated, and other locations where geomorphic stability is an issue. As described on page 23, the study area has a long history of channel modification. Watershed and channel response to anthropic manipulation will vary spatially and temporally based on specific site conditions (e.g. soils, vegetation, lithology, basin slope, etc.) as well as the extent and type(s) of impact. The Stream Reconnaissance Record Sheet focuses observations on diagnostic characteristics related to active processes both in the channel and the surrounding landscape, which will help identify site-specific solutions.

Figure 10. Riparian Corridor Site Analysis Form.

Parcel Number Code:	Landowner Name:	Date:
1. Ability to Maintain Water Quality: ___ high (protection candidate) ___ medium ___ low		
2. Ability to Improve Water Quality: ___ high (restoration candidate) ___ medium ___ low		
3. Size of parcel: ___ large (75 acres +) ___ medium (21 to 75 acres) ___ small (20 or less)		
4. Landowner interest: ___ highly interested ___ casual interest ___ no interest ___ unknown		
5. Natural Community Value: ___ high ___ medium ___ low		NOTE:
6. Wildlife Habitat Value: ___ high ___ medium ___ low		NOTE:
7. Current Threats: ___ low ___ medium ___ high		NOTE:
8. Potential Future Threats: ___ low ___ high		NOTE:
9. Criteria for Matching Programs Matrix: scored as + and /or -		
	Protected	Needs Attention or Restoration
water quality		
riparian areas		
streambank		
wetlands		
plant communities		
forest		
natural resources		
wildlife habitat		
animal movement corridor		
cropland soil loss		
livestock intrusion		
stormwater BMP's		
non-point source pollutants		
Recommendations specific to this property:		

Riparian Habitat Inventories

Detailed sampling and statistical analyses of plant communities may be advised if the Riparian Corridor Assessment or other activities turn up listed species. Sampling methods would be based on the vegetation to be sampled at a given site, but would usually involve transects and/or frames. This level of investigation would only be warranted to prioritize bona fide project sites.

Bog Turtle Habitat Assessment and Population Estimation

Since the turtles live in wetlands that can be very small, the general wetlands mapping has been insufficient to locate the majority of sites. In addition, the sites are generally marginal agricultural land that has been ditched, grazed, mowed, timbered and invaded by weeds. This makes sites difficult to categorize by "natural community" and other land cover screenings. It also appears that the best populations occur in meta-populations of a string of small wetlands connected by a riparian corridor. The best technique is to use higher resolution photography, including infrared

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and GPS technology to find and plot smaller wetlands more accurately. More accurate land cover and habitat potential prediction software (NC GAP) might also be consulted as part of this task.

Once candidate sites are located, the next step is to obtain landowner permission to do a screening visit of the wet spot in the late spring and early summer. The screening visit is when a small team of people investigates the site using hand and eye, looking to find turtles or their signs. The site is also assessed for important features like habitat quality, mud depth, hydrology and disturbance. Often a turtle, nest or recent shell is found indicating the current use of this site by the turtles. This then increases focus on neighboring wetlands. Confirmation of the presence of bog turtles in a good candidate site can also be accomplished by trapping, but this method is not suggested at this time.

Soils Evaluations

A systematic evaluation of hydric soil mapping, distributed throughout the study area, is recommended to support more detailed identification and evaluation of potential wetland restoration sites. Based on initial findings, a methodology is suggested to identify and prioritize areas for potential mitigation sites in the Little River Watershed. This GIS-based approach will conduct spatial analyses to develop a prioritized hierarchy of wetland conservation sites. The spatial analyses will be based on the following:

- Areas that are mapped as Alluvial land, wet (Ad) in the Alleghany County Soil Survey
- Areas mapped as wetlands on the National Wetlands Inventory map.
- Larger sized target polygons should rate higher than smaller polygons
- Cleared areas (agricultural fields, grazing pastures, etc.) should rate higher than forested areas
- Target polygons where the channel has been modified (moved, straightened, etc.) should rate higher than those that appear in natural conditions
- Areas that are mapped as Codorus Complex (Cx) in the Alleghany County Soil Survey
- The proximity of target polygons to other target polygons should proportionally affect rating
- Opportunity to provide wildlife habitat restoration, especially with respect to state or federally listed species
- Landowner willingness to cooperate should affect a higher rating

Once the highly rated areas are identified, a thorough soil analysis should be performed. The objective of the analysis will be to identify the limits of the hydric soil on the target polygon as well as document the history of the site with respect to soils, such as relict versus current redoximorphic features, areas that have either been filled or cut, and a general sense of the hydraulic conductivity of the soil. Hand augers will be utilized to obtain soil borings. The borings will be logged using standard NRCS guidelines for describing soils.

Mussel Survey

Some of the most imperiled fauna throughout North Carolina are freshwater mussels. A number of rare freshwater mussel species are known to occur in the New River Drainage in North Carolina. These include the green floater (*Lasmigona subviridis*), purple wartyback (*Cyclonaias tuberculata*), spike (*Elliptio dilatata*) and pistolgrip (*Tritogonia verrucosa*). The green floater is a Federal Species of Concern (FSC) and is considered Endangered in North Carolina. The spike and

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purple wartyback are considered Special Concern and Significantly Rare in North Carolina. The pistolgrip is believed to be extirpated from the state. The populations of the species listed above appear to be declining in the main stem of the New River in North Carolina.

Due to a limited amount of survey work, freshwater mussel populations have not been inventoried in the Little River within North Carolina; however, a viable population of the green floater has been documented in the Little River in Virginia, just downstream of the state line. Given the apparent decline of mussel populations in the main stem of the New River, it is important for resource managers to have a better understanding of the status of the aquatic fauna in the tributaries of the New River Basin. More survey work is needed in the North Carolina portion of the Little River to determine if a mussel fauna are present in this system.

It is recommended that surveys be conducted in the Little River from the state line moving upstream and should include the major tributaries (Bledsoe Creek, Glade Creek, Crab Creek etc.) and Laurel Branch.

Water Quality Monitoring and Benthic Surveys

In general, the Draft Monitoring Plan prepared by DWQ (Appendix VI) should be followed. It is recommended that monitoring occur in the Upper Bledsoe Creek sub-watershed to better define the urban influence of Sparta at the downstream location. A couple of other monitoring sites might also be added or substituted to better coincide with the sub-watersheds described above as focus areas. Staff from DWQ, EEP, and the consulting team should meet again to finalize monitoring strategies that complement other investigations in the focus areas.

Channel Stability Assessments:

Geomorphic stability will be evaluated on a reach basis using the Rapid Assessment of Channel Stability in the Vicinity of a Road Crossing (CSA) (Johnson, 1999) and hydraulic geometry measurements. Stratified random sampling would be applied throughout the focus areas to better prioritize conservation opportunities. Physical parameters evaluated with this CSA include:

Bank soils	Riparian vegetative bank protection
Bank angle	Debris jam potential
Obstruction, flow deflectors	Mass wasting/modes of bank failure
Bank cutting	Bar formation
Bed materials/embeddedness	Shear stress ratio
Channel constriction	Approach angle to crossings
Distance of crossings to meanders	

This CSA method is a highly reproducible assessment tool for evaluating causes of channel instability related to bridges and culverts. The methodology is also flexible in that it allows relative scores to be weighted appropriately if no crossings are present within a stream reach, and other parameters can be added as needed to address watershed-specific issues. Two parameters from Rosgens "level 3" analyses (Rosgen, 1996), the bank height/bankfull height ratio and the ratio of cross sectional area in the near bank region to total cross sectional area (A_{nb}/A), are often incorporated into overall CSA scores using relative weights derived from Rosgen.

Hydraulic geometry measurements should be taken at each reach. In most cases, quick and dirty cross sections measured down from a camline leveled at the bankfull elevation are sufficient.

Other sites may require more detailed surveys to include longitudinal profiles and sediment sampling. Surficial bed material will be quantified using the Wolman pebble count method or bulk sampling, with data collected at riffle and pool cross sections to support potential future sediment monitoring.

Sediment

Increased sediment supply to streams was identified as a major threat to water quality during the windshield survey, interviews with NCWRC fisheries staff and Messrs. Jim Siegfried and Bobby Shaw. The main sources of fine sediment that need to be addressed include new construction sites, dirt and gravel roads, and cattle access to streams. As a means to evaluate and monitor the fine sediment accumulation received by the streams, it is recommended that the following sampling technique be initiated (after Bunte and Abt, 2001).

Local deposits of fine sediment may provide reach-averaged conditions of sediment supply. Fine sediment may not be detectable in the main channel bed or on riffles, but should be visible in locations conducive to local deposits of fines. Such areas include pools, backwater areas, or the wake of a stream obstruction. Repeated monitoring of such locations may indicate whether the quantity of fines transported is variable over time.

A field analysis for monitoring the deposition of fine sediment in pools was developed by Lisle and Hilton (1992; 1999). Fine sediment is transported in gravel-bed streams after a high flow event during subsequent moderate and low flows. The fines are eventually trapped in pools and form deposits of measurable thickness near the sides or backwater areas of pools along zones of low shear stress. The parameter V^* quantifies the ratio of the fine sediment volume in pools V_{fines} to pool volume V_{pool} and is computed from

$$V^* = \frac{V_{fines}}{V_{pool} + V_{fines}} \quad (8)$$

In order to compute V^* , the water depth and the thickness of the fine sediment deposit is measured along a grid system spanned over the pool. The thickness of the fine sediment deposit is measured by probing with a graduated steel rod (Bunte and Abt, 2001). Water depth is measured up to the residual pool volume, or more precisely, the minimum water depth at which water would just overflow the downstream riffle. To calculate pool and fine sediment volumes, the cross-sectional areas of pools and fines are multiplied by the distance between cross-sections.

The value of V^* can range from 0 to 1, 0 designating no fines and 1 if the pool is completely filled. V^* is computed for about 10-15 pools (more if V^* varies heavily between pools) and averaged. A change in V^* can be used to measure and monitor spatial or temporal changes in fine sediment yield.

This technique should be applied at three to five streams and supplemented with installation of suspended sediment/stream stage monitoring devices. The apparatus are extremely cost-effective to build and install, and provide a link between suspended sediment loads and flow data. Once a fine sediment monitoring program is established, measures to effectively control the various erosional sources that have increased sediment supplies to the streams should be identified.

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It would also be beneficial to characterize sediment loadings from dirt roads. Comparable studies (Reid et al, 1981; Reid and Dunne, 1984) determined sediment delivery ratios for road-surface, ditch, and roadcuts, and showed that road-surface erosion produced ten times as much sediment as all other watershed sources except landslides. If sediment from dirt roads proves to be a detriment to aquatic function in the study area, then conservation measures should be explored that might even qualify as flexible mitigation.

GIS analysis of NCDOT maps, construction and maintenance records, combined with interviews of District staff should be used to select two to four of the focus areas to develop sediment budgets for dirt roads. The selected focus areas should exhibit some diversity of land use, basin slopes and aspects. At least one area should include Christmas tree farms. Sediment budgets should be developed for the selected sub-watersheds, and stratified random sampling would select specific road segments for monitoring. A limited study could accurately determine sheet erosion rates at a representative sample of roads and surface types and calculate sediment supply per unit length of road per year. Monitoring would include sampling at culverts during storm events of varying magnitude to determine sediment concentration to discharge relations. Similar measurements on paved segments would allow isolation of road erosion from ditch erosion rates.

SUMMARY

Eleven sub-watersheds are proposed as focus areas for further investigation and several methods are proposed to evaluate both watershed problems and opportunities. The sub-watersheds were identified to encompass the range of watershed conditions, including several combinations of characteristics that may be relevant to a thorough understanding of watershed issues. The assessment tools are proposed both to cost-effectively generate meaningful information and because conclusions drawn from these methods can be applied across the Little River watershed and Laurel Branch sub-watershed.

The concerted application of these methods will allow the scope and magnitude of water quality problems and potential solutions to be evaluated. This detailed examination of the physical, chemical, biological and cultural issues that affect water quality will identify causal relationships that link problems and opportunities. A systematic application of the methods proposed will provide the basic quantitative and qualitative framework for a plan containing practical conservation initiatives supported by a broad consensus of resource professionals, local officials and residents of the watershed.

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