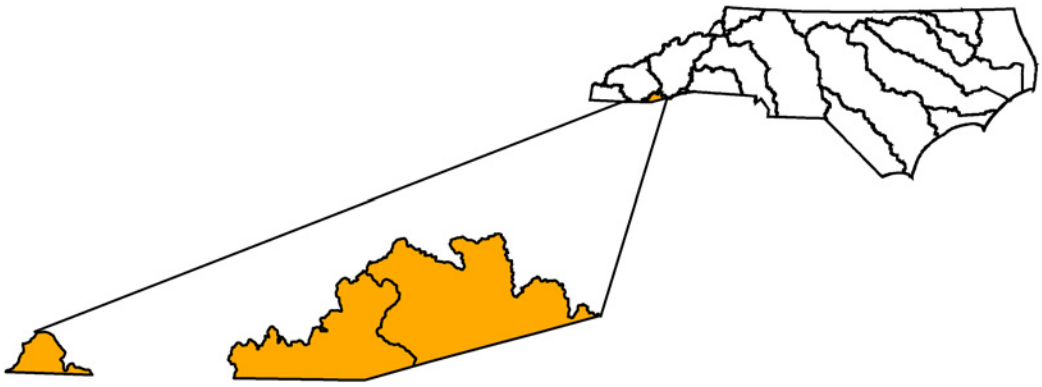
Savannah River
Basinwide Water Quality Plan

March 2007



North Carolina Department of
Environment and Natural Resources

Division of Water Quality
Basinwide Planning Unit

SAVANNAH RIVER BASIN
WATER QUALITY PLAN

March 2007

NC Department of Environment & Natural Resources
Division of Water Quality
Water Quality Section
1617 Mail Service Center
Raleigh, NC 27699-1617

(919) 733-5083 ext. 577

This document was approved and endorsed by the NC Environmental Management Commission on March 8, 2007 to be used as a guide by the NC Division of Water Quality in carrying out its Water Quality Program duties and responsibilities in the Savannah River basin. This plan is the third five-year update to the Savannah River Basinwide Water Quality Plan approved by the NC Environmental Management Commission in May 1997.

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

Executive Summary

Basinwide water quality planning is a watershed-based approach to restoring and protecting the quality of North Carolina's surface waters. The North Carolina Division of Water Quality (DWQ) prepares Basinwide water quality plans for each of the 17 major river basins in the state. Each basinwide plan is revised at five-year intervals. While these plans are prepared by DWQ, their implementation and the protection of water quality entail the coordinated efforts of many agencies, local governments and stakeholders throughout the state.

The goals of basinwide planning are to:

- Identify water quality problems and restore full use to Impaired waters.
- Identify and protect high value resource waters.
- Protect unimpaired waters while allowing for reasonable economic growth.

DWQ accomplishes these goals through the following objectives:

- Collaborate with other agencies to develop appropriate management strategies. This includes providing agencies information related to financial and funding opportunities.
- Assure equitable distribution of waste assimilative capacity.
- Evaluate cumulative effects of pollution.
- Improve public awareness and involvement.
- Regulate point and nonpoint sources of pollution where other approaches are not successful.

This document is the third five-year update of the *Savannah River Basinwide Water Quality Plan*. The first basinwide plan for the Savannah River basin was completed in 1997 and the second in 2002. The format of this plan was revised in response to comments received during the first and second planning cycles. DWQ replaced much of the general information in the first two plans with more detailed information specific to the Savannah River basin. For this plan, a greater emphasis was placed on identifying water quality concerns on the watershed level in order to facilitate protection and restoration efforts.

DWQ considered comments from the Western North Carolina Basinwide Planning Conference held in the region and subsequent discussions with local resource agency staff and citizens during draft plan development. This input will help guide continuing water quality management activities throughout the river basin over the next five years.

Basin Overview

The portion of the Savannah River Basin located in North Carolina lies entirely within The Southern Crystalline Ridges and Mountains ecoregion (Griffith et al 2002) and occupies 151 square miles (Figure *iii* and *iv*). Most of the land is contained within the Nantahala National Forest and Gorges State Park. The largest towns are Highlands and Cashiers. Additional areas of commercial, residential, and golf course development can be found scattered throughout the US 64 corridor between Lake Toxaway and Highlands. Outstanding Resource Waters located in the Savannah River Basin include the Chattooga River and many of its tributaries, Big Creek,

and Overflow Creek. In addition, a portion of the Horsepasture River downstream is included in the National Wild and Scenic River System.

Information presented in this basinwide water quality plan is based on data collected from September 1999 to August 2004. Maps of each subbasin are included in each of the subbasin chapters. Each subbasin has its own characteristics and water quality concerns. These are discussed in Chapters 1 and 2.

DWQ identifies water quality stressors as specifically as possible depending on the amount of information available in a watershed. Most often, the source of the stressor is based on the predominant land use in a watershed. In the Savannah River basin, new development/construction activities, land clearing, impervious surfaces, and point source discharges were all identified as possible stressors. However, unknown stressors impact many streams. Water quality decline can often be attributed to a combination of many stressors that lead to habitat and water quality degradation. In some way, every person, industry, landowner, and municipality in the basin impacts water quality. Therefore, every resident of the basin must play a role in management strategies designed to protect and restore the streams, lakes, and rivers of the basin.

Subbasin 03-13-01

This mountainous subbasin is divided into two pieces: a small portion of the Tullulah River headwaters in Clay County and a larger portion of the basin that includes the Chattooga River, Norton Mill, Big, Clear and Overflow Creeks. The majority of streams in this subbasin flow generally south toward Georgia. The Chattooga River forms part of the state boundary between Georgia and South Carolina. The Chattooga and Tullulah Rivers join to form the Tugaloo River in Georgia. A map of this subbasin including water quality sampling locations is presented as Figure 3.

This subbasin lies within the level IV ecoregion of the Southern Crystalline Ridges and Mountains. This ecoregion is characterized by elevations ranging between 1,200 and 4,500 feet, high rainfall rates, abundant forest cover, and acidic, loamy, well-drained soils (Griffith *et al* 2002). As would be expected for an area with rugged topography, most of the land within this subbasin is forested (96.8 percent) and lies within the Nantahala National Forest including the Southern Nantahala Wilderness and the Ellicott Rock Wilderness areas. Notable exceptions include the urbanizing areas in and around the Town of Highlands and the Cashiers community. Residential development is increasing rapidly around these communities and along primary roadways.

There are five NPDES dischargers in this subbasin; two are required to perform whole effluent toxicity testing. The Cashiers WWTP (NC0063321, 0.1 MGD) discharges to an unnamed tributary of the Chattooga River and has had three toxicity violations since 2001. The Mountain (formerly Highlands Camp and Conference Center) facility (NC0061123, MGD .006) discharges to Abes Creek and has had seven toxicity violations since 2000.

Subbasin 03-13-02

The Horsepasture and Toxaway Rivers originate in Jackson and Transylvania counties and flow in a southeastern direction toward South Carolina's Lake Jocassee. The Horsepasture falls more than 2,000 feet in the North Carolina portion of the watershed and contains several spectacular

waterfalls. Other tributaries in this subbasin include the Whitewater and Thompson Rivers. A map of this subbasin including water quality sampling locations is presented as Figure 5.

Most of the land within this subbasin is forested (95.6 percent). The Whitewater River watershed lies within the Nantahala National Forest. The Gorges State Park and Toxaway Game Lands encompass 10,000 acres in this subbasin (mostly the Toxaway River watershed). There are no municipalities; however, several residential and resort communities exist near Sapphire and Lake Toxaway.

Water quality in this subbasin is generally good to excellent. Nearly all waters are classified trout waters. Several streams including Bearwallow Creek and a portion of the Whitewater River are High Quality Waters. Additionally, 4.5 miles of the Horsepasture River are both a State Natural and Scenic River and a National Wild and Scenic River.

Use Support Summary

Use support assessments based on surface water classifications form the foundation of this basinwide plan. Surface waters are classified according to their best-intended use. Determining how well a waterbody supports its use (*use support* rating) is an important method of interpreting water quality data and assessing water quality.

Biological, chemical, and physical monitoring data collected between September 1999 and August 2004 were used to assign use support ratings in the Savannah River basin. No streams in the Savannah River basin were rated as Impaired (Table *i*).

Use support methodology has changed significantly since the 2002 revision of the *Savannah River Basinwide Water Quality Plan*. In the previous plan, surface waters were rated fully supporting (FS), partially supporting (PS), not supporting (NS) and not rated (NR). FS was used to identify waters that were meeting their designated use. Impaired waters were rated PS and NS, depending on the degree of degradation. NR was used to identify waters with no data or those that had inconclusive data.

The *2002 Integrated Water Quality Monitoring and Assessment Report Guidance* issued by the Environmental Protection Agency (EPA) requests that states no longer subdivide the Impaired category. In agreement with this guidance, North Carolina no longer subdivides the Impaired category and rates waters as Supporting (S), Impaired (I), Not Rated (NR), or No Data (ND). These ratings refer to whether the classified uses of the water (such as water supply, aquatic life, primary/secondary recreation) are being met. Detailed information on use support methodology is provided in Appendix VIII.

Table *i* Summary of Use Support Ratings by Category and Subbasin in the Savannah River Basin

Subbasin 03-13-01			Subbasin 03-13-02		
Use Support Rating	**Aquatic Life**	**Recreation**	**Use Support Rating**	**Aquatic Life**	**Recreation**
Monitored Waters					
Supporting	18.1 mi	0	Supporting	28.7 mi	3.9 mi
Impaired*	0	0	Impaired*	0	0
Not Rated	0.6 mi 23.7 ac	0	Not Rated	524.9 ac	0
Total	**18.7 mi 23.7 ac**	**0**	**Total**	**28.7 mi 524.9 ac**	**3.9 mi**
Unmonitored Waters					
No Data	68.7 mi 17.0 ac	87.4 mi 40.7 ac	No Data	77.9 mi 125.6 ac	102.8 mi 650.5 ac
Total	**68.7 mi 17.0 ac**	**87.4 mi 40.7 ac**	**Total**	**77.9 mi 125.6 ac**	**102.8 mi 650.5 ac**
Totals					
All Waters	**87.4 mi 40.7 ac**	**87.4 mi 40.7 ac**	**All Waters****	**106.6 mi 650.5 ac**	**106.7 mi 650.5 ac**

* The noted percent Impaired is the percent of monitored miles/acres only.
** The noted percent Impaired is the percent of monitored miles/acres only.

Use support methods were developed to assess ecosystem health and human health risk through the development of use support ratings for five categories: aquatic life, fish consumption, recreation, shellfish harvesting, and water supply. These categories are tied to the uses associated with the primary classifications applied to North Carolina rivers, streams, and lakes. A full description of the classifications is available in the DWQ document titled *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina*. This document is available on-line at http://h2o.enr.state.nc.us/csu/.

Challenges Related to Achieving Water Quality Protection

Thankfully, no streams in the Savannah River basin appear on the 303(d) list of impaired waters. However, as urbanization continues the risk of impairment increases. Balancing economic growth and water quality protection will be a tremendous challenge. Point source impacts on surface waters can be measured and addressed through the basinwide planning process and do not represent the greatest threat to water quality in the basin.

Cumulative Effects

While any one activity may not have a dramatic effect on water quality, the cumulative effect of land use activities in a watershed can have a severe and long-lasting impact.

The cumulative effects of nonpoint source pollution are the primary threat to water quality and aquatic habitat in the Savannah River basin. Nonpoint source pollution issues can be identified through the basinwide plan, but actions to address these impacts must be taken at the local level. Such actions should include:

- Develop and enforce local erosion control ordinances
- Require stormwater best management practices for existing and new development
- Develop and enforce buffer ordinances

- Conduct comprehensive land use planning that assesses and reduces the impact of development on natural resources.

This basinwide plan presents many water quality initiatives and accomplishments that are underway within the basin. These actions provide a foundation on which future initiatives can be built. Individual homeowners can participate in resource protection by doing the following on their own properties.

- To decrease polluted runoff from paved surfaces, households can develop alternatives to areas traditionally covered by impervious surfaces. Porous pavement materials are available for driveways and sidewalks, and native vegetation and mulch can replace high maintenance grass lawns.
- Homeowners can use fertilizers sparingly and sweep driveways, sidewalks, and roads instead of using a hose.
- Instead of disposing of yard waste, use the materials to start a compost pile.
- Learn to use Integrated Pest Management (IPM) in the garden and on the lawn to reduce dependence on harmful pesticides.
- Pick up after pets.
- Use, store, and dispose of chemicals properly.
- Drivers should check their cars for leaks and recycle their motor oil and antifreeze when these fluids are changed.
- Drivers can also avoid impacts from car wash runoff (e.g., detergents, grime, etc.) by using car wash facilities that do not generate runoff.
- Households served by septic systems should have them professionally inspected and pumped every 3 to 5 years. They should also practice water conservation measures to extend the life of their septic systems.
- Support local government watershed planning efforts and ordinance development.

Impacts from Steep Slope Disturbance

Dramatic elevation changes and steep slopes define mountain topography. Building sites perched along mountainsides provide access to unparalleled vistas and are a major incentive for development. However, construction on steep slopes presents a variety of risks to the environment and human safety.

Poorly controlled erosion and sediment from steep slope disturbance negatively impact water quality, hydrology, aquatic habitat, and can threaten human safety and welfare. Soil types, geology, weather patterns, natural slope, surrounding uses, historic uses, and other factors all contribute to unstable slopes. Improper grading practices disrupt natural stormwater runoff patterns and result in poor drainage, high runoff velocities, and increased peak flows during storm events. There is an inherent element of instability in all slopes and those who choose to undertake grading and/or construction activities should be responsible for adequate site assessment, planning, designing, and construction of reasonably safe and stable artificial slopes.

Local communities also have a role in reducing impacts from steep slope development. These impacts can also be addressed through the implementation of city and/or county land use and sediment and erosion control plans. Land use plans are a non-regulatory approach to protect water quality, natural resources and sensitive areas. In the planning process, a community gathers data and public input to guide future development by establishing long-range goals for the local

community over a ten- to twenty-year period. They can also help control the rate of development, growth patterns and conserve open space throughout the community. Land use plans examine the relationship between land uses and other areas of interest including quality-of-life, transportation, recreation, infrastructure and natural resource protection (Jolley, 2003).

Population Growth and Changes in Land Use

The Savannah River basin encompasses all or portions of four counties and one municipality. In 2000, the overall population in the basin (based on the percent of the county land area in the basin) was 11,482. The most populated areas are located in and around Highlands.

Savannah River ***Basin Statistics***
(North Carolina Portion)

Total Area: 172 sq. miles
Freshwater Stream Miles: 176.2 mi
No. of Counties: 4
No. of Municipalities: 1
No. of Subbasins: 2
Population (2000): 11,482*
Pop. Density (2000): 67 persons/sq. mile*

Water Quality Statistics

Aquatic Life
Percent Monitored Streams: 24.4% mi/79.4% ac
Percent Supporting: 24.1% mi
Percent Impaired: 0%

Recreation
Percent Monitored Streams: 2%
Percent Supporting: 2%
Percent Impaired: 0%

* Estimated based on % of county land area that is partially or entirely within the basin, not the entire county population.

Once one of the most remote and sparsely populated regions of the state, western North Carolina is now penetrated by modern interstates and highways that provide speedy access to the deepest folds of the rugged terrain. This improved access coupled with an abundance of recreational opportunities, cultural activities, and countless other amenities sets the stage for rapid population increases. With this growth comes increased pressure on the natural environment. Every person living in or visiting a watershed contributes to impacts on water quality. If water pollution is to be eliminated, each individual should be aware of these contributions and take actions to reduce them.

Between 1990 and 2000, county populations increased by over 18,000 people. The fastest growing county was Macon (21.2 percent increase), followed by Jackson (19.0 percent increase). County populations are expected to grow by another 27,000 people (21.2 percent) by 2020. This would result in a total population of over 128,000 people in the four counties partially or entirely contained within the Savannah River basin. Population growth trends and the accompanying impacts to water quality are discussed in Chapters 4 and 5.

Population growth results in dramatic impacts on the natural landscape. The most obvious impact is the expansion of urban and suburban areas. New stores, roads, and subdivisions are products of growing populations. What is not so obvious is the astonishing rate at which rural landscapes are converted to developed land. Between 1982 and 1997, the United States population increased by 15 percent. Over the same period, developed land increased by 34 percent – more than double the rate of population growth (NRI, 2001; U.S. Census Bureau, 2000). Locally, the trend can be even more pronounced. For example, the urban area of Charleston, SC expanded 250 percent between 1973 and 1994 while its population grew by 40 percent (Allen and Lu, 2000). Based on the current land cover information provided by the National Resources Inventory (USDA-NRCS, 2001), there was a 100 percent (2,300 acres) decrease in pasture land in the Savannah River basin from 1982 to 1997. Forestry also decreased

by nearly 100 acres (27.7 percent). Urban and built-up areas increased by 2,300 acres (27.7 percent). Land use cover tables and statistics are included in Appendix III.

Growing populations not only require more water, but they also lead to the discharge and runoff of greater quantities of waste and pollutants into the state's streams and groundwater. The impacts on rivers, lakes, and streams can be significant and permanent if stormwater runoff is not controlled. Thus, just as demand and use increases, some of the potential water supply is lost (Orr and Stuart, 2000).

Impacts from Stormwater Runoff

Stormwater runoff is rainfall or snowmelt that runs off the ground or impervious surfaces (e.g., buildings, roads, parking lots, etc.) instead of absorbing into the soil. In some cases, stormwater runoff drains directly into streams, rivers, lakes, and oceans. In other cases, particularly urbanized areas, stormwater drains into streets and manmade drainage systems consisting of inlets and underground pipes, commonly referred to as a storm sewer system. Stormwater runoff is a primary carrier of nonpoint source pollution in both urbanized and rural areas. The impact of stormwater runoff is particularly severe in developing areas where recently graded lands are highly susceptible to erosion. Water quality impacts are also evident in urbanized areas where stormwater runoff is increased by impervious surfaces and is rapidly channeled through ditches or curb and gutter systems into nearby streams. For more information on stormwater as it relates to growth and development, refer to Chapter 5.

There are several different stormwater programs administered by DWQ. One or more of these programs may affect communities in the Savannah River basin. The goal of DWQ stormwater discharge permitting regulations and programs is to prevent pollution from entering the waters of the state via stormwater runoff. These programs try to accomplish this goal by controlling the source(s) of pollution. For more information on statewide stormwater programs, refer to Chapter 6.

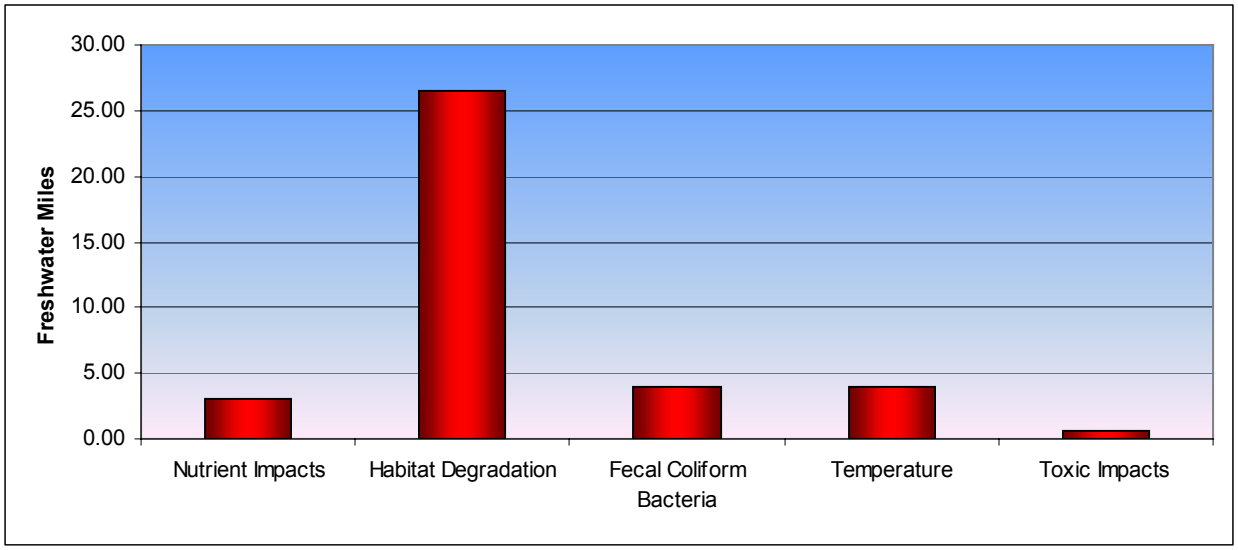
Septic Systems and Straight Pipes

In the Savannah River basin, wastewater from many households is not treated at a wastewater treatment plant (WWTP). Instead, it is treated on-site through the use of permitted septic systems. However, wastewater from some homes illegally discharges directly into streams through what is known as a "straight pipe". In some cases, wastewater can also enter streams through failing septic systems. In highly susceptible areas, wastewater from failing septic systems or straight pipes can contaminate a drinking water supply or recreational waters with nutrients, disease pathogens (such as fecal coliform bacteria), and endocrine disturbing chemicals. More information on DWQ wastewater programs can be found in Chapter 6.

Water Quality Stressors

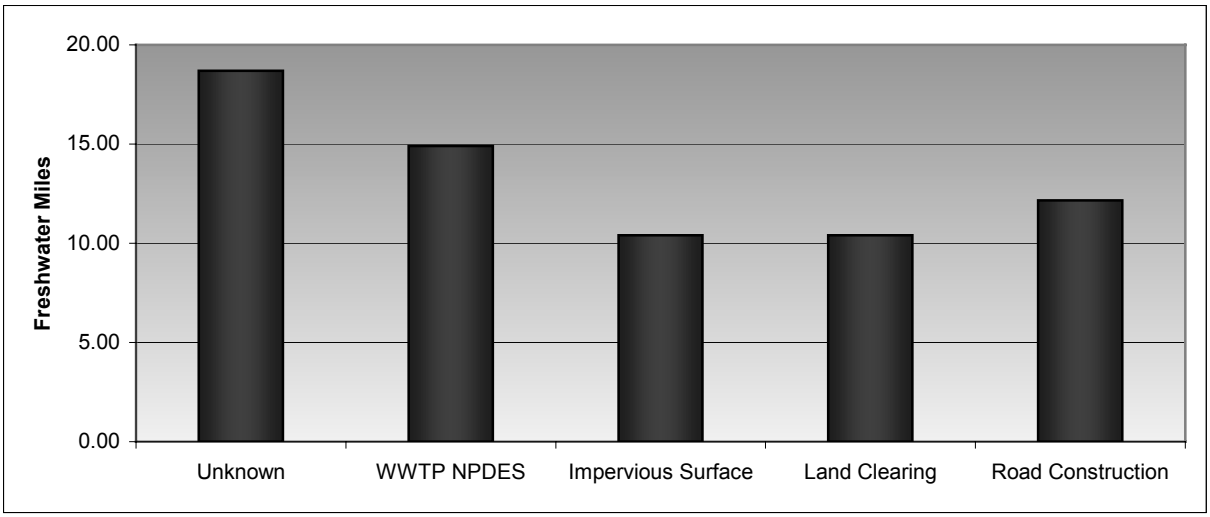
Water quality stressors are identified when impacts have been noted to biological (fish and benthic) communities or water quality standards have been violated. Whenever possible, water quality stressors are identified for Impaired waters as well as waters with notable impacts (Figures *i* & *ii*)

Figure *i* Stressors Identified for Streams with Noted Impacts



One of the most noted water quality stressors is instream habitat degradation. Instream habitat degradation is identified where there is a notable reduction in habitat diversity or a negative change in habitat. Sedimentation, streambank erosion, channelization, lack of riparian vegetation, loss of pools or riffles, loss of woody habitat, and streambed scour are all associated with habitat degradation. These stressors are typically a result of increased flow of stormwater runoff due to land use changes or to sediment runoff from land-disturbing activities. Streams with noted habitat degradation are discussed in the subbasin chapters (Chapters 1-2).

Figure *ii* Sources of Stressors Identified in the Savannah River Basin



Other chemical and biological factors can also impact water quality. These include excess algal growth, low dissolved oxygen, nitrogen and phosphorus levels, pH, and fecal coliform bacteria. Chapter 4 provides definitions and recommendations for reducing impacts associated with physical, chemical, and biological factors.

Local Involvement
DWQ is aware of only limited local activity in the Savannah River basin. Citizens should organize themselves to protect the resources most important to them. Local organizations and agencies are able to combine professional expertise and local knowledge not present at the state and federal level. This allows groups to holistically understand the challenges and opportunities of local water quality concerns. Involving a wide array of people in water quality projects also brings together a range of knowledge and interests and encourages others to become involved and invested in these projects. Working in cooperation across jurisdictional boundaries and agency lines opens the door to additional funding opportunities and eases the difficulty of generating matching or leveraged funds. This could potentially allow local entities to do more work and be involved in more activities because funding sources are diversified. The most important aspect of these local endeavors is that the more localized the project, the better the chances for success. Chapter 11 examines the importance of local, state, and federal initiatives.

The collaboration of local efforts is key to water quality improvements. DWQ is not aware of many local water quality initiatives in the Savannah Basin. DWQ encourages concerned citizens to get involved in resource protection.

Water Quality Standards and Classifications
Throughout the Savannah River basin, water quality is generally good and even excellent. Chapter 3 discusses water quality standards and classifications and includes maps showing the designated Water Supply (WS) watersheds, High Quality Waters (HQW), and Outstanding Resource Waters (ORW).

In the Savannah River basin, communities are being pressured to expand. This often involves construction and/or development in areas of pristine waters along several tributaries of the Horsepasture and Toxaway Rivers. HQW and ORW are supplemental classifications to the primary freshwater classification placed on a waterbody. Special management strategies are often associated with the supplemental HQW and ORW classification and are intended to prevent degradation of water quality below present levels from point and nonpoint sources of pollution. A brief summary of these strategies and the administrative code under which the strategies are found are included in Chapter 3.

Agriculture and Water Quality
Excess nutrient loading, pesticide and/or herbicide contamination, bacterial contamination, and sedimentation are often associated with agricultural activities, and all can impact water quality. Chapter 7 provides information related to the limited agricultural activities in the Savannah River basin and also identifies funding opportunities for best management practices (BMP). There were no North Carolina Agricultural Cost Share Program (NCACSP) projects in the basin during this assessment period.

Forestry and Water Quality
Based on land cover information provided by the North Carolina Corporate Geographic Database (CGIA) and the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 93 percent (44,500 acres) of land in the Savannah River basin consists of forestland. There were 10.4 streams miles (3b) that were noted or identified by stressors associated with land clearing or forestry activities. Where forest harvesting is identified as a source of water quality impact, DWQ will notify the Division of Forest Resources to investigate for potential

violations and the enforcement of management strategies. Chapter 8 presents more information related to the impacts of forestry on water quality.

Water Resources

Chapter 9 presents information related to minimum streamflow requirements, interbasin transfers, and the impact to water quality during drought conditions. The chapter also includes the federal cataloging units, or hydrologic units, as they relate to the state subbasin boundaries.

Natural Resources

Although small in total area compared to most of North Carolina's river basins, the Savannah River basin is one of the most ecologically diverse landscapes in the southeastern Appalachians and North Carolina. The region is located where the steep eastern face of the Blue Ridge turns and faces south, and with its relatively warm and extremely wet climate (up to 90 inches of rainfall a year), creates a unique setting within the Blue Ridge. A total of 87 rare plant species are known to exist among a diversity of habitats that include spray zones of waterfalls, rock faces of outcrops and overhanging crags and cliffs, and rich coves and other forest communities.

Chapter 10 presents information related to the ecological significance of the basin and identifies endangered and threatened species, significant natural areas and aquatic habitats, and public lands that are locally significant.

Figure iii General Map of the Entire Savannah River Basin

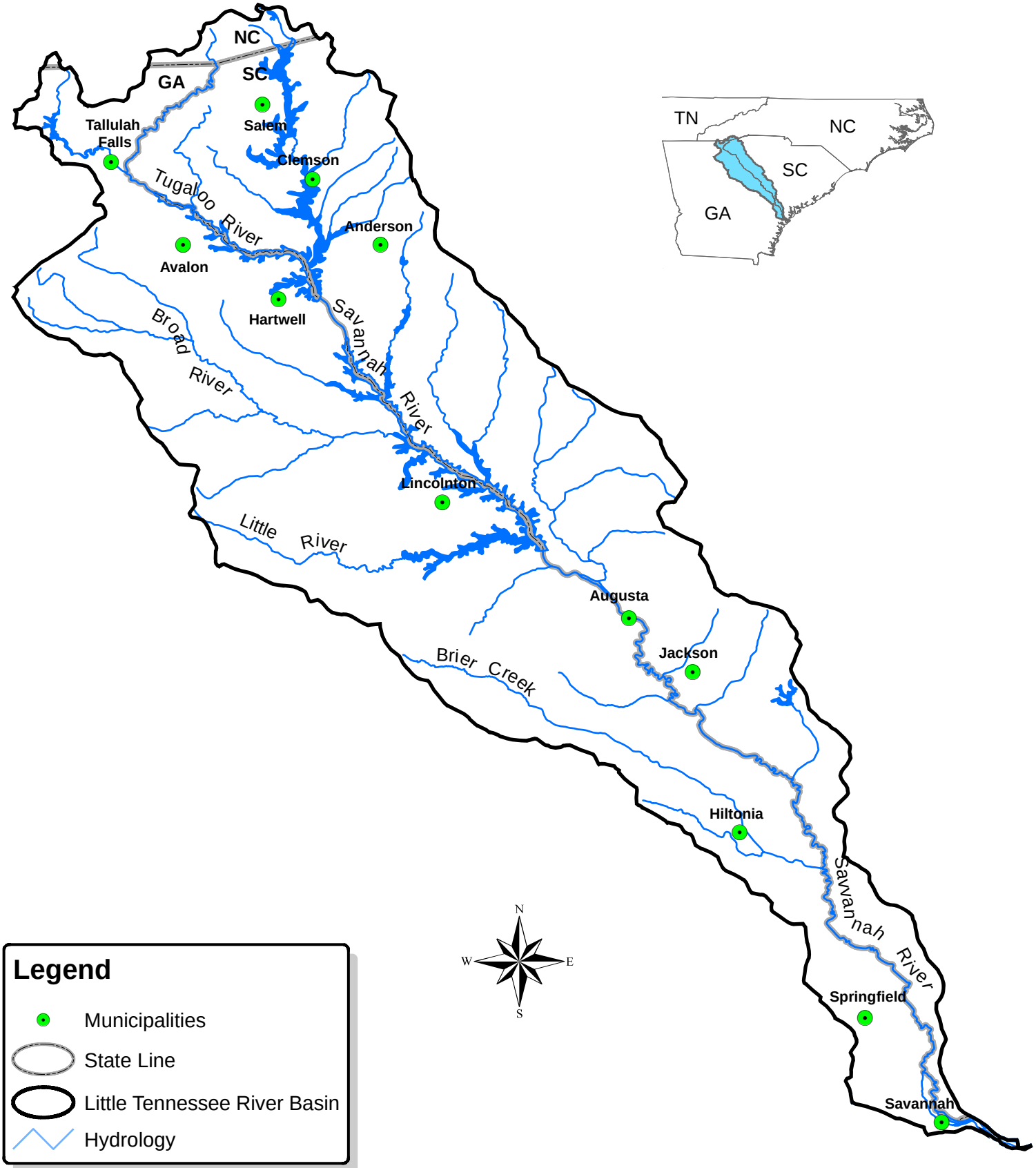
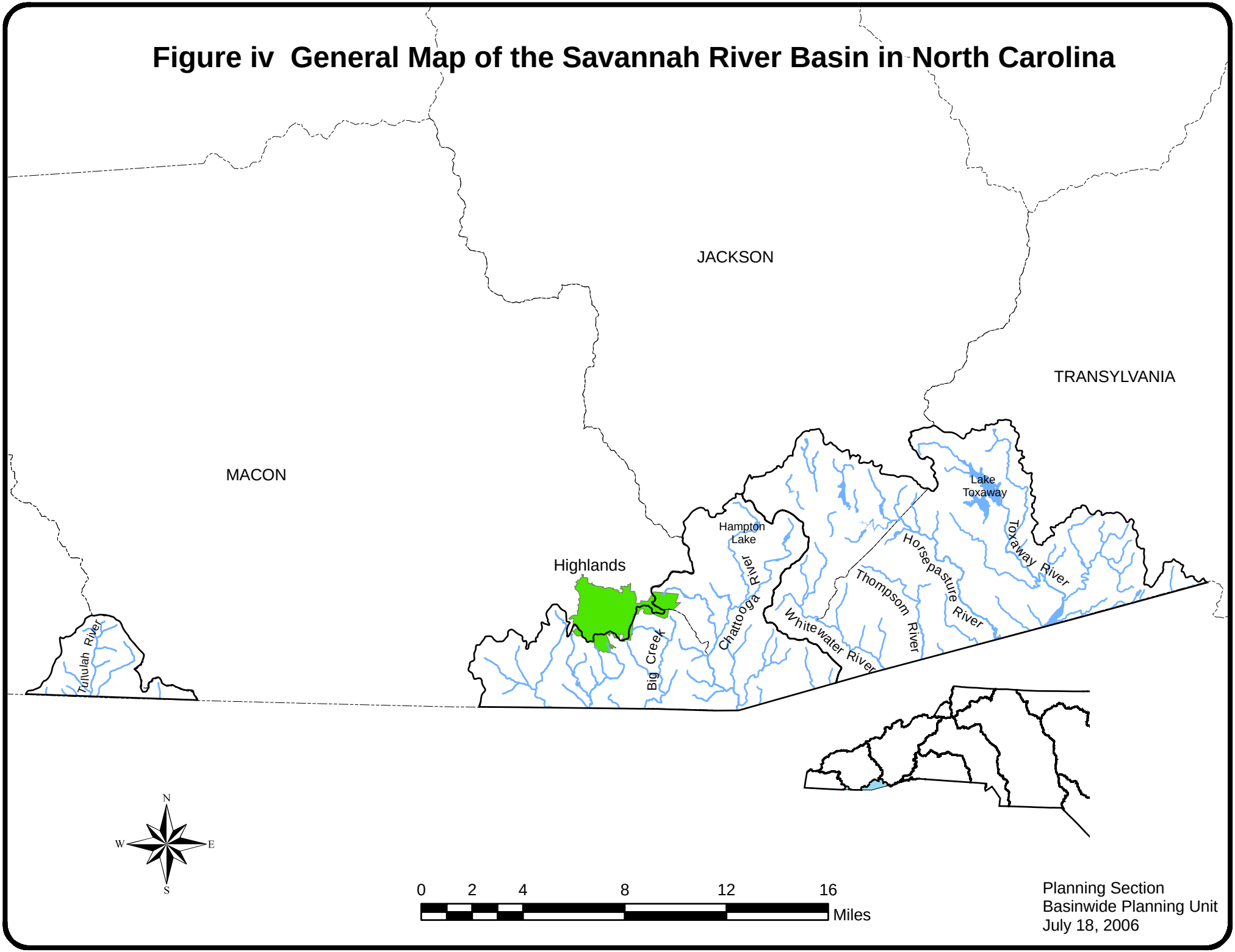


Figure iv General Map of the Savannah River Basin in North Carolina



Planning Section
Basinwide Planning Unit
July 18, 2006

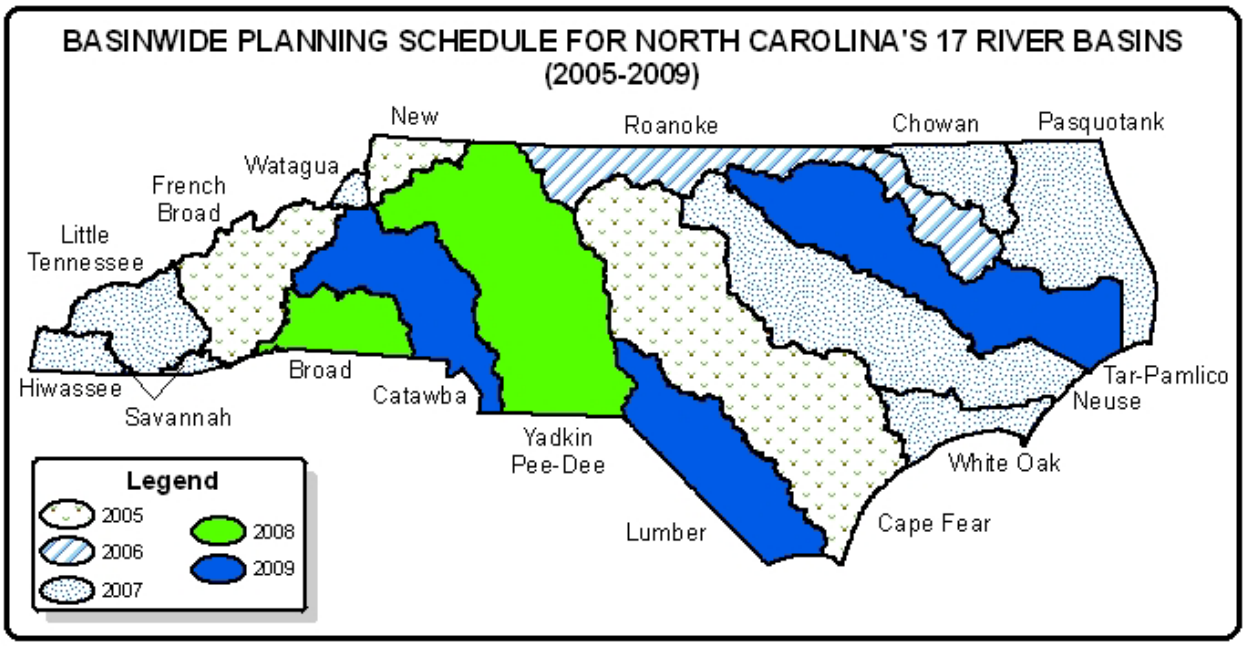
Introduction

What is Basinwide Water Quality Planning?

Basinwide water quality planning is a watershed-based approach to restoring and protecting the quality of North Carolina's surface waters. The NC Division of Water Quality (DWQ) prepares Basinwide water quality plans for each of the 17 major river basins in the state (Figure 1 and Table 1). Preparation of a basinwide water quality plan is a five-year process, which is broken down into three phases (Table 2).

While these plans are prepared by DWQ, their implementation and the protection of water quality entail the coordinated efforts of many agencies, local governments and stakeholder groups throughout the state. The first cycle of plans was completed in 1998. Each plan is updated at five-year intervals.

Figure 1 Basinwide Planning Schedule (2005 to 2009)



Goals of Basinwide Water Quality Planning

The goals of basinwide planning are to:

- Identify water quality problems and restore full use to Impaired waters.
- Identify and protect high value resource waters.
- Protect unimpaired waters yet allow for reasonable economic growth.

DWQ accomplishes these goals through the following objectives:

- Collaborate with other agencies to develop appropriate management strategies. This includes providing agencies information related to financial and funding opportunities.
- Assure equitable distribution of waste assimilative capacity.
- Evaluate cumulative effects of pollution.
- Improve public awareness and involvement.
- Regulate point and nonpoint sources of pollution where other approaches are not successful.

Benefits of Basinwide Water Quality Planning

Basinwide planning and management benefits water quality by:

- Focusing resources on one river basin at a time.
- Using sound ecological planning and fostering comprehensive NPDES permitting by working on a watershed scale.
- Ensuring better consistency and equitability by clearly defining the program's long-term goals and approaches regarding permits and water quality improvement strategies.
- Fostering public participation to increase involvement and awareness about water quality.
- Integrating and coordinating programs and agencies to improve implementation of point and nonpoint source pollution reduction strategies.

How You Can Get Involved

To assure that basinwide plans are accurately written and effectively implemented, it is important for citizens and local stakeholders to participate in all phases of the planning process. You may contact the basinwide planner responsible for your basin anytime during the plan's development. Upon request, the basin planner can also present water quality information and basin concerns to local stakeholder groups.

To make the plan more inclusive, DWQ is coordinating with the local Soil and Water Conservation Districts (SWCD), council of governments, NC Cooperative Extension Service, the county Natural Resources Conservation Service (NRCS), and stakeholder groups to develop language and identify water quality concerns throughout the basin. Citizens and local communities can also be involved during the planning process by contacting their county extension service or local SWCD.

During the public comment period, the draft plan is available online and by request for a period of at least 30 days. DWQ welcomes written comments and questions during this phase of the planning process and will incorporate comments and suggestions when appropriate.

Division of Water Quality Functions and Locations

For more information on the basinwide planning process, DWQ activities, or contacts, visit http://h2o.enr.state.nc.us/basinwide/ or call (919) 733-5083 and ask for the basin planner responsible for your basin of interest. You can also contact the appropriate Regional Office (Figure 2) for additional information. For general questions about the Department of Environment and Natural Resources, contact the Customer Service Center at 1-877-623-6748.

Table 1 Basinwide Planning Schedule (2004 to 2011)

Basin	DWQ Biological Data Collection	Draft Out For Public Review	Final Plan Receives EMC Approval	Begin NPDES Permit Issuance
Chowan	Summer 2005	7/2007	9/2007	11/2007
Pasquotank	Summer 2005	7/2007	9/2007	12/2007
Neuse	Summer 2005	9/2007	11/2007	1/2008
Broad	Summer 2005	1/2008	3/2008	7/2008
Yadkin-Pee Dee	Summer 2006	3/2008	5/2008	9/2008
Lumber	Summer 2006	1/2009	3/2009	7/2009
Tar-Pamlico	Summer 2007	5/2009	7/2009	9/2009
Catawba	Summer 2007	7/2009	9/2009	12/2009
French Broad	Summer 2007	3/2010	4/2010	7/2010
New	Summer 2008	8/2010	11/2010	1/2011
Cape Fear	Summer 2008	9/2010	11/2010	2/2011
Roanoke	Summer 2004	7/2006	9/2006	1/2007
White Oak	Summer 2004	3/2007	5/2007	6/2007
Savannah	Summer 2004	1/2007	3/2007	8/2007
Watauga	Summer 2004	11/2006	1/2007	9/2007
Hiwassee	Summer 2004	1/2007	3/2007	8/2007
Little Tennessee	Summer 2004	1/2007	3/2007	10/2007

Note: A basinwide plan was completed for all 17 basins during the second cycle (1998 to 2003).

Table 2 Five-Year Planning Process for Development of an Individual Basinwide Plan

Years 1 – 2 **Water Quality Data Collection and Identification of Goals and Issues**	• Identify sampling needs • Conduct biological monitoring activities • Conduct special studies and other water quality sampling activities • Coordinate with local stakeholders and other agencies to continue to implement goals within current basinwide plan
Years 2 – 3 **Data Analysis and Collect Information from State and Local Agencies**	• Gather and analyze data from sampling activities • Develop use support ratings • Conduct special studies and other water quality sampling activities • Work with state and local agencies to establish goals and objectives • Identify and prioritize issues for the next basin cycle • Develop preliminary pollution control strategies • Coordinate with local stakeholders and other state/local agencies
Years 3 – 5 **Preparation of Draft Basinwide Plan, Public Review, Approval of Plan, Issue NPDES Permits, and Begin Implementation of Plan**	• Develop draft basinwide plan based on water quality data, use support ratings, and recommended pollution control strategies • Circulate draft basinwide plan for review and present draft plan for public review • Revise plan (when appropriate) to reflect public comments • Submit plan to Environmental Management Commission for approval • Issue NPDES permits • Coordinate with other agencies and local interest groups to prioritize implementation actions • Conduct special studies and other water quality sampling activities

Some Other Reference Materials

There are several reference documents and websites that provide additional information about basinwide planning and the basin's water quality. These include:

- *Supplemental Guide To North Carolina's Basinwide Planning* (January 2007) This document includes general information about water quality issues and programs to address these issues. It is intended to be an informational document on water quality. Visit the website at http://h2o.enr.state.nc.us/basinwide/SupplementalGuide.htm to download this document.
- *Basinwide Assessment Report Savannah River Basin* (April 2005). This technical report presents physical, chemical, and biological data collected in the Savannah basin. This report can be found on the DWQ Environmental Sciences Section (ESS) website at http://www.esb.enr.state.nc.us/.
- *Savannah River Basinwide Water Quality Management Plan* (May 1997; March 2002). These first basinwide plans for the Savannah River basin present water quality data, information, and recommended management strategies for the first two five-year cycles.
- *North Carolina's Basinwide Approach to Water Quality Management: Program Description* (Creager, C.S. and J.P. Baker, 1991). NC DWQ Water Quality Section. Raleigh, NC.

How to Read the Basinwide Plan

Chapters 1 - 2: Subbasin and Watershed Information

- **Summarizes information and data by subbasin, including:**
  - **Recommendations from the previous basin plan.**
  - **Achievements, current priority issues and concerns.**
  - **Impaired waters and water with notable impacts.**
  - **Goals and recommendations for the next five years by subbasin.**

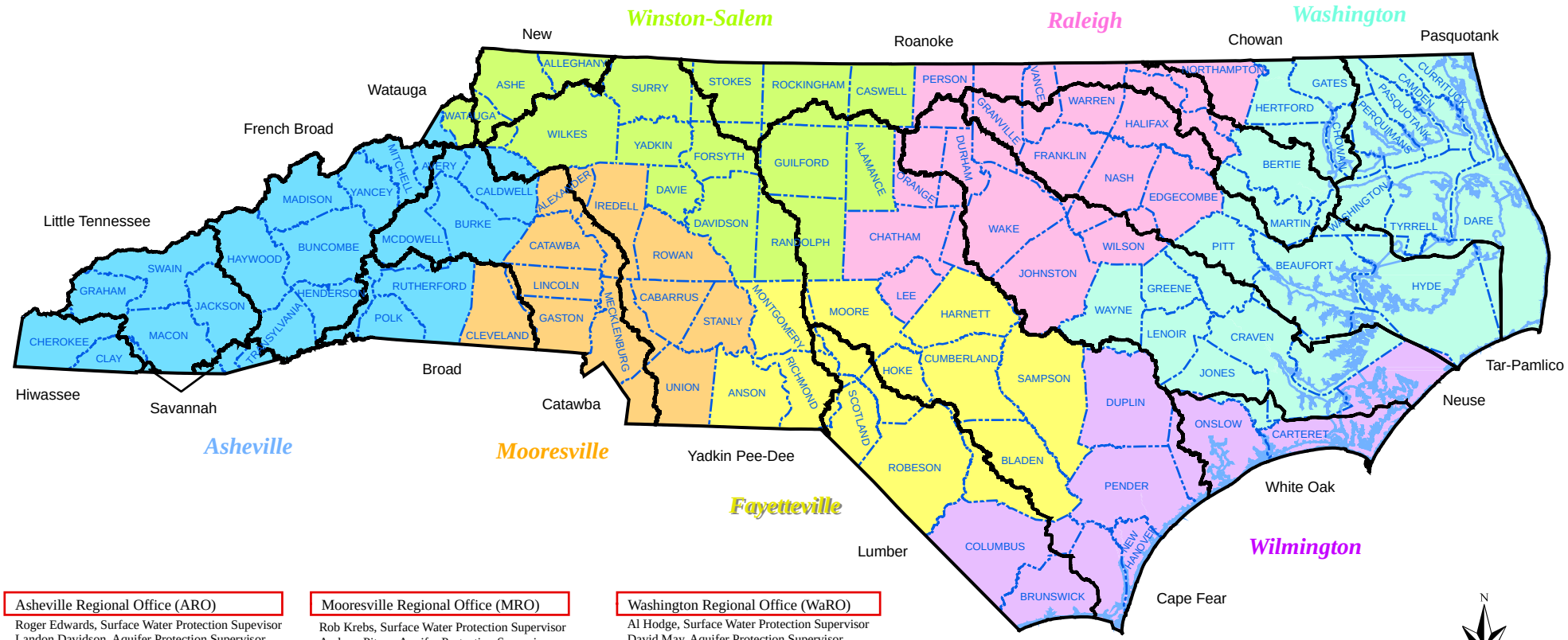
Chapter 3 – 11

- **Presents information on various topics of interest to the protection and restoration of water quality in the basin, including:**
  - **Stream classifications.**
  - **Population and land cover changes.**
  - **Water Quality stressors.**
  - **Agricultural, forestry and permitting activities in the basin.**
  - **Water and natural resources.**
  - **Local initiatives.**

Appendices

- **Population and land use changes over time and local governments in the basin.**
- **Water quality data collected by DWQ, use support methodology and 303(d) listing.**
- **NPDES dischargers and general stormwater permits.**
- **Points of contact, and a glossary of terms and acronyms.**

North Carolina Department of Environment and Natural Resources
Division of Water Quality Regional Offices



Asheville Regional Office (ARO)

Roger Edwards, Surface Water Protection Supevisor
Landon Davidson, Aquifer Protection Supervisor
2090 US Highway 70
Swannanoa, NC 28778
COURIER 12-59-01
Phone: (828) 296-4500
Fax: (828) 299-7043

Avery	Haywood	Polk
Buncombe	Henderson	Rutherford
Burke	Jackson	Swain
Caldwell	Macon	Transylvania
Cherokee	Madison	Yancey
Clay	McDowell	
Graham	Mitchell	

Mooresville Regional Office (MRO)

Rob Krebs, Surface Water Protection Supervisor
Andrew Pitner, Aquifer Protection Supervisor
610 East Center Avenue / Suite 301
Mooresville, NC 28115
COURIER 09-08-06
Phone: (704) 663-1699
Fax: (704) 663-6040

Alexander	Lincoln
Cabarrus	Mecklenburg
Catawba	Rowan
Cleveland	Stanly
Gaston	Union
Iredell	

Washington Regional Office (WaRO)

Al Hodge, Surface Water Protection Supervisor
David May, Aquifer Protection Supervisor
943 Washington Square Mall
Washington, NC 27889
COURIER 16-04-01
Phone: (252) 946-6481
Fax: (252) 946-9215
Fax: (252) 975-3716

Beaufort	Gates	Pamlico
Bertie	Greene	Pasquotank
Camden	Hertford	Perquimans
Chowan	Hyde	Pitt
Craven	Jones	Tyrrell
Currituck	Lenoir	Washington
Dare	Martin	Wayne

Winston-Salem Regional Office (WSRO)

Steve Tedder, Surface Water Protection Supervisor
Sherri Knight, Aquifer Protection Supervisor
585 Waughtown Street
Winston-Salem, NC 27107
COURIER 13-15-01
Phone: (336) 771-5000
Fax: (336) 771-4631

Alamance	Forsyth	Watauga
Alleghany	Guilford	Wilkes
Ashe	Randolph	Yadkin
Caswell	Rockingham	
Davidson	Stokes	
Davie	Surry	

Fayetteville Regional Office (FRO)

Belinda Henson, Surface Water Protection Supervisor
Art Barnhardt, Aquifer Protection Supervisor
225 Green Street
Systel Building Suite 714
Fayetteville, NC 28301-5043
COURIER 14-56-25
Phone: (910) 433-3300
Fax: (910) 486-0707

Anson	Moore
Bladen	Richmond
Cumberland	Robeson
Harnett	Sampson
Hoke	Scotland
Montgomery	

Raleigh Regional Office (RRO)

Chuck Wakild, Surface Water Protection Supervisor
Jay Zimmerman, Aquifer Protection Supervisor
3800 Barrett Drive
Raleigh, NC 27609
COURIER 52-01-00
Phone: (919) 791-4200
Fax: (919) 571-4718

Chatham	Johnston	Vance
Durham	Lee	Wake
Edgecombe	Nash	Warren
Franklin	Northampton	Wilson
Granville	Orange	
Halifax	Person	

Wilmington Regional Office (WiRO)

Ed Beck, Surface Water Protection Supervisor
Charlie Stehman, Aquifer Protection Supervisor
127 Cardinal Drive Extension
Wilmington, NC 28405-2845
COURIER 04-16-33
Phone: (910) 796-7215
Fax: (910) 350-2004

Brunswick	New Hanover
Carteret	Onslow
Columbus	Pender
Duplin	

Central Office

DENR
DIVISION OF WATER QUALITY
1617 MAIL SERVICE CENTER
RALEIGH NC 27699-1617
COURIER 52-01-00
Phone: (919) 733-7015
Fax: (919) 733-2496

NCDENR

Planning Section
Basinwide Planning Unit
January 2007

Chapter 1
Savannah River Subbasin 03-13-01
Including: Tahlullah and Chattooga Rivers

1.1 Subbasin Overview

Subbasin 03-13-01 at a Glance

Land and Water Area

Total area:	72 mi²
Land area:	71mi²
Water area:	<1 mi²

Population (County)

2000 Est. Pop:	4,215 people
Pop. Density:	59 persons/mi²

Land Cover (percent)

Forest/Wetland:	96.8%
Water:	0.6%
Urban:	0.4%
Cultivated Crop:	0.1%
Pasture/ Managed Herbaceous:	2.1%

Counties
Clay, Jackson, Macon

Municipalities
Cashiers, Highlands

Monitored Streams Statistics
Aquatic Life

Total Streams:	87.4 mi
Total Supporting:	18.1 mi
Total Impaired:	0.0 mi
Total Not Rated:	68.7 mi

Recreation

Total Streams:	0 mi/0 ac

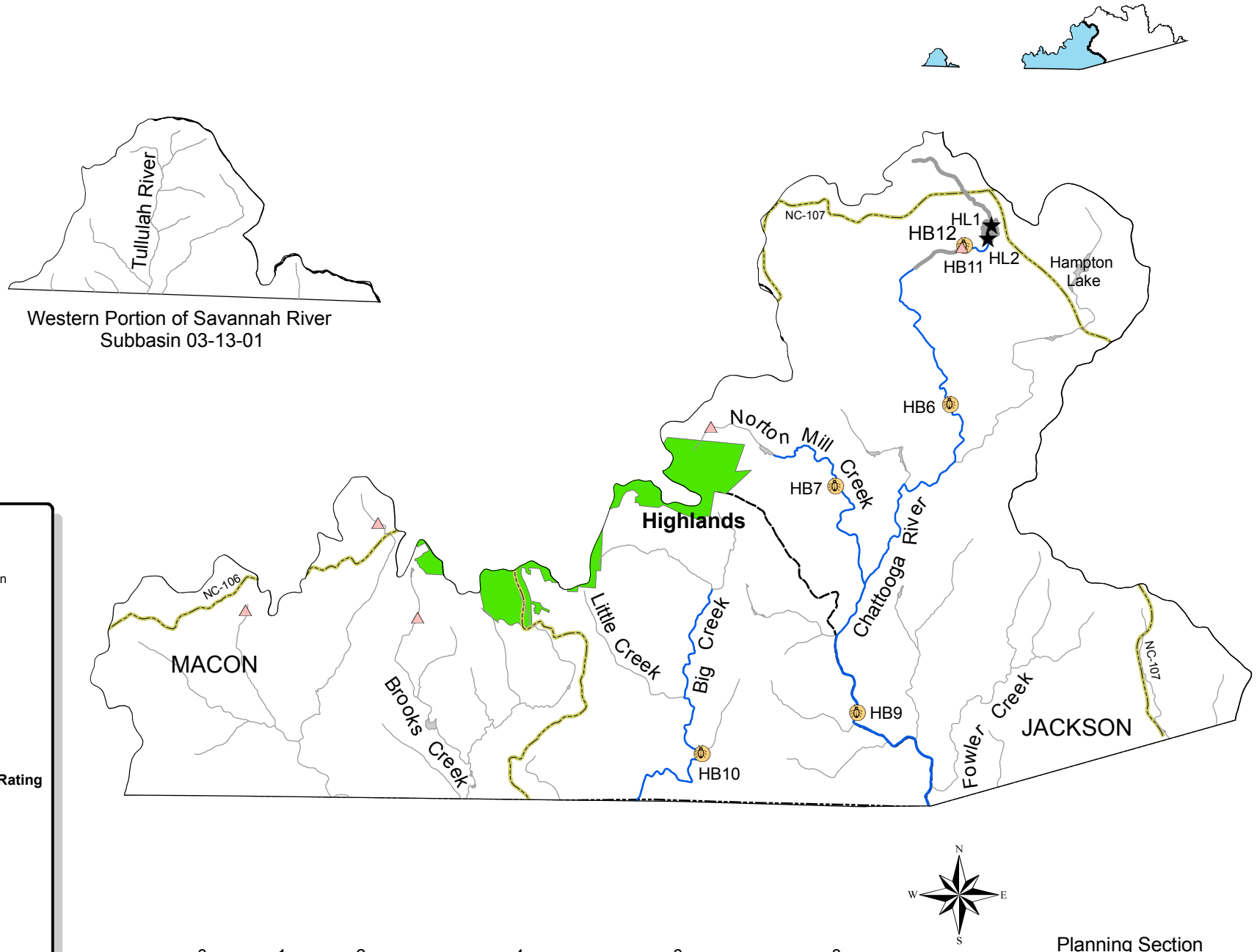
This mountainous subbasin is divided into two pieces: a small portion of the Tullulah River headwaters in Clay County and a larger portion of the basin that includes the Chattooga River, Norton Mill, Big, Clear and Overflow Creeks. The majority of streams in this subbasin flow generally south toward Georgia. The Chattooga River forms part of the state boundary between Georgia and South Carolina. The Chattooga and Tullulah Rivers join to form the Tugaloo River in Georgia. A map of this subbasin including water quality sampling locations is presented as Figure 3.

This subbasin lies within the level IV ecoregion of the Southern Crystalline Ridges and Mountains. This ecoregion is characterized by elevations ranging between 1,200 and 4,500 feet, high rainfall rates, abundant forest cover, and acidic, loamy, well-drained soils (Griffith *et al* 2002). As would be expected for an area with rugged topography, most of the land within this subbasin is forested (96.8 percent) and lies within the Nantahala National Forest and includes the Southern Nantahala Wilderness and the Ellicott Rock Wilderness areas. Notable exceptions include the urbanizing areas in and around the Town of Highlands and the Cashiers community. Residential development is increasing rapidly around theses communities and along primary roadways.

There are five NPDES dischargers in this subbasin; two are required to perform whole effluent toxicity testing. The Cashiers WWTP (NC0063321, 0.1 MGD) discharges to an unnamed tributary of the Chattooga River and has had three toxicity violations since 2001. The Mountain (formerly Highlands Camp and Conference Center) facility (NC0061123, MGD .006) discharges to Abes Creek and has had seven toxicity violations since 2000.

A map including the locations of the NPDES facilities and water quality monitoring stations is presented in Figure 3. Table 3 contains a summary of assessment unit numbers (AU#) and lengths, streams monitored, monitoring data types, locations and results, along with use support ratings for waters in the subbasin. Refer to Appendix VIII for more information about use support methodology.

Figure 3 Savannah River Subbasin 03-13-01



Planning Section
Basinwide Planning Unit
July 18, 2006

Table 3 Savannah Subbasin 03-13-01

AU Number	Classification	Length/Area	Description	Aquatic Life Assessment					Recreation Assessment			Stressors	Sources
				AL Rating	Station	Result	Year/ Parameter	% Exc	REC Rating	Station	Result		
Big Creek													
3-10-3	C Tr ORW	4.1 FW Miles	From source to North Carolina-Georgia State Line	**S**	HB10	E	2004		ND				
CHATTOOGA RIVER													
3a2	B Tr ORW	0.5 FW Miles	From dam at Cashiers Lake to Cashiers WWTP	**S**	HB11	NI	2001		ND				
3a3	B Tr ORW	0.6 FW Miles	From Cashiers WWTP to Ut below Cashiers Lake at the base of Timber Ridge	**NR**	HB12	NR	2001		ND			Toxic Impacts	WWTP NPDES
3b	B Tr ORW	10.4 FW Miles	From Ut below Cashiers Lake at the base of Timber Ridge to North Carolina-Georgia State Line	**S**	HB9	E	2004		ND			Habitat Degradation	Land Clearing
					HB9	E	2004					Habitat Degradation	Road Construction
					HB6	E	2004					Habitat Degradation	Impervious Surface
												Habitat Degradation	WWTP NPDES
CHATTOOGA RIVER (Cashiers Lake)													
3a1	B Tr ORW	23.7 FW Acres	From source to dam at Cashiers Lake	**NR**	HL1	ID			ND			Sediment	Unknown
					HL2	ID							
Norton Mill Creek													
3-3b	C Tr +	3.1 FW Miles	From dam at Camelot Lake to Chattooga River	**S**	HB7	G	2004		ND			Nutrient Impacts	Unknown

Table 3 Savannah Subbasin 03-13-01

AU Number / Description	Classification	Length/Area	Aquatic Life Assessment					Recreation Assessment				
			AL Rating	Station	Result	Year/ Parameter	% Exc	REC Rating	Station	Result	Stressors	Sources

Use Categories:
AL - Aquatic Life
REC - Recreation

Monitoring data type:
HF - Fish Community Survey
HB - Benthic Community Survey
HA - Ambient Monitoring Site
HL- Lake Monitoring

Results:
E - Excellent
G - Good
GF - Good-Fair
F - Fair
P - Poor
NI - Not Impaired

Use Support Ratings 2006:
S - Supporting, I - Impaired
NR - Not Rated
NR*- Not Rated for Recreation (screening criteria exceeded)
ND-No Data Collected to make assessment

Miles/Acres
FW- Fresh Water

m- Monitored
e- Evaluated

Results
CE-Criteria Exceeded > 10% and more than 10 samples
NCE-No Criteria Exceeded
ID- Insufficeint Data Available

Aquatic Life Rating Summary

S	m	18.1	FW Miles
NR	m	0.6	FW Miles
NR	m	23.7	FW Acres
ND		68.7	FW Miles
ND		17.0	FW Acres

Recreation Rating Summary

ND		87.4	FW Miles
ND		40.7	FW Acres

Fish Consumption Rating Summary

I	e	87.4	FW Miles
I	e	40.7	FW Acres

There were 4 benthic macroinvertebrate community samples collected during this assessment period. All streams sampled for benthic macroinvertebrates were classified using mountain criteria. Based on benthic macroinvertebrate data, two sites on the Chattooga River were Excellent and Big Creek maintained the Excellent bioclassifications generated from the 1999 basinwide sampling period. Norton Mill Creek declined in bioclassification from Excellent in 1999, to Good in 2004. There are no ambient monitoring locations in this subbasin. Refer to the *2005 Basinwide Assessment Report Savannah River Basin* at http://h2o.enr.state.nc.us/esb/Basinwide/SAV2005.pdf and Appendix IV for more information on monitoring.

Waters in the following sections and in Table 3 are identified by an assessment unit number (AU#). This number is used to track defined segments in the water quality assessment database, list 303(d) Impaired waters, and is used to identify waters throughout the basin plan. The AU# is a subset of the DWQ index number (classification identification number). A letter attached to the end of the AU# indicates that the assessment is smaller than the DWQ index segment. No letter indicates that the AU# and the DWQ index segment are the same. For example, index number 11-3-(14) might be split into two assessment units 11-3-(14)a and 11-3-(14)b.

1.2 Use Support Assessment Summary

Table 4 Summary of Use Support Ratings by Category in Subbasin 03-13-01

Use Support Rating	Aquatic Life	Recreation
Monitored Waters		
Supporting	18.1 mi	0
Impaired*	0	0
Not Rated	0.6 mi 23.7 ac	0
Total	**18.7 mi** **23.7 ac**	**0**
Unmonitored Waters		
No Data	68.7 mi 17.0 ac	87.4 mi 40.7 ac
Total	**68.7 mi** **17.0 ac**	**87.4 mi** **40.7 ac**
Totals		
All Waters	**87.4 mi** **40.7 ac**	**87.4 mi** **40.7 ac**

** The noted percent Impaired is the percent of monitored miles/acres only.
* The noted percent Impaired is the percent of monitored miles/acres only.

All surface waters in the state are assigned a classification appropriate to the best-intended use of that water. Waters are regularly assessed by DWQ to determine how well they are meeting their best-intended use. For aquatic life, an Excellent, Good, Good-Fair, Fair, or Poor bioclassification are assigned to a stream based on the biological data collected by DWQ. For more information about bioclassification and use support assessment, refer to Appendices IV and VIII, respectively. Appendix IX provides definitions of the terms used throughout this basin plan.

In subbasin 03-13-01, use support was assigned for the aquatic life, recreation, fish consumption and water supply categories. Waters are Supporting, Impaired, Not Rated, and No Data in the aquatic life and recreation categories on a monitored or evaluated basis. Waters are Impaired in the fish consumption category on an evaluated basis based on fish consumption advice issued by the Department of Health and Human Services (DHHS). All waters are Supporting in the water supply category on an evaluated basis based on reports from Division of Environmental Health (DEH) regional water treatment plant consultants. Refer to Table 4 for a summary of use support for waters in subbasin 03-13-01.

1.3 Status and Recommendations of Previously and Newly Impaired Waters

No stream segments were rated impaired in the 2002 basin plan and none were rated as impaired based on recent DWQ monitoring in the current assessment period (1999-2004). Section 1.4 below discusses specific streams where water quality impacts have been observed.

1.4 Status and Recommendations for Waters with Noted Impacts

Based on DWQ's most recent use support methodologies, the surface waters discussed in this section are not Impaired. However, notable water quality problems and concerns were documented for these waters during this assessment. Attention and resources should be focused on these waters to prevent additional degradation and facilitate water quality improvements. DWQ will notify local agencies of these water quality concerns and work with them to conduct further assessments and to locate sources of water quality protection funding. Additionally, water quality education on local issues and voluntary actions are useful tools to prevent water quality problems and to promote restoration efforts. The current status and recommendations for addressing these waters are presented below, and each is identified by an AU#. Refer to Section 1.1 for more information about AU#. Nonpoint source program agency contacts are listed in Appendix VII.

1.4.1 Chattooga River Including Cashiers Lake [AU# 3a1, 3a2, 3a3, and 3b]

Current Status
The Chattooga River watershed is classified as Recreation, Trout, and Outstanding Resource Waters and is subject to the special management strategy described in Section 1.5.2. Four sites were sampled for benthic macroinvertebrates in the Chattooga River headwaters during this assessment period (HB6, HB9, HB11, & HB12). None of the results from these collections indicate the river is impaired, but they do indicate that nonpoint source runoff from the Cashiers Community and the discharge from the Cashiers WWTP are impacting water quality in the headwaters. The data also indicate these negative impacts are reduced as clean water entering the river from undisturbed watersheds dilutes the upstream pollution. Because the benthic community at site HB12 could not be rated due to its small size, assessment unit 3a3 (From Cashiers WWTP to UT below Cashiers Lake at the base of Timber Ridge) is Not Rated for aquatic life.

Tuckaseigee Water and Sewer Authority (TWSA) owns and operates the Cashiers WWTP. In 2001, DWQ evaluated benthic communities about 50 meters upstream (Site HB11) and downstream of the plant discharge (Site HB12). These two sites were compared directly to each other to evaluate the effects of the discharge. They were also compared to an unnamed tributary of Shortoff Creek in an undisturbed watershed to evaluate the impacts of development and Cashiers Lake. The study indicated the discharge, Cashiers Lake, and upstream development impact the Chattooga River benthic community. Habitat diversity was low at both sites; the substrates were primarily sand and gravel, and pools and riffles were infrequent. Some of these habitat deficiencies can be attributed to upstream development activities and Cashiers Lake. The benthic community below the discharge indicated a substantial impact from the WWTP. Benthic diversity and abundance dropped dramatically there, indicating slightly toxic conditions.

TWSA received authorization to expand their plant capacity to the maximum permitted flow of 200,000 gallons per day with the addition of another aeration basin and supplemental clarifiers. These devices will improve their treatment capability. At the time of this writing, the plant is still under construction. Once completed, the plant's monitoring requirements for ammonia and temperature will increase from twice per month to once per week.

Cashiers Lake is a small, shallow impoundment located in Jackson County, and was sampled at the request of the Asheville Regional Office. Regional staff expressed concerns related to suspended sediments. Despite sampling during rainy conditions, turbidity was not above the trout waters standard of 10 mg/l. On-going wind mixing due to the shallow nature of the lake probably contributes to the perceived sediment problem. A review of all parameters sampled indicated that other standards and assessment criteria are being met. However, the minimum ten samples necessary to assign a use support rating were not collected. Therefore, Cashiers Lake is Not Rated for aquatic life.

DWQ continues to implement an Outstanding Resource Water (ORW) Management Strategy for the Chattooga River watershed (Section 1.5.1).

2007 Recommendations
Toxicity issues that may remain at the Cashiers WWTP after the upgrade is complete will be captured by the increased monitoring requirements. DWQ will continue to provide technical assistance to the plant operators and/or take necessary enforcement action to bring the plant into compliance should any toxicity problems arise.

In the face of expanding residential communities and urbanization in the Cashiers area, nonpoint source pollution presents a far greater threat to water quality in the Chattooga River and Cashiers Lake than the impact of Cashiers WWTP. In order to protect water quality, development along the river and, more importantly, it's many tributaries must be conducted in an ecologically sound manner, with an emphasis on stormwater runoff management. Refer to Chapter 5 for information on how local governments can achieve effective stormwater control on existing and future development.

In addition to local government action, residents should take an active role in water quality management. Citizens are encouraged to report erosion problems and possible water quality violations to state and county authorities. A list of contacts is provided in Appendix VII. They should also work through their homeowner associations to encourage and establish appropriate stormwater controls in their communities. Citizens can also track changes in water quality by starting a volunteer monitoring program to supplement state water quality data. Interested citizens should contact the VWIN program at the University of Asheville for guidance on how to start such a program.

1.4.2 Norton Mill Creek [AU# 3-3b]

Current Status
Norton Mill Creek is a large tributary to the Chattooga River. This segment receives runoff associated with second home building from some of the fast growing residential areas near Highlands and Cashiers. DWQ sampled benthic macroinvertebrates at site HB7 in 2004. This site declined from Excellent to Good during the period between 1999 and 2004. The most obvious habitat problems were infrequent riffles, prevalence of sand, and disturbance of the

riparian zone. The types of benthic species collected in 2004 indicate the decline could be due to an increase in nutrient runoff from the watershed.

Fish and Wildlife Associates, Inc. performed a biological assessment of Norton Mill Creek and Camelot Lake in 2000. This study evaluated nutrient concentrations, sediment accumulation, and benthic populations at two sites in and above the lake. The study noted that sediment deposition had reduced the lake's depth to less than two feet at the dam (Boaze, 2001).

2007 Recommendations
The recommendations given for the Chattooga River regarding stormwater control (Section 1.4.1) also apply to Norton Mill Creek. Residential landowners along the creek can use a variety of techniques to reduce pollution caused by runoff from their property. Residents should refer to Section 5.2.3 and the document "Improving Water Quality in Your Own Backyard." This pamphlet is available free of charge through the Division of Water Quality Website. http://h2o.enr.state.nc.us/nps/documents/BackyardPDF.pdf. DWQ will continue to monitor this stream.

1.4.3 Abes Creek [AU# 3-10-2-2-2]

Current Status
Abes Creek is part of the Overflow Creek watershed and is classified Outstanding Resource Waters. The Mountain Retreat and Learning Center WWTP (NPDES Permit# NC0061123) is one of two dischargers in the watershed permitted before the ORW designation and management strategy were applied. This facility has struggled with toxicity problems since monitoring began in 1993. The 2002 basin plan described enforcement action taken by DWQ to bring the facility into compliance. The basin plan also noted that DWQ engineers would continue to provide technical assistance. For much of the current assessment period (1999-2004) toxicity was under control and the facility was compliant.

In 2004, toxicity problems resurfaced at The Mountain WWTP. Onsite inspection by DWQ staff indicated that the problems were due to sampling technique and ammonia concentrations. As a variable use facility, The Mountain WWTP does not discharge continuously. In order to collect effluent samples, a technician must manually pump out the system. In this condition, the facility is not functioning efficiently and can produce wildly varying sample results. The type of treatment technology used at this facility normally produces consistent ammonia readings. This leads DWQ to believe the inconsistent readings are due primarily to the way in which samples are collected.

2007 Recommendations
In the short term, DWQ suggests The Mountain review it's sampling methods to determine if they can be adjusted to better reflect the plant's operation. In the long term, The Mountain should consider switching to a non-discharge system (septic, drip-irrigation, low-pressure-pipe, etc). DWQ recognizes the difficulty non-profit organizations, such as The Mountain, face when trying to raise funds for facility improvements. DWQ will alert the facility operators to any assistance programs available for treatment plant upgrades. The Mountain may also be able to enter into a Special Order of Consent with DWQ that would reduce their fines for violation if they establish a suitable plan to upgrade their system.

1.5 Additional Water Quality Issues within Subbasin 03-13-01

The previous sections discussed water quality concerns for specific stream segments. The following section discusses issues that may threaten water quality in the subbasin that are not specific to particular streams, lakes, or reservoirs. The issues discussed may be related to waters near certain land use activities or within proximity to different pollution sources.

This section also discusses ideas, rules and practices in place to preserve and maintain the pristine waters of the Savannah River basin. In subbasins 03-13-01 and 03-13-02 (Chapter 2), this is particularly important since many of the waters are designated as high quality, outstanding resource, or trout waters (HQW, ORW, and Tr, respectively). Special management strategies, or rules, are in place to better manage the cumulative impact of pollutant discharges and residential development.

1.5.1 Management Strategies for Water Quality Protection

Municipalities and smaller outlying communities are expanding. This involves construction and development along pristine waters in Subbasin 03-13-01. High Quality Water (HQW) and Outstanding Resource Water (ORW) are supplemental classifications to the primary freshwater classification(s) placed on a waterbody. Management strategies are associated with the supplemental HQW and ORW classifications and are intended to protect water quality. Below is a brief summary of these strategies and the administrative code under which the strategies are found. More detailed information can be found in the document entitled *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina* (NCDENR-DWQ, 2004). This document is available on-line at http://h2o.enr.state.nc.us/admin/rules/. Definitions of the primary and supplemental classifications can be found in Chapter 3.

New discharges and expansions of existing discharges may, in general, be permitted in waters classified as HQW provided that the effluent limits are met for dissolved oxygen (DO), ammonia/nitrogen levels (NH_3-N), and the biochemical oxygen demand (BOD_5). More stringent limitations may be necessary to ensure that the cumulative effects from more than one discharge of oxygen-consuming wastes will not cause the dissolved oxygen concentration in the receiving water to drop more than 0.5 milligrams per liter (mg/l) below background levels. Discharges from single-family residential structures into surface waters are prohibited. When a discharge from an existing single-family home fails, a septic tank, dual or recirculation sand filters, disinfection, and step aeration should be installed (Administrative Code 15A NCAC 2B .0224)

In addition to the above, development activities which require an Erosion and Sedimentation Control Plan under the NC Sedimentation Control Commission or an approved local erosion and sedimentation control program are required to follow stormwater management rules as specified in Administrative Code 15A NCAC 2H .1000 (NCDENR-DWQ, 1995). Under these rules, stormwater management strategies must be implemented if development activities are within one mile of and draining to waters designated as HQW. There are two development options outlined in the rule. The low-density option requires a 30-foot wide vegetative buffer between development activities and the stream. This option can be used when the built upon area is less than 12 percent of the total land area or the proposed development is for a single-family residential home on one acre or greater. Vegetated areas may be used to transport stormwater in the low-density option, but it must not lead to a discrete stormwater collection system (e.g.,

constructed). The high-density option is for all land disturbing activities on greater than one acre. For high-density projects, structural stormwater controls must be constructed (e.g., wet detention ponds, stormwater infiltration systems, innovative systems) and must be designed to control runoff from all surfaces affected by one inch or more of rainfall. More stringent stormwater management measures may be required on a case-by-case basis where it is determined additional measures are needed to protect and maintain existing and anticipated uses of the water (Administrative Code 15A NCAC 2H .1006).

ORWs are unique and special surface waters that have some outstanding resource value (e.g., outstanding fish habitat and fisheries, unusually high levels of water-based recreation, special ecological or scientific significance). No new discharge or expansions on existing discharges are permitted. Rules related to the development activities are similar to those for HQW, and stormwater controls for all new development activities requiring an Erosion and Sedimentation Control Plan under the NC Sedimentation Control Commission or an approved local erosion and sedimentation control program are required to follow stormwater management rules as specified in Administrative Code 15A NCAC 2H .1000 (NCDENR-DWQ, 1995). In addition, site-specific stormwater management strategies may be developed to protect the resource values of these waters.

Many of the streams in this subbasin are also classified as trout (Tr) waters, and therefore, are protected for natural trout propagation and maintenance of stocked trout. There are no watershed development restrictions associated with the trout classification; however, the NC Division of Land Resources (DLR), under the NC Sedimentation and Pollution Control Act (SPCA), has requirements to protect trout streams from land disturbing activities. Under G.S. 113A-57(1), "waters that have been classified as trout waters by the Environmental Management Commission (EMC) shall have an undisturbed buffer zone 25 feet wide or of sufficient width to confine visible siltation within the twenty-five percent of the buffer zone nearest the land-disturbing activity, whichever is greater." The Sedimentation Control Commission, however, can approve land-disturbing activities along trout waters when the duration of the disturbance is temporary and the extent of the disturbance is minimal. This rule applies to unnamed tributaries flowing to the affected trout water stream. Further clarification on classifications of unnamed tributaries can be found under Administration Code 15A NCAC 02B .0301(i)(1). For more information regarding land-disturbing activities along designated trout streams, see the DLR website at http://www.dlr.enr.state.nc.us/.

1.5.2 Outstanding Resource Waters Special Management Strategy

With the exception of the Tullulah River and Clear Creek watersheds, an Outstanding Resource Water (ORW) management strategy applies to all waters within this subbasin. Figure 4 presents the area and Table 5 lists the waters to which an ORW management strategy applies. Table 5 also distinguishes between those waters classified ORW and those to which the modified management strategy applies.

Figure 4 Chattooga River ORW Area

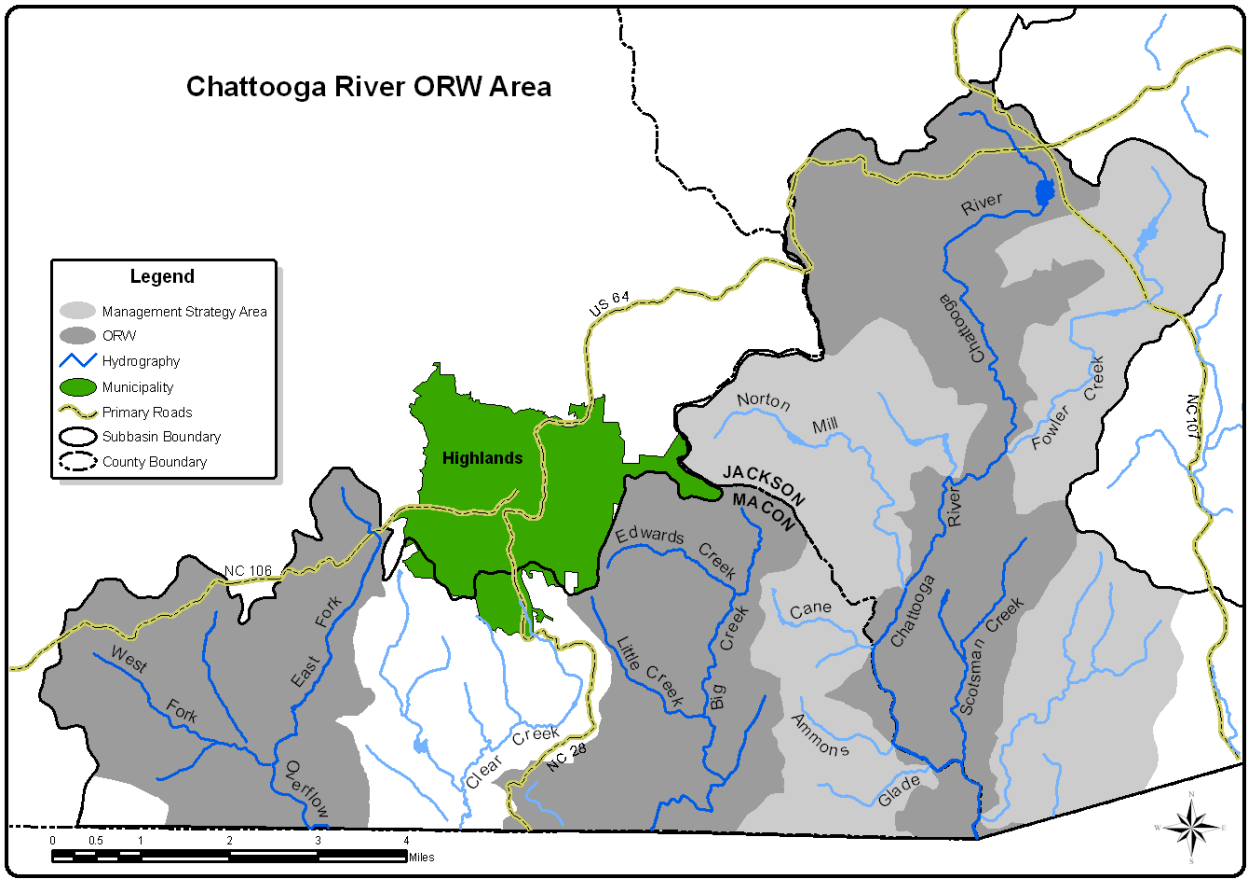


Table 5 Waters to which an ORW Management Strategy Applies

Watershed	Management Strategy Status
Chattooga River mainstem & two headwater tributaries	Classified ORW
Scotsman Creek and its tributaries	Classified ORW
Big Creek and its tributaries incl. Edwards & Little Creeks	Classified ORW
East & West Fork Overflow Creeks and tributaries	Classified ORW
North & South Fowler Creeks and tributaries	Modified management strategy applies
Green & Norton Mill Creeks and tributaries	Modified management strategy applies
Cane Creek and its tributaries	Modified management strategy applies
Ammons Branch and Glade Creek	Modified management strategy applies

Special protection measures that apply to waters classified ORW are set forth in 15A NCAC 02B.0225. No new discharges or expansions are permitted and a 30-foot buffer or stormwater controls are required for most new development. Specifically, development activities requiring a Sediment/Erosion Control Plan will be regulated as follows:

Low Density Option: Developments which limit single family developments to one acre lots and other types of developments to 12 percent built-upon area, have no stormwater collection system

as defined in 2H .1002(13), and have built-upon areas at least 30 feet from surface waters will be deemed to be in compliance.

High Density Option: Higher density developments will be allowed if stormwater control systems described in 2H .1003(i), (k) and (l) are installed, operated and maintained, so that the runoff from all built-upon areas generated from one inch of rainfall is controlled. The size of the control system must take into account the runoff from any pervious surfaces draining to the system.

The Asheville Regional Office of the Division of Land Resources (DLR), Land Quality Section has maps depicting and ORW areas throughout the region. When a construction project on land that is larger than one acre is proposed in an ORW watershed, DWQ is notified by DLR and these more stringent development standards are required as part of the sediment/erosion control plan approval process. Additionally, when DWQ receives a request for a permit for a discharge from a new subdivision, construction of a new sewer line, or for a 401 certification, DWQ determines the stream classification and notifies the local government and the applicant of these requirements.

The difference between the two strategies presented in Table 5 is that existing discharges on waters not classified ORW will be allowed to expand, provided there is no increase in pollutant loading. The prohibition of new discharges and the development restrictions outlined above apply equally to those waters classified ORW and to those with a modified management strategy. There are only three existing discharges within the modified management strategy area: Cullasaja Homeowner's Association, Mark Laurel Homeowner's Association and The Mountain.

1.5.3 Wooly Adelgid Pesticide Use

Citizens in the Savannah River basin informed DWQ of widespread, improper pesticide use by untrained persons attempting to control the spread of wooly adelgid infestations in eastern hemlock stands. The eastern hemlock is common along streams in the southern Appalachians. When used improperly or excessively, pesticides intended for use on trees can runoff into nearby streams causing catastrophic declines in aquatic communities. The NC Division of Forrest Resources can advise concerned citizens on the proper techniques for wooly adelgid control. http://www.dfr.state.nc.us/

1.5.4 Septic System Concerns

Development of rural land in areas not served by sewer systems is occurring rapidly in the Savannah River basin. Hundreds of permit applications for onsite septic systems are approved every year. Septic systems generally provide a safe and reliable method of disposing of residential wastewater when they are sited (positioned on a lot), installed, operated, and maintained properly. Rules and guidelines are in place in North Carolina to protect human health and the environment. Water quality is protected by locating the systems at least 50 feet away from streams and wetlands, limiting buildable lot sizes to a ¾-acre minimum, and installing drain fields in areas that contain suitable soil type and depth for adequate filtration; drinking water wells are further protected by septic system setbacks.

Septic systems typically are very efficient at removing many pollutants found in wastewater including suspended solids, metals, bacteria, phosphorus, and some viruses. However, they are

not designed to handle other pollutants that they often receive such as solvents, automotive and lubricating oil, drain cleaners, and many other household chemicals. Additionally, some byproducts of organic decomposition are not treated. Nitrates are one such byproduct and are the most widespread contaminant of groundwater in the United States (Smith, et al., 2004).

One septic system generates about 30 to 40 pounds of nitrate nitrogen per year (NJDEP, 2002). Nitrates and many household chemicals are easily dissolved in water and therefore move through the soil too rapidly to be removed. Nitrates are known to cause water quality problems and can also be harmful to human health (Smith, et al., 2004).

Proper location, design, construction, operation, and maintenance of septic systems are critical to the protection of water quality in a watershed. If septic systems are located in unsuitable areas, are improperly installed, or if the systems have not been operated and/or maintained properly, they can be significant sources of pollution. Additionally if building lots and their corresponding septic systems are too densely developed, the natural ability of soils to receive and purify wastewater before it reaches groundwater or adjacent surface water can be exceeded (Smith, et al., 2004). Nutrients and some other types of pollution are often very slow to leave a lake system. Therefore, malfunctioning septic systems can have a significant long-term impact on water quality and ecological health (PACD, 2003).

Local governments, in coordination with local health departments, should evaluate the potential for water quality problems associated with the number and density of septic systems being installed throughout their jurisdiction. Long-term county-wide planning for future wastewater treatment should be undertaken. There are water quality concerns associated with both continued permitting of septic systems for development in outlying areas and with extending sewer lines and expanding wastewater treatment plant discharges. Pros and cons of various wastewater treatment options should be weighed for different parts of the county (based on soil type, depth, proximity to existing sewer lines, etc.) and a plan developed that minimizes the risk of water quality degradation from all methods employed.

In addition, local governments, again in coordination with local health departments, should consider programs to periodically inform citizens about the proper operation of septic systems and the need for routine maintenance and replacement. Owners of systems within 100 feet of streams or lakes should be specifically targeted and encouraged to routinely check for the warning signs of improperly functioning systems and to contact the health department immediately for assistance in getting problems corrected.

Chapter 2
Savannah River Subbasin 03-13-02
Including: Horsepasture, Thompson, and Whitewater Rivers

2.1 Subbasin Overview

Subbasin 03-13-02 at a Glance

Land and Water Area

Total area:	98 mi²
Land area:	96 mi²
Water area:	2 mi²

Population Statistics

2000 Est. Pop.:	7,267 people
Pop. Density:	75 persons/mi²

Land Cover (percent)

Forest/Wetland:	95.6%
Surface Water:	2.1%
Urban:	0.3%
Cultivated Crop:	0.1%
Pasture/ Managed Herbaceous:	1.9%

Counties

Jackson, Transylvania

Municipalities

Cashiers

Monitored Streams Statistics

Aquatic Life

Total Streams:	106.6 mi
Total Supporting:	28.7 mi
Total Impaired:	0 mi
Total Not Rated:	0 mi

Recreation

Total Streams:	3.9 mi
Total Supporting:	3.9 mi

The Horsepasture and Toxaway Rivers originate in Jackson and Transylvania counties and flow in a southeastern direction toward South Carolina's Lake Jocassee. The Horsepasture falls more than 2,000 feet in the North Carolina portion of the watershed and contains several spectacular waterfalls. Other tributaries in this subbasin include the Whitewater and Thompson Rivers.

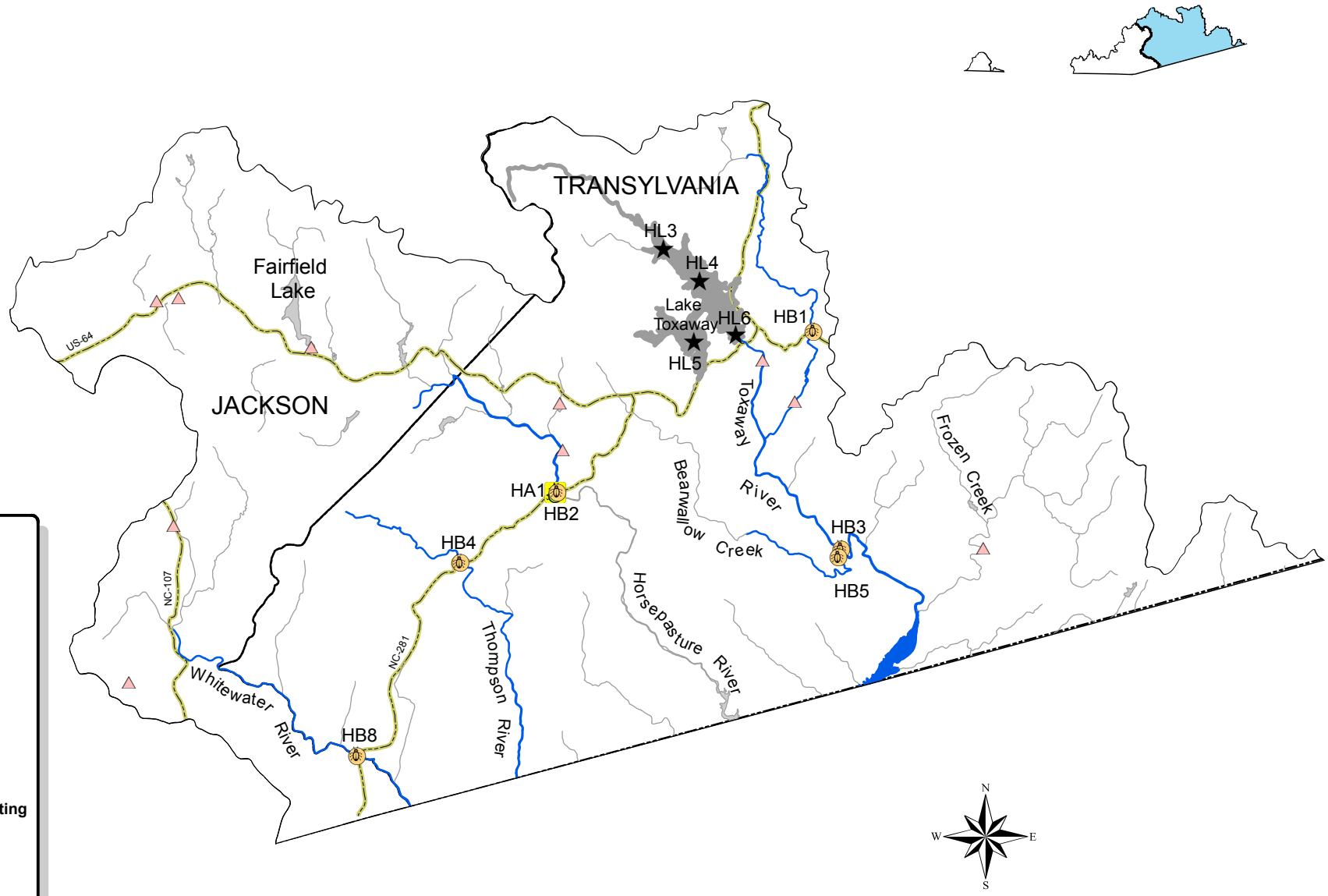
Most of the land within this subbasin is forested (95.6 percent). The Whitewater River watershed lies within the Nantahala National Forest. The Gorges State Park and Toxaway Game Lands encompass 10,000 acres in this subbasin (mostly the Toxaway River watershed). There are no municipalities; however, several residential and resort communities exist near Sapphire and Lake Toxaway.

Water quality in this subbasin is generally good to excellent. Nearly all waters are classified trout waters. Several streams including Bearwallow Creek and a portion of the Whitewater River are High Quality Waters. Additionally, 4.5 miles of the Horsepasture River are both a State Natural and Scenic River and a National Wild and Scenic River.

Additional information regarding population and land use throughout the entire basin can be found in Appendix I and III, respectively.

There are eleven NPDES dischargers in this subbasin, two of which are required to perform whole effluent toxicity testing. The Carolina Mountain Water WWTP (NC0067954, 0.006 MGD) discharges to an unnamed tributary of the Whitewater River and has had no toxicity violations since 1997. The other NPDES facility in this subbasin is the Wade Hampton Club WWTP (NC0062553, MGD 0.125). This facility discharges to an unnamed tributary to Silver Run Creek and has had no toxicity violations since 1998. For the listing of NPDES permit holders, refer to Appendix V.

Figure 5 Savannah River Subbasin 03-13-02



Legend

Monitoring Stations
- Ambient Monitoring Station
- Benthic Community
- Fish Community
- Lake Monitoring Station
- Recreation Locations

NPDES Discharges
- Major
- Minor

Aquatic Life Use Support Rating
- Impaired
- No Data
- Not Rated
- Supporting

- Primary Roads
- County Boundary
- Municipality
- Subbasin Boundary

Planning Section
Basinwide Planning Unit
July 18, 2006

Table 6 Savannah Subbasin 03-13-02

AU Number	Classification	Length/Area	Description	Aquatic Life Assessment					Recreation Assessment			Stressors	Sources
				AL Rating	Station	Result	Year/ Parameter	% Exc	REC Rating	Station	Result		
Bearwallow Creek													
4-7-(2)	C Tr HQW	2.2 FW Miles	From a point 2.3 miles upstream of mouth to Toxaway River	**S**	HB5	E	2004		ND				
Horsepasture River													
4-13-(0.5)b	C Tr	3.9 FW Miles	From dam at Sapphire Lake to NC 281	**S**	HA1	NCE			**S**	HA1	NCE	Fecal Coliform Bacteria	Unknown
					HB2	G	2004					Fecal Coliform Bacteria	WWTP NPDES
												Habitat Degradation	Unknown
												Temperature	Unknown
Indian Creek													
4-5-(3)	C Tr	5.4 FW Miles	From Dam at Indian Lake Estates Recreation Lake to Toxaway River	**S**	HB1	E	2004		ND				
Thompson River													
4-14-6	C Tr	5.9 FW Miles	From source to North Carolina-South Carolina State Line	**S**	HB4	E	2004		ND				
TOXAWAY RIVER													
4-(4)	C	6.2 FW Miles	From Dam at Lake Toxaway Estates, Inc. to North Carolina-South Carolina State Line	**S**	HB3	E	2004		ND				
TOXAWAY RIVER (Lake Toxaway)													
4-(1)	B Tr	524.9 FW Acres	From source to Dam at Lake Toxaway Estates, Inc.	**NR**	HL3	ID			ND				
					HL4	ID							
					HL5	ID							
					HL6	ID							

Table 6 Savannah Subbasin 03-13-02

AU Number	Classification	Length/Area	Description	Aquatic Life Assessment					Recreation Assessment			Stressors	Sources
				AL Rating	Station	Result	Year/ Parameter	% Exc	REC Rating	Station	Result		
Whitewater River													
4-14-(1.5)	C Tr HQW	5.2 FW Miles	From Little Whitewater Creek to North Carolina-South Carolina State Line	S	HB8	E	2004		ND				

Use Categories:
AL - Aquatic Life
REC - Recreation

Monitoring data type:
HF - Fish Community Survey
HB - Benthic Community Survey
HA - Ambient Monitoring Site
HL- Lake Monitoring

Results:
E - Excellent
G - Good
GF - Good-Fair
F - Fair
P - Poor
NI - Not Impaired

Use Support Ratings 2006:
S - Supporting, I - Impaired
NR - Not Rated
NR*- Not Rated for Recreation (screening criteria exceeded)
ND-No Data Collected to make assessment

Miles/Acres
FW- Fresh Water

m- Monitored
e- Evaluated

Results
CE-Criteria Exceeded > 10% and more than 10 samples
NCE-No Criteria Exceeded
ID- Insufficeint Data Available

Aquatic Life Rating Summary

S	m	28.7	FW Miles
NR	m	524.9	FW Acres
ND		77.9	FW Miles
ND		125.6	FW Acres

Recreation Rating Summary

S	m	3.9	FW Miles
ND		102.8	FW Miles
ND		650.5	FW Acres

Fish Consumption Rating Summary

I	e	106.7	FW Miles
I	e	650.5	FW Acres

A map including the locations of the NPDES facilities and water quality monitoring stations is presented in Figure 5. Table 6 contains a summary of assessment unit numbers (AU#) and lengths, streams monitored, monitoring data types, locations and results, along with use support ratings for waters in the subbasin. Refer to Appendix VIII for more information about use support ratings.

There were 10 benthic macroinvertebrate community samples collected during this assessment period. The Whitewater River and the Thompson River maintained Excellent bioclassifications, Indian Creek improved from Good in 1999 to Excellent in 2004, and the Horsepasture River declined in bioclassification from Excellent in 1999 to Good in 2004. Data were also collected from one ambient monitoring station. This ambient station is located on the Horsepasture River mainstem at NC281. No water quality standards were violated. Refer to the *2005 Basinwide Assessment Report Savannah River Basin* at http://h2o.enr.state.nc.us/esb/Basinwide/SAV2005.pdf and Appendix IV for more information on monitoring.

Waters in the following sections and in Table 6 are identified by an assessment unit number (AU#). This number is used to track defined segments in the water quality assessment database, list 303(d) Impaired waters, and is used to identify waters throughout the basin plan. The AU# is a subset of the DWQ index number (classification identification number). A letter attached to the end of the AU# indicates that the assessment is smaller than the DWQ index segment. No letter indicates that the AU# and the DWQ index segment are the same. For example, index number 11-3-(14) might be split into two assessment units 11-3-(14)a and 11-3-(14)b.

2.2 Use Support Assessment Summary

Table 7 Summary of Use Support Ratings by Category in Subbasin 03-13-02

Use Support Rating	Aquatic Life	Recreation
Monitored Waters		
Supporting	28.7 mi	3.9 mi
Impaired*	0	0
Not Rated	524.9 ac	0
Total	**28.7 mi 524.9 ac**	**3.9 mi**
Unmonitored Waters		
No Data	77.9 mi 125.6 ac	102.8 mi 650.5 ac
Total	**77.9 mi 125.6 ac**	**102.8 mi 650.5 ac**
Totals		
All Waters**	**106.6 mi 650.5 ac**	**106.7 mi 650.5 ac**

* The noted percent Impaired is the percent of monitored miles/acres only.
** The noted percent Impaired is the percent of monitored miles/acres only.

All surface waters in the state are assigned a classification appropriate to the best-intended use of that water. Waters are regularly assessed by DWQ to determine how well they are meeting their best-intended use. For aquatic life, an Excellent, Good, Good-Fair, Fair, or Poor bioclassification is assigned to a stream based on the biological data collected by DWQ. For more information about bioclassification and use support assessment, refer to Appendices IV and VIII, respectively. Appendix IX provides definitions of the terms used throughout this basin plan.

In subbasin 03-13-02, use support was assigned for the aquatic life, recreation, fish consumption and water supply categories. (Table 7) Waters are Supporting, Impaired, Not Rated, and No Data in the aquatic life and recreation categories on a monitored or evaluated basis. Waters are Impaired in the fish consumption category on an evaluated basis based on fish consumption advice issued by the Department of Health and Human Services (DHHS). All waters are Supporting in the water supply category on an evaluated basis based on reports from Division of Environmental

Health (DEH) regional water treatment plant consultants. Refer to Table 7 for a summary of use support for waters in subbasin 03-13-02.

2.3 Status and Recommendations of Previously and Newly Impaired Waters

No stream segments were rated impaired in the 2002 basin plan and none were rated as impaired based on recent DWQ monitoring in the current assessment period (1999-2004). Section 2.4 below discusses specific streams where water quality impacts have been observed.

2.4 Status and Recommendations for Waters with Noted Impacts

The surface waters discussed in this section are not Impaired. However, notable water quality problems and concerns were documented for these waters during this assessment. Attention and resources should be focused on these waters to prevent additional degradation and facilitate water quality improvements. DWQ will notify local agencies of these water quality concerns and work with them to conduct further assessments and to locate sources of water quality protection funding. Additionally, education on local water quality issues and voluntary actions are useful tools to prevent water quality problems and to promote restoration efforts. The current status and recommendations for addressing these waters are presented below, and each is identified by an AU#. Nonpoint source program agency contacts are listed in Appendix VII.

2.4.1 Horsepasture River [AU# 4-13-(.5)b] and Headwaters Including: Hog Back and Little Hogback Creeks, Hogback Lake [AU# 4-13-9 and 4-13-8]

Current Status

DWQ samples the Horsepasture River's benthic community at site HB2. Between 1999 and 2004 this location declined from Excellent to Good. However, it should be noted that the bioclassification at this site has varied since DWQ first sampled here in 1985 (Table 8). DWQ also maintains an ambient monitoring station at this location. Ambient data indicate that physical water quality did not change significantly at this site between 1999 and 2004 and suggests the recent variability in bioclassification may be natural. The ambient data also revealed fecal coliform bacteria concentrations are trending upwards, but do not yet violate state standards. This could be due to the increased presence of septic systems in the watershed and/or intense recreational use. The Horsepasture River is a popular swimming destination in the summer. Sapphire Lakes WWTP #1 has also had difficulty meeting its fecal coliform permit limit. DWQ is pursuing enforcement actions to correct the problem.

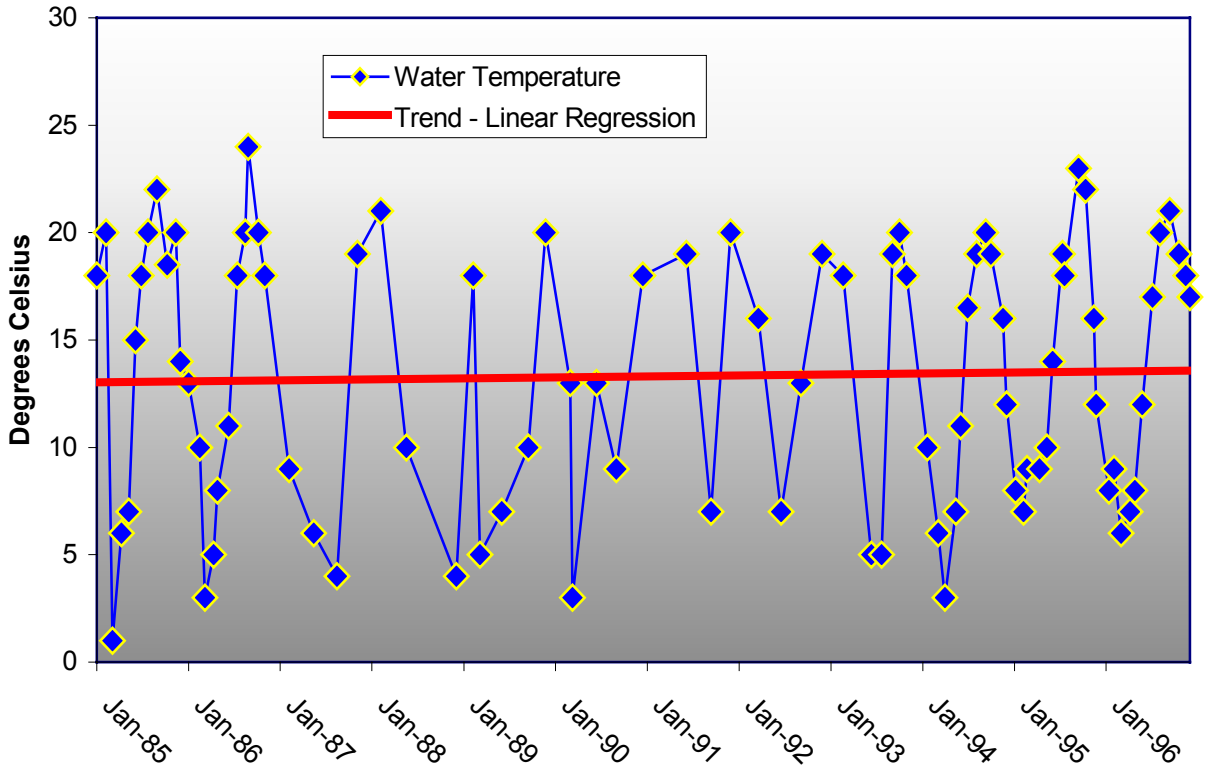
Concerned citizens provided DWQ with photographic evidence of instream habitat degradation in many tributaries of the Horsepasture River, especially the Hog Back Creek watershed. The photographs document the impact of development in the watershed and include: removal of riparian vegetation resulting in bank collapse, erosion near stormwater collection system outfalls, un-stabilized road cuts, heavy siltation in small streams, and failing erosion control structures.

Table 8 Bioclassifications for the Horsepasture River at NC281

Year	Bioclassification
1984	Good-Fair
1985	Fair
1986	Good
1987	Good
1989	Good-Fair
1994	Good
1999	Excellent
2004	Good

The average ambient water temperature appears to be rising at site HA1. This was determined by fitting a linear regression trend line for temperature data from 1985 through 1996. Because there is no flow information to accompany this data, DWQ could not perform a season-and-flow adjusted trend analysis, and these results should be considered preliminary. Some possible causes for a long-term temperature increase include a large-scale climatic shift or direct human induced changes such as increased impervious cover or riparian vegetation removal coupled with impacts from small ponds. Despite some new development, impervious surfaces remain a relatively small percentage (<2 percent) of the landscape in the Horsepasture River watershed (Figure 6). Therefore, the most likely causes of increasing water temperature include riparian vegetation removal, small ponds, and climate change. Changes due to riparian vegetation removal are relatively easy and inexpensive to correct by replanting the riparian zone with shade trees.

Figure 6 Ambient Water Temperature in the Horsepasture River



The NC Ecosystem Enhancement Program (NCEEP) has initiated an approximately 8,000-foot stream mitigation project on Logan Creek, a tributary to the Horsepasture River near the town of Cashiers in Jackson County. The project is currently in the early design phase, with construction expected to begin by the summer of 2007. For additional information about NCEEP watershed initiatives, see Section 11.3.1.

DWQ received a request to reclassify the Horsepasture River to Outstanding Resource Waters in 2006. In the summer of 2006, DWQ conducted biological studies of the river and its major tributaries to determine if they would qualify for ORW classification. A great deal of the study was conducted in rapidly developing areas. Active land clearing activities at several sites will likely affect the riparian zone's effectiveness at controlling pollutant loading including sedimentation. In at least one instance, sediment control measures apparently put in place immediately adjacent to the stream to slow these problems were circumvented. With the Horsepasture River itself starting out near, and flowing through a relatively low-gradient area from the confluence of Logan Creek to the confluence of Rock Creek, this area, including many of the tributaries may be very sensitive to sedimentation and sediment-borne pollutants. Additional controls on, or better regulation of non-point source pollutants may be needed to protect the current status of these resources and to maintain the excellent water quality observed in the lower portion of the Horsepasture River.

2007 Recommendations

Nonpoint source pollution presents the greatest threat to water quality in the Horsepasture River. In order to protect water quality, development along the river and its many tributaries must be conducted in an ecologically sound manner including an emphasis on managing stormwater runoff. Refer to Chapter 5 for information on how local governments can achieve effective stormwater control on existing and future development.

In addition to local government action, residents should take an active role in water quality management. Citizens are encouraged to report erosion problems and possible water quality violations to state and county authorities. They should also work through their homeowner associations to encourage and establish appropriate stormwater controls in their communities. Citizens can also track changes in water quality by starting a volunteer monitoring program to supplement state water quality data. Interested citizens should contact the VWIN program at the University of Asheville for guidance on how to start such a program. Residential landowners along the creek can use a variety of techniques to reduce pollution caused by runoff from their property. Residents should refer to the document "Improving Water Quality in Your Own Backyard." This pamphlet is available free of charge through the Division of Water Quality Website http://h2o.enr.state.nc.us/nps/documents/BackyardPDF.pdf.

2.4.2 Toxaway River (Lake Toxaway) [AU# 4-(1) & 4-(4)]

Current Status

Bottom water in Lake Toxaway was sampled in conjunction with a study being conducted by the Division of Water Resources (DWR) in response to odor complaints below the dam. In 2001, 2002, and 2003, the DWR received complaints regarding the odor of bottom water released into the Toxaway River from Lake Toxaway. Bottom water is released from the reservoir in an attempt to provide colder water in the Toxaway River downstream of the dam to support a trout fishery. In response to the public complaints, a study of the river downstream of the Lake Toxaway Dam was conducted by DWR to determine the source of the odor problem. In support

of this investigation, DWQ sampled the bottom water of Lake Toxaway near the dam to evaluate the levels of metals, particularly manganese, an element associated with taste and odor problems in drinking water. Results of this sampling indicate that both manganese and iron increased significantly in response to increased hypoxic conditions near the bottom of the lake as the summer progressed. At these elevated concentrations, staining, odor, and unpleasant taste are noticeable. Lake Toxaway is Not Rated in the aquatic life use support category because DWQ did not collect the minimum ten samples necessary to assign a use support rating.

DWQ also sampled the benthic community in the Toxaway River about five miles below the dam. At this point (Site HB3), the benthic community was rated Excellent, indicating either the dam did not have a significant impact, or the impact attenuated relatively quickly after release. The river is rated Supporting for aquatic life from the dam at Lake Toxaway to the state line.

2007 Recommendations

The Toxaway River below the lake is now protected within Gorges State Park. Therefore, the most likely threats to water quality will manifest in the lake and headwaters. In order to protect water quality in this area, development must proceed in an ecologically sound manner. Refer to Chapter 5 for recommendations on how growth and development can be managed effectively.

2.5 Additional Water Quality Issues within Subbasin 03-13-02

The previous sections discussed water quality concerns for specific stream segments. The following section discusses issues that may threaten water quality in the subbasin that are not specific to particular streams, lakes, or reservoirs. The issues discussed may be related to waters near certain land use activities or within proximity to different pollution sources.

This section also discusses ideas, rules, and practices in place to preserve and maintain the pristine waters of the Savannah basin. In subbasins 03-13-01 (Chapter 1) and 03-13-02, this is particularly important since many of the waters are designated high quality or outstanding resource waters (HQW and ORW, respectively).

2.5.1 Management Strategies for Water Quality Protection

Municipalities and smaller outlying communities are expanding. This involves construction and development along pristine waters in Subbasin 03-13-02. HQW and ORW are supplemental classifications to the primary freshwater classification(s) placed on a waterbody (Chapter 3). Management strategies are associated with the supplemental HQW and ORW classifications and are intended to protect the current use of the waterbody. A summary of the special management strategies for HQW and ORW waters can be found in Chapter 1. Detailed information can be found in the document entitled *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina* (NCDENR-DWQ, 2004). This document is available on-line at http://h2o.enr.state.nc.us/admin/rules/.

Many of the streams in this subbasin are also classified as trout (Tr) waters, and therefore, are protected for natural trout propagation and maintenance of stocked trout. There are no watershed development restrictions associated with the trout classification; however, the NC Division of Land Resources (DLR), under the NC Sedimentation and Pollution Control Act (SPCA), has requirements to protect trout streams from land disturbing activities. Under G.S. 113A-57(1), "waters that have been classified as trout waters by the Environmental Management Commission

(EMC) shall have an undisturbed buffer zone 25 feet wide or of sufficient width to confine visible siltation within the twenty-five percent of the buffer zone nearest the land-disturbing activity, whichever is greater." The Sedimentation Control Commission, however, can approve land-disturbing activities along trout waters when the duration of the disturbance is temporary and the extent of the disturbance is minimal. This rule applies to unnamed tributaries flowing to the affected trout water stream. Further clarification on classifications of unnamed tributaries can be found under Administration Code 15A NCAC 02B .0301(i)(1). For more information regarding land-disturbing activities along designated trout streams, see the DLR website at http://www.dlr.enr.state.nc.us/.

2.5.2 Septic System Concerns

Development of rural land in areas not served by sewer systems is occurring rapidly in the Savannah River basin. Hundreds of permit applications for onsite septic systems are approved every year. Septic systems generally provide a safe and reliable method of disposing of residential wastewater when they are sited (positioned on a lot), installed, operated, and maintained properly. Rules and guidelines are in place in North Carolina to protect human health and the environment. Water quality is protected by locating the systems at least 50 feet away from streams and wetlands, limiting buildable lot sizes to a ¾-acre minimum, and installing drain fields in areas that contain suitable soil type and depth for adequate filtration; drinking water wells are further protected by septic system setbacks.

Septic systems typically are very efficient at removing many pollutants found in wastewater including suspended solids, metals, bacteria, phosphorus, and some viruses. However, they are not designed to handle other pollutants that they often receive such as solvents, automotive and lubricating oil, drain cleaners, and many other household chemicals. Additionally, some byproducts of organic decomposition are not treated. Nitrates are one such byproduct and are the most widespread contaminant of groundwater in the United States (Smith, et al., 2004).

One septic system generates about 30 to 40 pounds of nitrate nitrogen per year (NJDEP, 2002). Nitrates and many household chemicals are easily dissolved in water and therefore move through the soil too rapidly to be removed. Nitrates are known to cause water quality problems and can also be harmful to human health (Smith, et al., 2004).

Proper location, design, construction, operation, and maintenance of septic systems are critical to the protection of water quality in a watershed. If septic systems are located in unsuitable areas, are improperly installed, or if the systems have not been operated and/or maintained properly, they can be significant sources of pollution. Additionally if building lots and their corresponding septic systems are too densely developed, the natural ability of soils to receive and purify wastewater before it reaches groundwater or adjacent surface water can be exceeded (Smith, et al., 2004). Nutrients and some other types of pollution are often very slow to leave a lake system. Therefore, malfunctioning septic systems can have a significant long-term impact on water quality and ecological health (PACD, 2003).

Local governments, in coordination with local health departments, should evaluate the potential for water quality problems associated with the number and density of septic systems being installed throughout their jurisdiction. Long-term county-wide planning for future wastewater treatment should be undertaken. There are water quality concerns associated with both continued permitting of septic systems for development in outlying areas and with extending

sewer lines and expanding wastewater treatment plant discharges. Pros and cons of various wastewater treatment options should be weighed for different parts of the county (based on soil type, depth, proximity to existing sewer lines, etc.) and a plan developed that minimizes the risk of water quality degradation from all methods employed.

In addition, local governments, again in coordination with local health departments, should consider programs to periodically inform citizens about the proper operation of septic systems and the need for routine maintenance and replacement. Owners of systems within 100 feet of streams or lakes should be specifically targeted and encouraged to routinely check for the warning signs of improperly functioning systems and to contact the health department immediately for assistance in getting problems corrected.

2.5.3 Wooly Adelgid Pesticide Use

Citizens in the Savannah River basin informed DWQ of widespread, improper pesticide use by untrained persons attempting to control the spread of wooly adelgid infestations in eastern hemlock stands. The eastern hemlock is common along streams in the southern Appalachians. When used improperly or excessively, pesticides intended for use on trees can runoff into nearby streams causing catastrophic declines in aquatic communities. The NC Division of Forrest Resources can advise concerned citizens on the proper techniques for wooly adelgid control. http://www.dfr.state.nc.us/

Chapter 3
North Carolina Water Quality Classifications and Standards

3.1 Description of Surface Water Classifications and Standards

North Carolina's Water Quality Standards Program adopted classifications and water quality standards for all the state's river basins by 1963. The program remains consistent with the Federal Clean Water Act and its amendments. Water quality classifications and standards have also been modified to promote protection of surface water supply watersheds, high quality waters, and the protection of unique and special pristine waters with outstanding resource values.

3.1.1 Statewide Classifications

All surface waters in the state are assigned a *primary* classification that is appropriate to the best uses of that water. In addition to primary classifications, surface waters may be assigned a *supplemental* classification. Most supplemental classifications have been developed to provide special protection to sensitive or highly valued resource waters. Table 9 briefly describes the best uses of each classification. A full description is available in the document titled: *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina*. Information on this subject is also available at DWQ's website: http://h2o.enr.state.nc.us/wqhome.html.

3.1.2 Statewide Water Quality Standards

Each primary and supplemental classification is assigned a set of water quality *standards* that establish the level of water quality that must be maintained in the waterbody to support the uses associated with each classification. Some of the standards, particularly for HQW and ORW waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. These strategies are discussed briefly below. The standards for C and SC waters establish the basic protection level for all state surface waters. The other primary and supplemental classifications have more stringent standards than for C and SC, and therefore, require higher levels of protection.

Some of North Carolina's surface waters are relatively unaffected by pollution sources and have water quality higher than the standards that are applied to the majority of the waters of the state. In addition, some waters provide habitat for sensitive biota such as trout, juvenile fish, or rare and endangered aquatic species.

High Quality Waters (Class HQW)
There are 15.5 stream miles HQW waters in the Savannah River basin (Figure 7). Special HQW protection management strategies are intended to prevent degradation of water quality below present levels from both point and nonpoint sources. HQW requirements for new wastewater discharge facilities, and facilities which expand beyond their currently permitted loadings, address oxygen-consuming wastes, total suspended solids, disinfection, emergency requirements, volume, nutrients (in nutrient sensitive waters) and toxic substances.

Table 9 Primary and Supplemental Surface Water Classifications

PRIMARY FRESHWATER AND SALTWATER CLASSIFICATIONS	
Class*	**Best Uses**
C and SC	Aquatic life propagation/protection and secondary recreation.
B and SB	Primary recreation and Class C and SC uses.
SA	Suitable for commercial shellfish harvesting and SB and SC uses.
WS	*Water Supply (WS)*: Assigned to watersheds based on land use characteristics. The WS classifications have management strategies to protect the surface water supply. For WS-I through WS-IV, these include limits on point source discharges and local programs to control nonpoint source and stormwater runoff. A WS Critical Area (CA) has more stringent protection measures and is designated within one-half mile from a WS intake or WS reservoir. All WS classifications are suitable for Class C uses.
WS-I	Generally located in natural and undeveloped watersheds.
WS-II	Generally located in predominantly undeveloped watersheds.
WS-III	Generally located in low to moderately developed watersheds.
WS-IV	Generally located in moderately to highly developed watersheds.
WS-V	Generally upstream of and draining to Class WS-IV waters. No categorical restrictions on watershed development or treated wastewater discharges.
SUPPLEMENTAL CLASSIFICATIONS	
Class	**Best Uses**
Sw	*Swamp Waters*: Waters that have low velocities and other natural characteristics that are different from adjacent streams (i.e., lower pH, lower levels of dissolved oxygen).
Tr	*Trout Waters*: Provides protection to freshwaters for natural trout propagation and survival of stocked trout.
HQW	*High Quality Waters*: Waters that have excellent water quality, primary nursery areas and other functional nursery areas, WS-I and WS-II or SA waters.
ORW	*Outstanding Resource Waters*: Unique and special waters of exceptional state or national recreational or ecological significance which require special protection.
NSW	*Nutrient Sensitive Waters*: Waters subject to excessive plant growth and requiring limitations on nutrient inputs.

* Primary classifications beginning with "S" are assigned to saltwaters.

For nonpoint source pollution, development activities which require a Sedimentation and Erosion Control Plan in accordance with rules established by the NC Sedimentation Control Commission or an approved local erosion and sedimentation control program, and which drain to and are within 1 mile of HQWs, are required to control runoff from the development using either a low density or high density option. The low-density option requires a 30-foot vegetated buffer between development activities and the stream; whereas, the high-density option requires structural stormwater controls. In addition, the Division of Land Resources (DLR) requires more stringent erosion controls for land-disturbing projects within 1 mile of and draining to HQWs.

Criteria for HQW Classification

- Waters rated as Excellent based on DWQ's chemical and biological sampling.
- Streams designated as native or special native trout waters by the Wildlife Resources Commission (WRC).
- Waters designated as primary nursery areas or other functional nursery areas by the Division of Marine Fisheries.
- Waters classified by DWQ as WS-I, WS-II or SA.

Outstanding Resource Waters (Class ORW)

There are 36.9 stream miles and 23.7 lake acres of ORW waters in the Savannah River basin (Figure 7). These waters have excellent water quality (rated based on biological and chemical sampling as with HQWs) and an associated outstanding resource.

The ORW rule defines outstanding resource values as including one or more of the following:

- an outstanding fisheries resource;
- a high level of water-based recreation;
- a special designation such as National Wild and Scenic River or a National Wildlife Refuge;
- within a state or national park or forest; or
- a special ecological or scientific significance.

The requirements for ORW waters are more stringent than those for HQWs. Special protection measures that apply to North Carolina ORWs are set forth in 15A NCAC 2B .0225. At a minimum, no new discharges or expansions are permitted, and a 30-foot vegetated buffer or stormwater controls for new developments are required. In some circumstances, the unique characteristics of the waters and resources that are to be protected require that a specialized (or customized) ORW management strategy be developed. This strategy is described in Section 1.5.2. A total of 21.7 stream miles and 17.0 lake acres fall under the modified ORW strategy.

Primary Recreation (Class B)

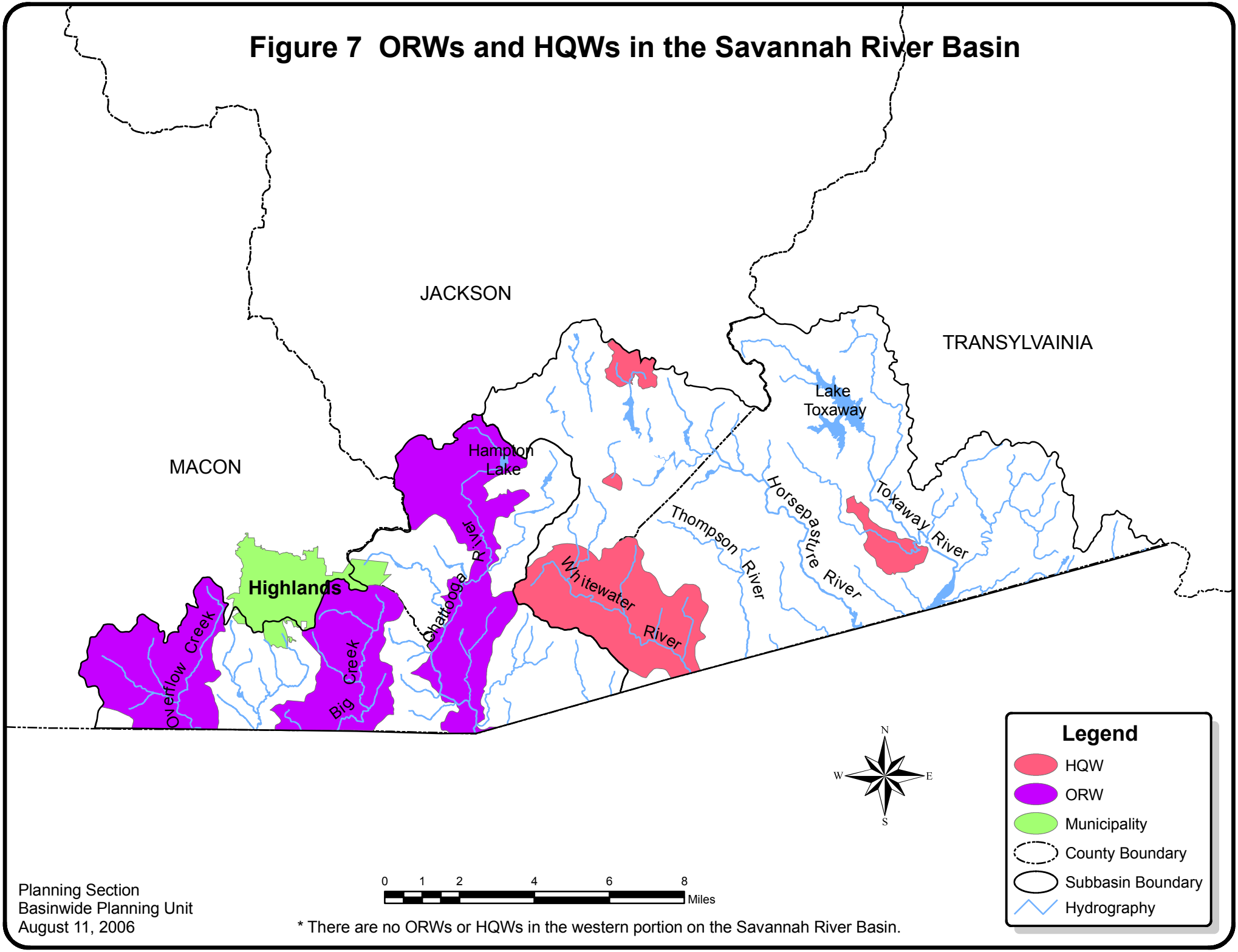
There are 33.0 stream miles and 637.8 lake acres classified for primary recreation in the Savannah River basin. Waters classified as Class B are protected for primary recreation, include frequent and/or organized swimming, and must meet water quality standards for fecal coliform bacteria. Sewage and all discharged wastes into Class B waters much be treated to avoid potential impacts to the existing water quality.

Trout Waters (Class Tr)

There are 162.8 stream miles and 619.0 lake acres classified as trout (Tr) waters in the Savannah River basin. Different water quality standards for some parameters, such as dissolved oxygen, temperature and turbidity, have been developed to protect freshwaters for natural trout propagation and survival of stocked trout. These water quality standards result in more restrictive limits for wastewater discharges to trout waters.

There are no watershed development restrictions associated with the Tr classification; however, the NC Division of Land Resources (DLR), under the NC Sedimentation and Pollution Control Act (SPCA), has requirements to protect Tr streams from land disturbing activities. Under G.S. 113A-57(1), "waters that have been classified as Tr waters by the Environmental Management Commission (EMC) shall have an undisturbed buffer zone 25 feet wide or of sufficient width to confine visible siltation within the twenty-five percent of the buffer zone nearest the land-disturbing activity, whichever is greater." The Sedimentation Control Commission, however, can approve land-disturbing activities along Tr waters when the duration of the disturbance is temporary and the extent of the disturbance is minimal. This rule applies to unnamed tributaries flowing to the affected Tr water stream. Further clarification on classifications of unnamed tributaries can be found under Administration Code 15A NCAC 02B .0301(i)(1). For more information regarding land-disturbing activities along designated Tr streams, see the DLR website at http://www.dlr.enr.state.nc.us/.

Figure 7 ORWs and HQWs in the Savannah River Basin



Planning Section
Basinwide Planning Unit
August 11, 2006

* There are no ORWs or HQWs in the western portion on the Savannah River Basin.

The NC WRC administers a state fishery management classification, Designated Public Mountain Trout Water. It provides for public access to streams for fishing and regulates fishing activities (seasons, size limits, creel limits, and bait and lure restrictions). Although many of these waters are also classified Tr by DWQ, this is not the same classification.

Water Supply Watersheds (Class WS)
The Savannah River basin currently does not contain any water supply classified streams. The purpose of the Water Supply Watershed Protection Program is to provide a proactive drinking water supply protection program for communities. Local governments administer the program based on state minimum requirements. There are restrictions on wastewater discharges, development, landfills and residual application sites to control the impacts of point and nonpoint sources of pollution to water supplies.

There are five water supply classifications (WS-I to WS-V) that are defined according to the land use characteristics of the watershed. The WS-I classification carries the greatest protection for water supplies. No development is allowed in these watersheds. Generally, WS-I lands are publicly owned. WS-V watersheds have the least amount of protection and do not require development restrictions. These are either former water supply sources or sources used by industry. WS-I and WS-II classifications are also HQW by definition because requirements for these levels of water supply protection are at least as stringent as those for HQWs. Those watersheds classified as WS-II through WS-IV require local governments having jurisdiction within the watersheds to adopt and implement land use ordinances for development that are at least as stringent as the state's minimum requirements. A 30-foot vegetated setback is required on perennial streams in these watersheds.

3.1.3 Reclassification of Surface Waters

A surface water classification may be changed after a request is submitted to the Classifications and Standards Unit. DWQ reviews each request for reclassification and conducts an assessment of the surface water to determine if the reclassification is appropriate. If it is determined that a reclassification is justified, the request must proceed through the state rule-making process. To initiate a reclassification, the "Application to Request Reclassification of NC Surface Waters" must be completed and submitted to DWQ's Classifications and Standards Unit. For more information on requests for reclassification and contact information, visit http://h2o.enr.state.nc.us/csu/.

Chapter 4
Water Quality Stressors

4.1 Stressor and Source Identification

4.1.1 Introduction – Stressors

Human activities can negatively impact surface water quality, even when the activity is far removed from the waterbody. The many types of pollution generated by human activities may seem insignificant when viewed separately, but when taken as a whole can be very stressful to aquatic ecosystems. Water quality stressors are identified when impacts have been noted to biological (fish and benthic) communities or water quality standards have been violated. Stressors apply to one or more use support categories and may be identified for Impaired as well as Supporting waters with noted impacts.

Identifying stressors is challenging because direct measurements of the stressor may be difficult or prohibitively expensive. DWQ staff use field observations from sample sites, special studies and data from ambient monitoring stations as well as information from other agencies and the public to identify potential water quality stressors. It is important to identify stressors and potential sources of stressors so that water quality programs can target limited resources to address water quality problems.

Cumulative Effects

While any one activity may not have a dramatic effect on water quality, the cumulative effect of land use activities in a watershed can have a severe and long-lasting impact.

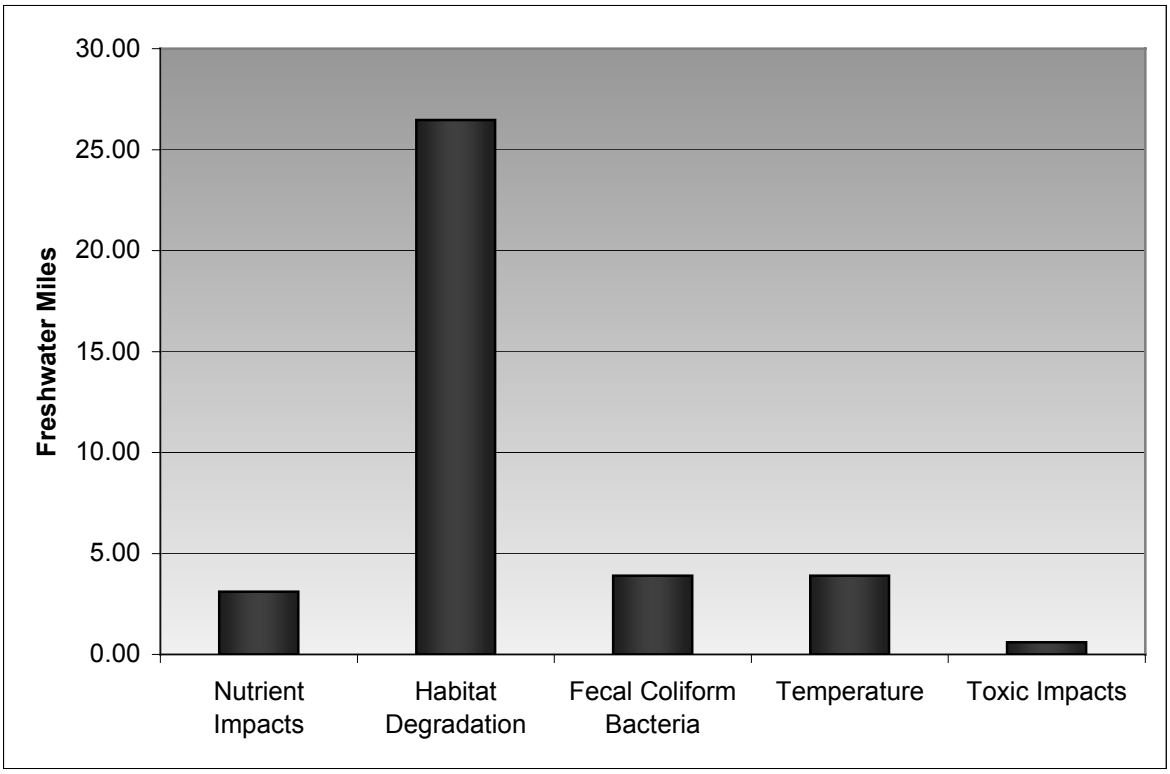
Most stressors to the biological community are complex groupings of many different stressors that individually may not degrade water quality or aquatic habitat, but together can severely impact aquatic life. Sources of stressors are most often associated with land use in a watershed, as well as the quality and quantity of any treated wastewater that may be entering a stream. During naturally severe conditions such as droughts or floods, any individual stressor or group of stressors may have more severe impacts to aquatic life than during normal climatic conditions. The most common source of stressors is from altered watershed hydrology.

Stressors to recreational uses include pathogenic indicators such as fecal coliform bacteria, escheria coli and enterrococci. Stressors to fish consumption are mercury and any other substance that causes the issuance of a fish consumption advisory by the NC Division of Health and Human Services (NCDHHS).

4.1.2 Overview of Stressors Identified in the Savannah River Basin

The stressors noted below are summarized for all waters and for all use support categories. Figure 8 presents the stressors identified for those waters with noted impacts. For specific discussion of stressors to the impairments or noted impacts, refer to the subbasin chapters (Chapters 1 – 2). Stressor definitions and potential impacts are discussed in the remainder of this chapter.

Figure 8 Stressors Identified for Streams with Noted Impacts in the Savannah River Basin



4.1.3 Introduction – Sources of Stressors

Pollutants that enter waters fall into two general categories: *point sources* and *nonpoint sources*.
Point sources are typically piped discharges and are controlled through regulatory programs administered by the state. All regulated point source discharges in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state.

Point Sources

Piped discharges from:
- Municipal wastewater treatment plants
- Industrial facilities
- Small package treatment plants
- Large urban and industrial stormwater systems

Nonpoint sources are from a broad range of land use activities. Nonpoint source pollutants are typically carried to waters by rainfall, runoff, and snowmelt. Sediment and nutrients are most often associated with nonpoint source pollution. Other pollutants associated with nonpoint source pollution include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or deposited from the atmosphere into surface waters. Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur intermittently, depending on rainfall events and land disturbance. Given these characteristics, it is difficult and

Nonpoint Sources

- Construction activities
- Roads, parking lots and rooftops
- Agriculture
- Failing septic systems and straight pipes
- Timber harvesting
- Hydrologic modifications

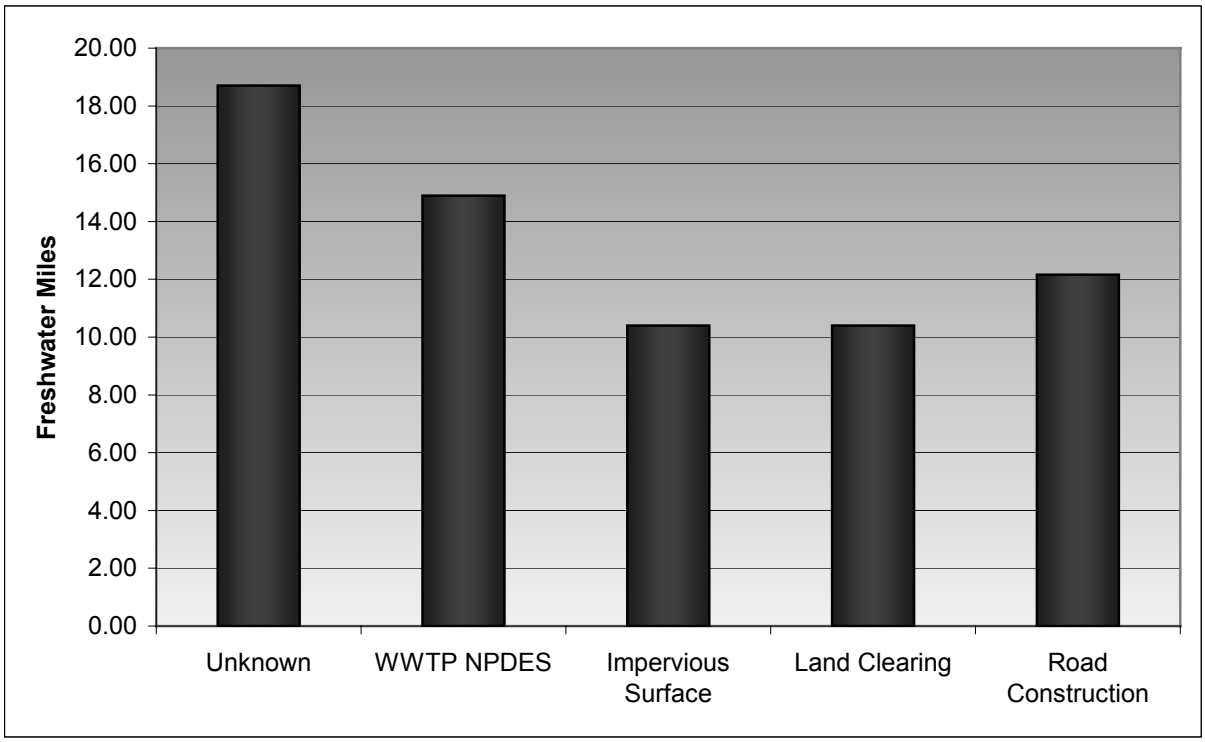
resource intensive to quantify nonpoint contributions to water quality degradation in a given watershed.

DWQ identifies the source of a stressor, point or nonpoint, as specifically as possible depending on the amount of information available in a watershed. Most often the source is based on the predominant land use in a watershed. Sources of stressors identified in the Savannah River basin during the most recent assessment period include urban or impervious surface runoff, land clearing, and road building. Point source discharges are also considered a water quality stressor source. In addition to these sources, many impacts originate from unknown sources.

4.1.4 Overview of Stressor Sources Identified in the Savannah River Basin

The sources noted below are summarized for all waters and for all use support categories. Figure 9 identifies sources of stressors noted for waters in the Savannah River Basin during the most recent assessment period. Refer to the subbasin chapters (Chapters 1 – 2) for a complete listing and discussion of sources by stream.

Figure 9 Sources of Stressors Identified in the Savannah River Basin



WWTP NPDES (wastewater treatment plants) were noted as a potential source of water quality problems in 14.9 stream miles in the Savannah basin. WWTPs are just one of many sources that can contribute excess nutrients that may increase the potential for algal blooms and cause exceedances in the chlorophyll *a* standard. Poor plant maintenance and operation can also result in stream toxicity problems from excess chlorine. Better treatment technology and upgrades to facilities in the Savannah basin are likely to decrease the number of stream miles impacted by WWTPs.

Impervious surface as a stressor source accounted for noted impacts to 10.4 stream miles and road construction activities accounted for noted impacts to 12.2 stream miles. Impervious surface cover and road construction activities are often associated with increased development. Refer to Chapter 5 for more information related to population growth and land cover changes and their potential impacts on water quality.

Stressor sources could not be identified for 18.7 stream miles in the Savannah River basin. These stream segments may be in areas where sources could not be identified during field observations, but the streams had noted impacts (i.e., habitat degradation). DWQ and the local agencies will work to identify potential sources for these stream segments during the next basinwide cycle.

4.2 Aquatic Life Stressors – Habitat Degradation

4.2.1 Introduction and Overview

Instream habitat degradation is identified as a notable reduction in habitat diversity or a negative change in habitat. This term includes sedimentation, streambank erosion, channelization, lack of riparian vegetation, loss of pools and/or riffles, loss of organic (woody and leaf) habitat, and streambed scour. These stressors to aquatic insect and fish communities can be caused by many different land use activities and less often by discharges of treated wastewater. In the Savannah River basin, no streams are Impaired by habitat degradation. However, habitat degradation is an identified stressor on 16.1 stream miles. Many of the stressors discussed below are either directly caused by or are a symptom of altered watershed hydrology. Altered hydrology increases both sources of stressors and delivery of the stressors to the receiving waters. Refer to the subbasin chapters (Chapters 1 – 2) for more information on the types of habitat degradation noted in a particular stream segment.

Good instream habitat is necessary for aquatic life to survive and reproduce. Streams that typically show signs of habitat degradation are in watersheds that have a large amount of land-disturbing activities (i.e., construction, mining, timber harvest, agricultural activities) or a large percentage of impervious surfaces. A watershed in which most of the riparian vegetation has been removed from streams or channelization (straightening) has occurred also exhibits instream habitat degradation. Streams that receive a discharge quantity that is much greater than the natural flow in the stream often have degraded habitat as well.

Some Best Management Practices to Improve Habitat Degradation

Agriculture

- No till or conservation tillage practices
- Strip cropping and contour farming
- Leaving natural buffer areas around small streams and rivers

Construction

- Using phased grading/seeding plans
- Limiting time of exposure
- Planting temporary ground cover
- Using sediment basins and traps

Forestry

- Controlling runoff from logging roads
- Replanting vegetation on disturbed areas
- Leaving natural buffer areas around small streams and rivers

Quantifying the amount of habitat degradation is very difficult in most cases. To assess instream habitat degradation in most streams would require extensive technical and monetary resources and then even more resources to restore them. Although DWQ and other agencies (i.e., SWCD, NRCS, town and county governments) are starting to address this issue, local efforts are needed to prevent further instream habitat degradation and to

restore streams that have been Impaired by activities that cause habitat degradation. As point source dischargers become less common sources of water quality impairment, nonpoint sources that pollute water and cause habitat degradation must be addressed to further improve water quality in North Carolina's streams and rivers.

4.2.2 Sedimentation

Sedimentation is a natural process that is important to the maintenance of diverse aquatic habitats. It is the process by which soil particles that washed off the landscape and stream banks are deposited within the stream. Streams naturally tend toward a state of equilibrium between erosion and deposition of sediments. As streams meander through their floodplains, the outside of the stream cuts into the bank eroding it away, while the inside of the stream deposits sediments to create sand bars further downstream. The natural process of erosion and deposition can be disrupted by human activities such as dams, dredging, agriculture, development, or logging. Construction projects or logging in the upper reaches of a watershed may worsen erosion or sediment deposition on someone else's property further downstream. If people straighten, narrow, or move stream channels without taking into consideration their natural energy, erosion and sediment deposition rates can increase, resulting in the loss of valuable agricultural land, damage to roads or structures, destruction of productive wetlands, and addition of sediments and nutrients to waterways that can degrade surface water quality and biodiversity.

Overloading of sediment in the form of sand, silt and clay particles fills pools and covers or embeds riffles that are vital aquatic insect and fish habitats. Suspended sediment can decrease primary productivity (i.e., photosynthesis) by shading sunlight from aquatic plants, thereby affecting the overall productivity of a stream system. Suspended sediment also has several effects on various fish species including avoidance and redistribution, reduced feeding efficiency which leads to reduced growth by some species, respiratory impairment, reduced tolerance to diseases and toxicants, and increased physiological stress (Roell, 1999). Sediment filling rivers and streams decreases their storage volume and increases the frequency of floods (NCDENR-DLR, 1998). Suspended sediment also increases the cost of treating municipal drinking water.

Streambank erosion and land-disturbing activities are sources of sedimentation. Streambank erosion is often caused by high stormwater flows immediately following rainfall events or snowmelts. Watersheds with large amounts of impervious surface transport water to streams more rapidly and at higher volumes than in watersheds with more vegetative cover. In many urban areas, stormwater is delivered directly to the stream by a stormwater sewer system. This high volume and concentrated flow of water after rain events undercuts streambanks often causing streambanks to collapse. This leads to large amounts of sediment being deposited into the stream. Many urban streams are adversely impacted by sediment overloading from the watershed as well as from the streambanks. Minimizing impervious surface area and reducing the amount of stormwater outlets releasing stormwater directly to the stream can often prevent substantial amounts of erosion.

Land-disturbing activities such as the construction of roads and buildings, crop production, livestock grazing, and timber harvesting can accelerate erosion rates by causing more soil than usual to be detached and moved by water. In most land-disturbing activities, sedimentation can be controlled through the use of appropriate best management practices (BMPs). BMPs that minimize the amount of acreage and length of time that the soil is exposed during land-

disturbing activities can greatly reduce the amount of soil erosion. For more information on sedimentation as it relates to changes in land use, refer to Chapter 5.

Livestock grazing with unlimited access to the stream channel and banks can also cause severe streambank erosion resulting in sedimentation and degraded water quality. Although they often make up a small percentage of grazing areas by surface area, riparian zones (vegetated stream corridors) are particularly attractive to cattle that prefer the cooler environment and lush vegetation found beside rivers and streams. This concentration of livestock can result in increased sedimentation of streams due to "hoof shear", trampling of bank vegetation, and entrenchment by the destabilized stream. Despite livestock's preference for frequent water access, farm veterinarians have reported that cows are healthier when stream access is limited (EPA, 1999). For more information on the livestock exclusion, refer to Chapter 7.

4.2.3 Loss of Riparian Vegetation

During the 2004 basinwide sampling, DWQ biologists reported minor impacts to the riparian zone along some streams. Riparian vegetation loss was most common in residential and commercial areas (NCDENR-DWQ, 2005). Removing trees, shrubs and other vegetation to plant grass or place rock (also known as riprap) along the bank of a river or stream degrades water quality. Removing riparian vegetation eliminates habitat for aquatic macroinvertebrates that are food for trout and other fish. Rocks lining a streambank absorb the sun's heat and warm the water. Some fish require cooler water temperatures as well as the higher levels of dissolved oxygen cooler water provides. Trees, shrubs and other native vegetation cool the water by shading it. Straightening a stream, clearing streambank vegetation, and lining the streambanks with grass or rock severely impact the habitat that aquatic insects and fish need to survive.

Establishing, conserving and managing streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. Forested buffers in particular provide a variety of benefits including filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife (NCDENR-DWQ, 2004). To obtain a free copy of DWQ's *Buffers for Clean Water* brochure, call (919) 733-5083, ext. 558.

4.2.4 Loss of Instream Organic Microhabitats

Organic microhabitat (i.e., leafpacks, sticks and large wood) and edge habitat (i.e., root banks and undercut banks) play very important roles in a stream ecosystem. Organic matter in the form of leaves, sticks and other materials serve as the base of the food web for small streams. Additionally, these microhabitats serve as special niches for different species of aquatic insects, providing food and/or habitat. For example, many stoneflies are found almost exclusively in leafpacks and on small sticks. Some beetle species prefer edge habitat, such as undercut banks. If these microhabitat types are not present, there is no place for these specialized macroinvertebrates to live and feed. The absence of these microhabitats in some streams in the Savannah River basin is directly related to the absence of riparian vegetation. Organic microhabitats are critical to headwater streams, the health of which is linked to the health of the entire downstream watershed. For more information related to headwater streams, refer to Chapter 5.

4.2.5 Channelization

Channelization refers to the physical alteration of naturally occurring stream and riverbeds. Typical modifications are described in the text box. Although increased flooding, streambank erosion and channel instability often occur in downstream areas after channelization has occurred, flood control, reduced erosion, increased usable land area, greater navigability and more efficient drainage are frequently cited as the objectives of channelization projects (McGarvey, 1996). Direct or immediate biological effects of channelization include injury and mortality of aquatic insects, fish, shellfish/mussels and other wildlife populations, as well as habitat loss. Indirect biological effects include changes in the aquatic insect, fish and wildlife community structures, favoring species that are more tolerant of or better adapted to the altered habitat (McGarvey, 1996).

Typical Channel Modifications

- Removal of any obstructions, natural or artificial, that inhibit a stream's capacity to convey water (clearing and snagging).
- Widening, deepening or straightening of the channel to maximize conveyance of water.
- Lining the bed or banks with rock or other resistant materials.

Restoration or recovery of channelized streams may occur through processes, both naturally and artificially induced. In general, streams that have not been excessively stressed by the channelization process can be expected to return to their original forms. However, streams that have been extensively altered may establish a new, artificial equilibrium (especially when the channelized streambed has been hardened). In such cases, the stream may enter a vicious cycle of erosion and continuous entrenchment. Once the benefits of a channelization project become outweighed by the costs, both in money and environmental integrity, channel restoration efforts are likely to be taken (McGarvey, 1996).

Channelization of streams within the continental United States is extensive and promises to become even more so as urban development continues. Overall estimates of lost or altered riparian habitats within US streams are as high as 70 percent. Unfortunately, the dynamic nature of stream ecosystems makes it difficult (if not impossible) to quantitatively predict the effects of channelization (McGarvey, 1996). Channelization has occurred historically in parts of the Savannah River basin and continues to occur in some watersheds, especially in small headwater streams.

4.2.6 Small Dams, Impoundments, and Water Features

The consensus among river ecologists is that dams are the single greatest cause of the decline of river ecosystems (World Commission on Dams, 2000). This report was focused on large dams, but by design, all dams, including small impoundments, alter the natural flow regime, and with it virtually every aspect of a river ecosystem, including water quality, sediment transport and deposition, fish migrations and reproduction, and riparian and floodplain habitat and the organisms that rely on this habitat (Raphals, 2001). Dams also require ongoing maintenance. For example, reservoirs in sediment-laden streams lose storage capacity as silt accumulates in the reservoir.

Dams cause significant adverse impacts to the ecology of rivers and streams by blocking migration of fish to upriver spawning habitat; warming water temperatures in impoundments

well above downstream conditions and accumulating sediment, which degrades water quality and often buries high quality fisheries habitat.

The damming and/or diverting of streams can lead to the loss of habitat resulting from the inundation of wetlands, riparian areas, and farmland in upstream areas of the impounded waterway, or erosion of these resources in downstream areas. As dams trap sediment and other pollutants, changes in water quality especially in tailwaters and downstream areas occur. They include: reduced sediment transport, decreased dissolved oxygen, altered temperature regimes, and increased levels of some pollutants, such as hydrogen sulfide, nutrients, and manganese.

Once streams are impounded, water demand dictates the artificial regulation and control of streamflow. The new flow rates and volume often do not reproduce natural conditions preceding the impoundment. Releases of impounded water with decreased levels of dissolved oxygen, high turbidity, or altered temperature can reduce downstream populations of fish and other organisms. Not only can reservoir water temperatures and oxygen content differ significantly from expected seasonal temperatures in the formerly free-flowing stream or river, but critical minimum flows needed for riparian areas are often not maintained as well. (EPA, 1995).

These effects are seen in both large and small impoundments. In 2003, the Tennessee Department of Environment and Conservation, Division of Water Pollution Control was awarded a grant to perform a probabilistic monitoring study of 75 streams below small impoundments. Many of these are similar to those found in western North Carolina. The study measured effects of the impoundments on aquatic life, nutrients, dissolved oxygen, pH, iron, manganese, habitat, flow and periphyton density in the downstream stream reaches.

Macroinvertebrate communities were adversely affected in most of the streams sampled. Of the 75 sites below impoundments, only four passed biological criteria guidelines or were comparable to unimpounded streams in both seasons sampled. A shift in the type of dominant organisms toward more tolerant taxa was also observed.

Lack of adequate flow was one of the biggest problems downstream of impoundments. Approximately one third of the perennial streams that were randomly selected for reconnaissance were dry. Of those with flow during the summer reconnaissance, one fourth had dry channels by the fall sampling period. Thirty-nine percent of the dams with year-round discharge provided insufficient flow to supply adequate habitat for aquatic life during at least one season.

Disruption of habitat was a major concern below most of the impoundments. Sediment deposition was the most significant habitat problem in impounded streams with 80% failing to meet regional expectations. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many aquatic organisms. Other frequently documented habitat problems included embedded substrate, instability of banks, loss of stream sinuosity and disruption of bank vegetation.

The most frequently encountered chemical water quality problems below impoundments were elevated iron, manganese and nutrients as well as low dissolved oxygen concentrations. Elevated manganese was the number one problem. Ammonia was the most frequently elevated nutrient.

Dissolved oxygen in lakes and streams is critical to support fish and aquatic life. Low levels of dissolved oxygen may be caused by decay of organic material, respiration of algae, inflow of

substantial amounts of ground water, or reduced stream flow. Dissolved oxygen was below criteria in at least one season at 21 of the impounded test sites. Many sites that passed dissolved oxygen criteria during daylight hours did not maintain saturation comparable to reference levels. Streams with dissolved oxygen saturation below this level may not be providing adequate oxygen to support benthic communities appropriate for the ecoregion.

Water temperature is an important component of the aquatic environment. Almost all facets of life history and distribution of aquatic macroinvertebrates are influenced by temperature. Eight of the impounded streams violated the temperature criterion at the time of sampling. Most of the test sites fell outside the temperature ranges found in regional reference streams.

Approximately half of the impounded test sites had elevated suspended solids (TSS) compared to regional reference streams. Total suspended solids (TSS) can include a wide variety of material, such as silt and decaying organic matter. High TSS can block light from reaching submerged vegetation. Particles can clog gills, reduce growth rates, decrease resistance to disease and prevent egg and larval development of benthic fauna. Suspended particles absorb heat from sunlight, which can result in higher water temperatures. Pollutants such as bacteria, nutrients, pesticides and metals may attach to sediment particles and be transported to the water where they are released or carried further downstream. (Arnwine, 2006)

These results clearly demonstrate the negative impact small dams and impoundments can have on stream habitat and water quality. DWQ strongly encourages developers and homeowners to carefully consider these impacts before choosing to install a water feature. In many cases, the harm caused will outweigh the benefits. Additionally, many existing small dams and impoundments may have outlived their usefulness. These old dams negatively influence biological communities and may have become maintenance problems. Removal options should be explored for these dams.

4.2.7 Recommendations for Reducing Habitat Degradation

In March 2002, Environmental Management Commission (EMC) sent a letter to the Sedimentation Control Commission (SCC) expressing seven recommendations for improving erosion and sedimentation control, based on a comprehensive performance review of the turbidity standard conducted in 2001 by DWQ staff. Specifically, the recommendations are that the EMC and SCC:

(1) Evaluate, in consultation with the Attorney General's Office, whether statutory authority is adequate to mandate temporary ground cover over a percentage of the uncovered area at a construction site within a specific time after the initial disturbance of the area. If it is found that statutory authority does not exist, then the EMC and SCC should prepare resolutions for the General Assembly supporting new legislation to this effect.

(2) Prepare resolutions supporting new legislation to increase the maximum penalty allowed in the Sedimentation Pollution Control Act from $5,000 to $25,000 for the initial response to a noncompliant site.

(3) Jointly support a review of the existing Erosion and Sediment Control Planning and Design Manual by the NC Division of Land Resources (DLR). This review should

include, but not be limited to, a redesign of the minimum specifications for sedimentation basins.

(4) Evaluate, in consultation with the Attorney General's Office, whether the statutory authority is adequate for effective use of the "Stop Work Order" tool and, if found not to be adequate, to prepare resolutions for the General Assembly supporting new legislation that will enable staff to more effectively use the "Stop Work Order" tool.

(5) Support increased research into and experimentation with the use of polyacrylamides (PAMs) and other innovative soil stabilization and turbidity reduction techniques.

(6) Jointly support and encourage the awarding of significant monetary penalties for all activities found to be in violation of their Stormwater Construction General Permit, their Erosion and Sediment Control Plan, or the turbidity standard.

(7) Hold those individuals who cause serious degradation of the environment through excessive turbidity and sedimentation ultimately responsible for restoration of the area.

DWQ will continue to work cooperatively with DLR and local programs that administer sediment control in order to maximize the effectiveness of the programs and to take appropriate enforcement action when necessary to protect or restore water quality. However, more voluntary implementation of BMPs is needed for activities that are not subject to these rules in order to substantially reduce the amount of widespread sedimentation present in the Savannah River basin. Additionally, more public education is needed basinwide to educate landowners about the value of riparian vegetation along small tributaries and the impacts of sedimentation to aquatic life.

Funding is available through numerous federal and state programs for landowners to restore and/or protect riparian buffer zones along fields or pastures, develop alternative watering sources for livestock, and fence animals out of streams (refer to Chapters 7 and 11). EPA's *Catalog of Federal Funding Sources for Watershed Protection* (Document 841-B-99-003) outlines some of these and other programs aimed at protecting water quality. A copy may be obtained by calling the National Center for Environmental Publications and Information at (800) 490-9198 or by visiting the website at http://www.epa.gov/OWOW/watershed/wacademy/fund.html. Local contacts for various state and local agencies are listed in Appendix VII.

4.3 Aquatic Life Stressors – Water Quality Parameters

4.3.1 Introduction and Overview

In addition to the habitat stressors discussed in the previous section, the stressors discussed below are identified by measurable water quality parameters. These are usually direct measures of water quality parameters from ambient water quality monitoring stations. Some of these parameters are incorporated into water quality standards designed to protect aquatic life. As with habitat degradation, altered watershed hydrology increases the sources of these stressors as well as delivery of the stressors to the receiving waters. The following water quality parameters were identified as stressors in the Savannah River basin. Refer to the subbasin chapters (Chapter 1 – 2) for more information on the affected waters.

4.3.2 Nutrient Impacts

Nutrient Impacts are related to elevated concentrations of nitrogen and/or phosphorus and are generally more pronounced in larger, slow moving bodies of water. Nitrogen and phosphorus occur naturally, but can be introduced to streams in excess by human activities. Common human sources include leaking sewer/septic systems and over application of fertilizers. The symptoms of nutrient impacts are widely varied, but often include increased algal growth and wild swings in dissolved oxygen concentrations. Nutrient impacts can also cause shifts in the make-up of aquatic communities. In the Savannah River basin, such a shift was noted in the fast moving Norton Mill Creek (Chapter 1.4.2). While overall stream health remains good in this stream, a dramatic shift in the benthic community towards species that favor nutrient rich conditions indicates water quality may be worsening in the 3.1 mile reach.

4.3.3 Toxic Impacts

Toxic impacts are noted as a stressor during biological monitoring when biologists see an unusual number of deformities in benthic insects. Waters are not impaired due to toxic impacts, but toxic impacts can be noted as a potential stressor on the system. In the Savannah River basin during the most recent assessment period, toxic impacts were noted on 0.6 miles of the Chattooga River below the Cashiers WWTP. Refer to Chapter 1 for more information.

4.3.4 Temperature

All aquatic species require specific temperature ranges in order to be healthy and reproduce. For example, trout prefer temperatures below 20 degrees C and cannot survive in the warm reservoirs of the piedmont and coastal plain where temperatures can exceed 30 degrees C. An aquatic species becomes stressed when water temperatures exceed their preferred temperature range, and stressed fish are more susceptible to injury and disease. In the Savannah Basin, the ambient water quality station on the Horsepasture River indicates that the water temperature occasionally exceeds the preferred range for trout in a 3.9-mile segment. While these excursions do not constitute water quality impairment, they do suggest that care must be taken to ensure stream temperature is not elevated by human activities. The human activities most likely to contribute to temperature increases in the Savannah Basin include removal of shade trees along stream banks and construction of dams and ponds. In both cases, more sunlight reaches the stream causing a temperature increase. Impervious surfaces can also increase stream temperatures. Rain falling onto hot roofs and parking lots absorbs heat before flowing quickly through gutters and storm drains into nearby creeks.

4.3.5 Fish Consumption Advisories and Advice Related to Mercury

The presence and accumulation of mercury in North Carolina's aquatic environment are similar to contamination observed throughout the country. Mercury has a complex life in the environment, moving from the atmosphere to soil, to surface water, and eventually, to biological organisms. Mercury circulates in the environment as a result of natural and human (anthropogenic) activities. A dominant pathway for mercury in the environment is through the atmosphere. Mercury emitted from industrial and municipal stacks into the ambient air can circulate around the globe. At any point, mercury may then be deposited onto land and water. Once in the water, mercury can accumulate in fish tissue and humans. Mercury is also

commonly found in wastewater; however, mercury in wastewater is typically not at levels that could be solely responsible for elevated fish levels

Fish is part of a healthy diet and an excellent source of protein and other essential nutrients. However, nearly all fish and shellfish contain trace levels of mercury. The risks from mercury in fish depend on the amount of fish eaten and the levels of mercury in the fish. In March 2003, the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) issued a joint consumer advisory for mercury in fish and shellfish. The advice is for women who might become pregnant, women who are pregnant, nursing mothers, and young children. Aside from being issued jointly by two federal agencies, this advisory is important because it emphasizes positive benefits of eating fish and gives examples of commonly eaten fish that are low in mercury. In the past, the FDA issued an advisory on consumption of commercially caught fish, while the EPA issued advice on recreationally caught fish.

By following these three recommendations for selecting and eating fish, women and young children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury. These recommendations are:

- **Do not eat shark, swordfish, king mackerel, or tilefish**. They contain high levels of mercury.

- Eat up to 12 ounces (two average meals) a week of a variety of fish and shellfish that are lower in mercury. Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish. Another commonly eaten fish, albacore ("white") tuna, has more mercury than canned light tuna. So, when choosing your two meals of fish, you may eat up to 6 ounces (one average meal) of albacore per week.

- Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters. Don't consume any other fish during that week.

For more detailed information, visit EPA's website at http://www.epa.gov/waterscience/fish/ or visit the FDA at http://www.cfsan.fda.gov/seafood1.html. The FDA's food information toll-free phone number is 1-888-SAFEFOOD.

The NC Department of Health and Human Services (NCDHHS) also issues fish consumption advisories and advice for those fish species and areas at risk for contaminants. NCDHHS notifies people to either limit consumption or avoid eating certain kinds of fish. While most freshwater fish in North Carolina contain very low levels of mercury and are safe to eat, several species have been found to have higher levels. More information regarding use support assessment methodology related to fish consumption advisories and advice can be found in Appendix VIII.

Due to high levels of mercury in seventeen saltwater and five freshwater fish species, the NCDHHS offers the following health advice (updated March 31, 2006).

> Women of childbearing age (15 to 44 years), pregnant women, nursing women, and children under 15:

- **Do not eat** the following ocean fish: almaco jack, banded rudderfish, canned white tuna (albacore tuna), cobia, crevalle jack, greater amberjack, south Atlantic grouper (gag, scamp, red, and snowy), king mackerel, ladyfish, little tunny, marlin, orange roughy, shark, Spanish mackerel, swordfish, tilefish, or tuna (fresh or frozen).
- **Do not eat** the following freshwater fish: bowfin (blackfish), catfish (caught wild), chain pickerel (jack fish), or warmouth caught in North Carolina waters south and east of Interstate 85.
- **Do not eat** largemouth bass caught in North Carolina waters (statewide).
- Eat up to two meals per week of other fish. A meal is 6 ounces of cooked fish for adults or 2 ounces of cooked fish for children under 15.

All other people:

- Eat no more than one meal (6 ounces) per week of ocean and/or freshwater fish listed above. These fish are often high in mercury.
- Eat up to four meals per week of other fish. A meal is 6 ounces of cooked fish for adults or 2 ounces of cooked fish for children under 15.

For more information and detailed listing of site-specific advisories, visit the NCDHHS website at http://www.schs.state.nc.us/epi/fish/current.html or call (919) 733-3816.

4.5 Recreation Stressor – Fecal Coliform Bacteria

Water quality standards for fecal coliform bacteria are intended to ensure safe use of waters for recreation and shellfish harvesting (refer to Administrative Code Section 15A NCAC 2B .0200). The North Carolina fecal coliform standard for freshwater is 200 colonies/100ml based on the geometric mean of at least five consecutive samples taken during a 30-day period and not to exceed 400 colonies/100ml in more than 20 percent of the samples during the same period.

No waters in the Savannah River basin are Impaired for fecal coliform bacteria. Current methodology requires additional bacteriological sampling for streams with a geometric mean greater than 200 colonies/100ml or when concentrations exceed 400 colonies/100ml in more than 20 percent of the samples. These additional assessments are prioritized such that, as monitoring resources become available, the highest priority is given to those streams where the likelihood of full-body contact recreation is the greatest. No streams in the Savannah River basin were prioritized for additional sampling during the most recent assessment period because no stream segments indicated elevated bacteria levels.

Fecal coliform bacteria live in the digestive tract of warm-blooded animals (humans as well as other mammals) and are excreted in their waste. Fecal coliform bacteria do not actually pose a danger to people or animals. However, where fecal coliform are present, disease-causing bacteria may also be present and water that is polluted by human or animal waste can harbor other pathogens that may threaten human health. Pathogens associated with fecal coliform bacteria can cause diarrhea, dysentery, cholera and typhoid fever in humans. Some pathogens can also cause infection in open wounds.

The presence of disease-causing bacteria tends to affect humans more than aquatic creatures. High levels of fecal coliform bacteria can indicate high levels of sewage or animal wastes that could make water unsafe for human contact (swimming). Fecal coliform bacteria and other potential pathogens associated with waste from warm-blooded animals are not harmful to fish and aquatic insects. However, high levels of fecal coliform bacteria may indicate contamination that increases the risk of contact with harmful pathogens in surface waters.

Under favorable conditions, fecal coliform bacteria can survive in bottom sediments for an extended period of time (Howell et al., 1996; Sherer et al., 1992; Schillinger and Gannon, 1985). Therefore, concentrations of bacteria measured in the water column can reflect both recent inputs as well as the resuspension of older inputs.

Sources of Fecal Coliform in Surface Waters

- Urban stormwater
- Wild animals and domestic pets
- Improperly designed or managed animal waste facilities
- Livestock with direct access to streams
- Improperly treated discharges of domestic wastewater, including leaking or failing septic systems and straight pipes

Reducing fecal coliform bacteria in wastewater requires a disinfection process, which typically involves the use of chlorine and other disinfectants. Although these materials may kill the fecal coliform bacteria and other pathogenic disease-causing bacteria, they also kill bacteria essential to the proper balance of the aquatic environment, and thereby, endanger the survival of species dependent on those bacteria.

There are a number of factors beyond the control of any state regulatory agency that contribute to elevated levels of disease-causing bacteria. Therefore, the state does not encourage swimming in surface waters. To assure that waters are safe for swimming indicates a need to test waters for pathogenic bacteria. Although fecal coliform standards have been used to indicate the microbiological quality of surface waters for swimming and shellfish harvesting for more than 50 years, the value of this indicator is often questioned. Evidence collected during the past several decades suggests that the coliform group may not adequately indicate the presence of pathogenic viruses or parasites in water.

The detection and identification of specific pathogenic bacteria, viruses and parasites such as *Giardia*, *Cryptosporidium* and *Shigella* are expensive, and results are generally difficult to reproduce quantitatively. Also, to ensure the water is safe for swimming would require a whole suite of tests for many organisms, as the presence/absence of one organism would not document the presence/absence of another. This type of testing program is not possible due to resource constraints.

Chapter 5
Population Growth, Land Cover Changes, and Water Quality in Western North Carolina

Once one of the most remote and sparsely populated regions of the state, western North Carolina is now penetrated by modern interstates and highways that provide speedy access to the deepest folds of the rugged terrain. This improved access coupled with an abundance of recreational opportunities, cultural activities, and countless other amenities sets the stage for rapid population increases. With this growth comes increased pressure on the natural environment. Every person living in or visiting a watershed contributes to impacts on water quality. If water pollution is to be eliminated, each individual should be aware of these contributions and take actions to reduce them. The following section describes the most common impacts of human activity and offers suggestions to lessen those impacts.

5.1 Impacts of Population Growth and Land Cover Changes

5.1.1 Rapid Urbanization

Population growth results in dramatic impacts on the natural landscape. The most obvious impact is the expansion of urban and suburban areas. New stores, roads, and subdivisions are products of growing populations. What is not so obvious is the astonishing rate at which rural landscapes are converted to developed land. Between 1982 and 1997, the United States population increased by 15 percent. Over the same period, developed land increased by 34 percent – more than double the rate of population growth (NRI, 2001; U.S. Census Bureau, 2000). Locally, the trend can be even more pronounced. For example, the urban area of Charleston, SC expanded 250 percent between 1973 and 1994 while its population grew by 40 percent (Allen and Lu, 2000).

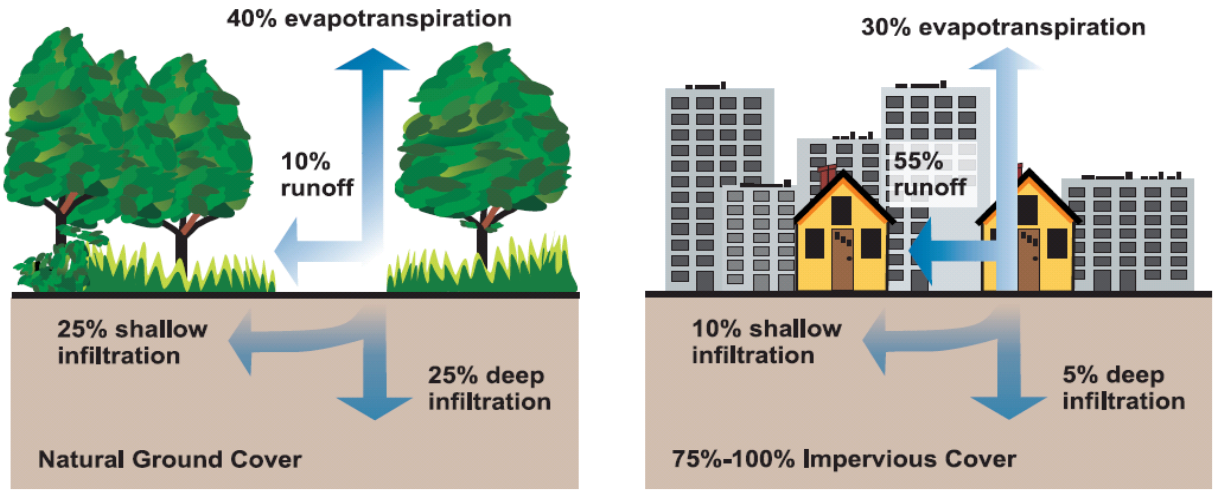
County populations in the Savannah River basin are expected to grow by over 20 percent between 2000 and 2020 (See Appendix I). If development patterns follow the trends described above, there could be a 40 percent increase in developed land in the Hiwassee River basin by 2020. Such an increase in developed land poses a significant threat to water quality and stream health because it will be accompanied by a similar increase in impervious surfaces.

Impervious surfaces are materials that prevent infiltration of water into the soil and include roads, rooftops, and parking lots (Figure 10). Impervious surfaces alter the natural hydrology, prevent the infiltration of water into the ground, and concentrate the flow of stormwater over the landscape. In undeveloped watersheds, stormwater filters down through the soil, replenishing groundwater quantity with water of good quality.

Vegetation stabilizes the soil, slows the flow of stormwater over land, and filters out some pollutants, by both slowing the flow of the water and trapping some pollutants in the root system. As the imperviousness of a watershed increases, the greater volume of stormwater increases the possibility of flooding and reduces the potential for pollutants to settle out, meaning that more pollution is delivered to drinking water streams and aquifers. Too much paving and hardening of a watershed can reduce infiltration and groundwater levels which in turn can decrease the

availability of aquifers, streams and rivers for drinking water supplies (Kauffman and Brant, 2000). It is well established that stream degradation begins to occur when 10 percent or more of a watershed is covered with impervious surfaces (Schueler, 1995).

Figure 10 Impervious Cover and Surface Runoff (EPA, 2003)



Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface ruunoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.

5.1.2 Population Growth and Urbanization Impacts on Aquatic Resources

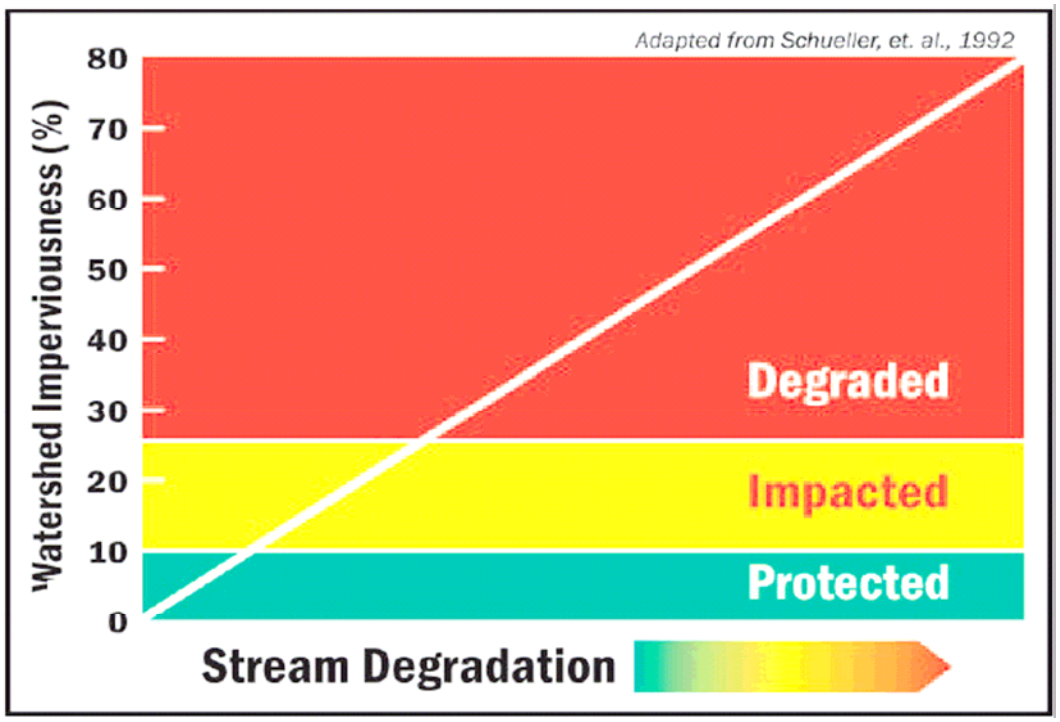
Urbanization poses one of the greatest threats to aquatic resources. The small towns and communities in western North Carolina are usually not considered urban centers, but even small concentrations of urbanizing areas have significant impacts on local waterways. For example, a one-acre parking lot produces 16 times more runoff than a one-acre meadow (Schueler and Holland, 2000). A wide variety of studies over the past decade converge on a central point: when more than 10 percent of the acreage in a watershed is covered in roads, parking lots, rooftops, and other impervious surfaces, the rivers and streams within the watershed become seriously degraded. Brown trout populations have been shown to decline sharply at 10 to 15 percent imperviousness. If urbanized area covers more than 25 percent of a watershed, these studies point to an irreversible decline in ecosystem health (Beach, 2002 and Galli, 1991).

Greater numbers of homes, stores, and businesses require greater quantities of water. Growing populations not only require more water, but they also lead to the discharge and runoff of greater quantities of waste and pollutants into the state's streams, rivers, lakes and groundwater. Thus, just as demand and use increases, some of the potential water supply is lost (Orr and Stuart, 2000).

As development in surrounding metropolitan areas consumes neighboring forests and fields, the impacts on rivers, lakes, and streams can be significant and permanent if stormwater runoff is not controlled (Orr and Stuart, 2000). As watershed vegetation is replaced with impervious surfaces, the ability of the landscape to absorb and diffuse the effects of natural rainfall is diminished. Urbanization results in increased surface runoff and correspondingly earlier and higher peak streamflows after rainfall. Flooding frequency also increases. These effects are compounded when small streams are channelized (straightened) or piped, and storm sewer systems are

installed to increase transport of stormwater downstream. Bank scour from these frequent high flow events tends to enlarge streams and increase suspended sediment. Scouring also destroys the variety of habitat in streams, leading to degradation of benthic macroinvertebrate populations and loss of fisheries (EPA, 1999). See Figure 11.

Figure 11 Impervious Cover and Stream Degradation



5.2 Key Elements of a Comprehensive Watershed Protection Strategy

Extensive research on the impacts of development and alarming population growth projections make it clear that comprehensive land use planning is necessary to protect aquatic resources. In order for land use planning to effectively protect watersheds in the long-term, tools and strategies must be applied at several scales. Effective implementation will require commitment ranging from the individual citizen to the state government. A comprehensive watershed protection plan should act on the following elements:

Basin Scale (Implemented by Town, County, and State Governments)

1. Characterize the watersheds within a basin as developed or undeveloped, identifying the watersheds that are currently less than 10 percent impervious and those that are more than ten percent impervious.
2. Focus new construction projects to the already developed watersheds first. Then assign any construction that cannot be accommodated in developed watersheds to a limited number of undeveloped watersheds. The watersheds to be developed should be determined by their ecological importance and by other regional growth considerations, such as the value of terrestrial ecosystems, the economic development potential as determined by proximity to roads and rail lines, and the disposition of landowners in the area toward land preservation and development.
3. Adopt policies that maintain impervious surfaces in undeveloped watersheds at less than ten percent. These can include private conservation easements, purchase of development

rights, infrastructure planning, urban service boundaries, rural zoning (20-200 acres per unit, depending on the area), and urban growth boundaries.
4. Ensure that local governments develop land use plans to provide adequate land for future development within developed or developing watersheds.

Neighborhood Scale (Implemented by Town and County Governments)

1. Allow residential densities that support transit, reduce vehicle trips per household and minimize land consumption. The minimum density for new development should be seven to ten net units per acre.
2. Require block densities that support walking and reduce the length of vehicle trips. Cities that support walking and transit often have more than 100 blocks per square mile.
3. Connect the street network by requiring subdivision road systems to link to adjacent subdivisions.
4. Integrate houses with stores, civic buildings, neighborhood recreational facilities, and other daily or weekly destinations.
5. Incorporate pedestrian and bike facilities (greenways) into new development and ensure these systems provide for inter-neighborhood travel.
6. Encourage and require other design features and public facilities that accommodate and support walking by creating neighborhoods with a pleasing scale and appearance. (e.g., short front-yard setbacks, neighborhood parks, alleys, and architectural and material quality)

Site Scale (Implemented by Individual Property Owners, Developers, and Town and County Governments)

1. Require application of the most effective structural stormwater practices, especially focusing on hot spots such as high-volume streets, gas stations, and parking lots.
2. Establish buffers and setbacks that are appropriate for the area to be developed – more extensive in undeveloped watersheds than in developed watersheds. In developed watersheds, buffers and setbacks should be reconciled to other urban design needs such as density and a connected street network.
3. Educate homeowners about their responsibility in watershed management, such as buffer and yard maintenance, proper disposal of oil and other toxic materials, and the impacts of excessive automobile use (Beach, 2002).

5.3 Focus Areas for Managing the Impacts of Population Growth

The elements of watershed protection listed in Section 5.2 above are intended to guide land use planning and population density decision-making. This section discusses specific concepts necessary to reduce the impacts of population growth.

5.3.1 Control Stormwater Runoff and Pollution

Introduction to Stormwater

Stormwater runoff is rainfall or snowmelt that runs off the ground and impervious surfaces (e.g., buildings, roads, parking lots, etc.). Because urbanization usually involves creation of new impervious surfaces, stormwater can quickly become a major concern in growing communities.

The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands traps rainwater and snowmelt and allows them to filter slowly into the ground. In contrast, impervious

(nonporous) surfaces like roads, parking lots, and rooftops prevent rain and snowmelt from infiltrating, or soaking, into the ground. Most of the rainfall and snowmelt remains above the surface, where it runs off rapidly in unnaturally large amounts.

Common Pollutants in Stormwater

Storm sewer systems concentrate runoff into smooth, straight conduits. This runoff gathers speed and power as it travels through the pipes. When this runoff leaves the storm drains and empties into a stream, its excessive volume and power blast out streambanks, damaging streamside vegetation and destroying aquatic habitat. These increased storm flows carry sediment loads from construction sites and other denuded surfaces and eroded streambanks. They often carry higher water temperatures from streets, rooftops, and parking lots, which are harmful to the health and reproduction of aquatic life. The steep slopes and large elevation changes in western North Carolina intensify this effect as water rushes downhill.

Storm sewers should not be confused with sanitary sewers, which transport human and industrial wastewaters to a treatment plant before discharging into surface waters. There is no pre-treatment of stormwater in North Carolina.

Uncontrolled stormwater runoff has many impacts on both humans and the environment. Cumulative effects include flooding, undercut and eroding streambanks, widened stream channels, threats to public health and safety, impaired recreational use, and increased costs for drinking and wastewater treatment. For more information on stormwater runoff, visit the DWQ Stormwater Permitting Unit at http://h2o.enr.state.nc.us/su/stormwater.html or the NC Stormwater information page at http://www.ncstormwater.org/. Additional fact sheets and information can also be found at http://www.stormwatercenter.net/intro_factsheets.htm and www.bae.ncsu.edu/stormwater/index.html.

Common Stormwater Pollutants

- Sediment
- Oil, grease, and toxic chemicals from motor vehicles
- Pesticides and nutrients from lawns and gardens
- Viruses, bacteria, and nutrients from pet waste and failing septic systems
- Road salts
- Heavy metals from roof shingles, motor vehicles, and other sources
- Thermal pollution from dark impervious surfaces such as streets and rooftops

Controlling Stormwater Runoff and Pollution

Many daily activities have the potential to cause stormwater pollution. Any situation where activities can contribute more pollutants to stormwater runoff is an area that should be considered for efforts to minimize stormwater impacts. A major component in reducing stormwater impacts involves planning up front in the design process. New construction designs should include plans to prevent or minimize the amount of runoff leaving the site. Wide streets, large cul-de-sacs, long driveways, and sidewalks lining both sides of the street are all features of urbanizing areas that create excess impervious cover and consume natural areas. In many instances, the presence of intact riparian buffers and/or wetlands in urban areas can reduce the impacts of urban development. Establishment and protection of buffers should be considered where feasible, and the amount of impervious cover should be limited as much as possible.

"Good housekeeping" to reduce the volume of stormwater leaving a site and reducing the amount of pollutants used in our own backyards can also minimize the impact of stormwater runoff.

DWQ has published a pamphlet entitled *Improving Water Quality in Your Own Backyard: Stormwater Management Starts at Home*. The pamphlet provides information on how homeowners and businesses can reduce the amount of runoff leaving their property and how to reduce the amount and types of pollutants in that runoff. This document is available on-line at http://h2o.enr.state.nc.us/nps/documents/BackyardPDF.pdf or by calling (919) 733-5083 ext. 558.

Preserving the natural streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. In particular, forested buffers provide a variety of benefits including filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife (NCDENR-DWQ, 2004). For more information or to obtain a free copy of DWQ's *Buffers for Clean Water* brochure, call (919) 733-5083, ext. 558.

5.3.2 Protect Headwater Streams

Many streams in a given river basin are only small trickles of water that emerge from the ground (Figure 12). A larger stream is formed at the confluence of these trickles. This constant merging eventually forms a large stream or river. Most monitoring of fresh surface waters evaluates these larger streams. The many miles of small trickles, collectively known as headwaters, are not directly monitored and in many instances are not even indicated on maps. These streams account for approximately 80 percent of the stream network and provide many valuable services for quality and quantity of water delivered downstream (Meyer et al., 2003). However, degradation of headwater streams can (and does) impact the larger stream or river.

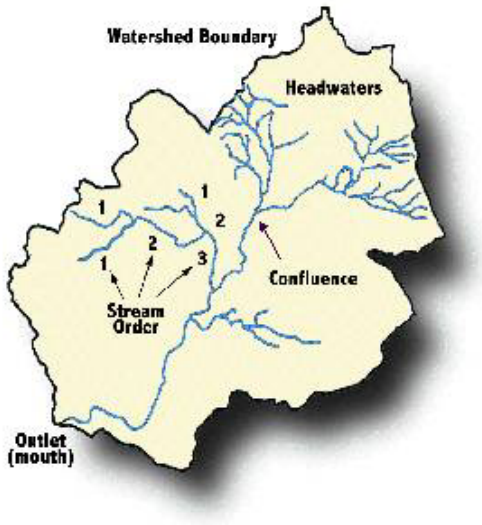


Figure 12 Diagram of Headwater Streams within a Watershed Boundary

There are three types of headwater streams: 1) perennial (flow year-round); 2) intermittent (flow during wet seasons); and 3) ephemeral (flow only after precipitation events). All types of headwater streams provide benefits to larger streams and rivers. Headwater streams control flooding, recharges groundwater, maintain water quality, reduce downstream sedimentation, recycle nutrients, and create habitat for plants and animals (Meyer et al., 2003).

In smaller headwater streams, fish communities are not well developed and benthic macroinvertebrates dominate aquatic life. Benthic macroinvertebrates are often thought of as "fish food" and, in mid-sized streams and rivers, they are critical to a healthy fish community. However, these insects, both in larval and adult stages, are also food for small mammals, such as river otter and raccoons, birds and amphibians (Erman, 1996). Benthic macroinvertebrates in headwater streams also perform the important function of breaking down coarse organic matter, such as leaves and twigs, and releasing fine organic matter. In larger rivers, where coarse organic matter is not as abundant, this fine organic matter is a primary food source for benthic macroinvertebrates and other organisms in the system (CALFED, 1999). When the benthic macroinvertebrate community is changed or extinguished in an area, even temporarily, as occurs during land use changes, it can have repercussions in many parts of both the terrestrial and aquatic food web.

Headwater streams also provide a source of insects for repopulating downstream waters where benthic macroinvertebrate communities have been eliminated due to human alterations and pollution. Adult insects have short life spans and generally live in the riparian areas surrounding the streams from which they emerge (Erman, 1996). Because there is little upstream or stream-to-stream migration of benthic macroinvertebrates, once headwater populations are eliminated, there is little hope for restoring a functioning aquatic community. In addition to macroinvertebrates, these streams support diverse populations of plants and animals that face similar problems if streams are disturbed. Headwater streams are able to provide these important ecosystem services due to their unique locations, distinctive flow patterns, and small drainage areas.

Because of the small size of headwater streams, they are often overlooked during land use activities that impact water quality. All landowners can participate in the protection of headwaters by keeping small tributaries in mind when making land use management decisions on the areas they control. This includes activities such as retaining vegetated stream buffers, minimizing stream channel alterations, and excluding cattle from streams. Local rural and urban planning initiatives should also consider impacts to headwater streams when land is being developed. For a more detailed description of watershed hydrology and watershed management, refer to EPA's Watershed Academy website at http://www.epa.gov/OWOW/watershed/wacademy/acad2000/watershedmgt/principle1.html.

5.3.3 Reduce Impacts from Steep Slope Disturbance

Dramatic elevation changes and steep slopes define mountain topography. Building sites perched along mountainsides provide access to unparalleled vistas and are a major incentive for development. However, construction on steep slopes presents a variety of risks to the environment and human safety.

Poorly controlled erosion and sediment from steep slope disturbance negatively impacts water quality, hydrology, aquatic habitat, and can threaten human safety and welfare. Soil types, geology, weather patterns, natural slope, surrounding uses, historic uses, and other factors all contribute to unstable slopes. Steep slope disturbance usually involves some form of grading. Grading is the mechanical excavation and filling of natural slopes to produce a level working surface. Improper grading practices disrupt natural stormwater runoff patterns and result in poor drainage, high runoff velocities, and increased peak flows during storm events. There is an inherent element of instability in all slopes and those who choose to undertake grading and/or

construction activities should be responsible for adequate site assessment, planning, designing, and construction of reasonably safe and stable artificial slopes.

In cases where construction activities occur on steep slopes, slope stabilization should be mandated through a Site Grading Plan and/or Site Fingerprinting. Site Grading Plans identify areas intended for grading and address impacts to existing drainage patterns. They identify practices to stabilize, maintain and protect slopes from runoff and include a schedule for grading disturbance as well as methods for disposal of borrow and fill materials. Site Fingerprinting is a low-impact development (LID) best management practice (BMP) that minimizes land disturbances. Fingerprinting involves clearing and grading only those onsite areas necessary for access and construction activities. Extensive clearing and grading accelerates sediment and pollutant transport off-site. Fingerprinting and maintenance of vegetated buffers during grading operations provide sediment control that reduces runoff and off-site sedimentation (Yaggi and Wegner, 2002).

Local communities also have a role in reducing impacts from steep slope development. These impacts can also be addressed through the implementation of city and/or county land use and sediment and erosion control plans. Land use plans are a non-regulatory approach to protect water quality, natural resources and sensitive areas. In the planning process, a community gathers data and public input to guide future development by establishing long-range goals for the local community over a ten- to twenty-year period. They can also help control the rate of development, growth patterns and conserve open space throughout the community. Land use plans examine the relationship between land uses and other areas of interest including quality-of-life, transportation, recreation, infrastructure and natural resource protection (Jolley, 2003).

Sediment and Erosion Control Plans are a regulatory approach to reducing the impacts of development and ensure that land disturbing activities do not result in water quality degradation, soil erosion, flooding, or harm to human health (i.e., landslides). The Division of Land Resources (DLR) Land Quality Section (LQS) has the primary responsibility for assuring that erosion is minimized and sedimentation is reduced during construction activities. Under the Sedimentation Pollution Control Act, cities and counties are given the option to adopt local ordinances that meet or exceed the minimum requirements established by the State. Local programs must be reviewed and approved by the NC Sedimentation Control Commission. Once approved, local staff performs plan reviews and enforces compliance. If for some reason the local program is not being enforced, the NC Sedimentation Control Commission can assume administrative control of the local program until the local government assures the State that it can administer and enforce sediment and erosion control rules. The Sedimentation and Pollution Control Act as well as an example of a local ordinance can be found on the DLR website (http://www.dlr.enr.state.nc.us/pages/sedimentation.html).

The requirements outlined in the Sedimentation Pollution Control Act were designed to be implementable statewide and may not fully capture the needs of mountain communities. For example, only projects disturbing more than 1-acre of land are required to produce a sediment and erosion control plan. Many small construction projects fall below this threshold. In steep mountainous terrain, even these small disturbances can produce an astounding volume of sediment runoff. DWQ strongly encourages local governments to adopt Sediment and Erosion Control ordinances that exceed the State's minimum requirements.

5.3.4 Implement Effective Education Programs

North Carolina's natural resources are under stress and could be lost in the absence of a widespread awareness of their existence, their significance and their value. Government officials, business leaders and private citizens must better understand the complexity of the natural ecosystems that support our quality of life and make this state an appealing place to live, work and visit.

These natural resources are not isolated from each other or from the people; each element is part of the ecosystem, interrelated and interconnected. When one part of the system is affected, other parts feel the impact. Sound development decisions require an understanding of these interconnections as well as of the life-support roles played by natural resources.
The cause and effect relationship between human behavior and the environment and the economics of that relationship must be well understood by decision makers - including individuals, business, industry, government, and elected officials - to instill a conservation ethic and a sense of stewardship into the choices facing the state. Such stewardship of land, water, air and biological resources is required to continue to enjoy the existing quality of life and to ensure future improvements.

Environmental policy is often viewed as regulatory in nature. The coercive powers of the state are limited, and no regulatory initiative that presses these limits can long survive. Environmental quality ultimately depends upon the understanding and support of individual and corporate citizens who come to embrace standards and practices that discourage pollution while they prize high quality air, water and soil. This relationship between knowledge of the environment and support for its protection form a basis of public policy development. While the need for education to improve our understanding of ecology and environment is accepted as important, the practice of environment education may take many forms. DWQ encourages implementation of educational programs tailored to specific audiences that invoke the following principles:

Respect and care for the community of life.
All things are connected. When something affects one part of the environment, other parts feel the impact. The more we understand and respect our own community, the better we will understand this interconnectedness and our responsibilities to the global community of life.

Improve the quality of human life.
The aim of development is to improve the overall quality of human life. Development must enable all people to realize their potential and lead lives of dignity and fulfillment. This kind of development requires a healthy and robust supporting ecosystem.

Conserve North Carolina's vitality and diversity.
Renewable natural resources are the base of all economies. Soil, water, air, timber, medicines, plants, fish, wildlife and domesticated species -- all come from natural systems and can be maintained through conservation.

Life support systems are the ecological processes that shape climate, cleanse air and water, regulate water flow, recycle essential elements, create and regenerate soil and keep our environment fit for life. We must prevent pollution and degradation of these ecosystems as well as the natural plant and wildlife habitats they provide.

Biological diversity includes the total array of species, genetic varieties, habitats and ecosystems on Earth. It contributes to our quality of life, including a healthy economy. It is a foundation of the Earth's biosphere, buffering us from the inevitable changes in the environment.

Change personal understanding and practice.
Society must promote values that build and support its ability to continuously improve the quality of living for its citizens. This requires maintaining the quality and integrity of our natural environment. Knowledge, awareness and decision-making skills must be taught through formal and non-formal education to promote problem solving and constructive action to nurture the life-giving qualities of our ecosystem.

Enable communities to care for their own environment.
Living within the limits set by the environment depends on the beliefs and commitment of individuals, but it is through communities that people share concerns and promote practices that can nourish rather than cripple their natural life-support systems.

Provide a state and local knowledge base for integrating development and conservation.
Economic policy can be an effective instrument for sustaining ecosystems and natural resources. Every economy depends on the environment as a source of life support and raw materials. The knowledge base for each city, county and the state must be strengthened, and information on environmental matters made more accessible. The State's adult and student populations must understand certain ecological and civics concepts, and North Carolina's place within those concepts.

5.4 The Role of Local Governments

5.4.1 Reduce Impacts from Existing Urbanization

Below is a summary of management actions recommended for local authorities, followed by discussions on large watershed management issues. These actions are necessary to address current sources of impairment and to prevent future degradation in all streams. The intent of these recommendations is to describe the types of actions necessary to improve stream conditions, not to specify particular administrative or institutional mechanisms for implementing remedial practices. Those types of decisions must be made at the local level.

Because of uncertainties regarding how individual remedial actions cumulatively impact stream conditions and in how aquatic organisms will respond to improvements, the intensity of management effort necessary to bring about a particular degree of biological improvement cannot be established in advance. The types of actions needed to improve biological conditions can be identified, but the mix of activities that will be necessary – and the extent of improvement that will be attainable – will only become apparent over time as an adaptive management approach is implemented. Management actions are suggested below to address individual problems, but many of these actions are interrelated (NCDENR-DWQ, 2003).

Actions one through five are important to restoring and sustaining aquatic communities in watersheds, with the first three recommendations being the most important.

(1) **Feasible and cost-effective stormwater retrofit projects should be implemented throughout the watershed to mitigate the hydrologic effects of development** (e.g.,

increased stormwater volumes and increased frequency and duration of erosive and scouring flows). This should be viewed as a long-term process. Although there are many uncertainties, costs in the range of $1 million per square mile can probably be anticipated.

(a) Over the short term, currently feasible retrofit projects should be identified and implemented.
(b) In the long term, additional retrofit opportunities should be implemented in conjunction with infrastructure improvements and redevelopment of existing developed areas.
(c) Grant funds for these retrofit projects may be available from EPA initiatives, such as EPA Section 319 funds, or the North Carolina Clean Water Management Trust Fund.

(2) **A watershed scale strategy to address toxic inputs should be developed and implemented, including a variety of source reduction and stormwater treatment methods.** As an initial framework for planning toxicity reduction efforts, the following general approach is proposed:

(a) Implementation of available BMP opportunities for control of stormwater volume and velocities. As recommended above to improve aquatic habitat potential, these BMPs will also remove toxics from stormwater.
(b) Development of a stormwater and dry weather sampling strategy in order to facilitate the targeting of pollutant removal and source reduction practices.
(c) Implementation of stormwater treatment BMPs, aimed primarily at pollutant removal, at appropriate locations.
(d) Development and implementation of a broad set of source reduction activities focused on: reducing non-storm inputs of toxics; reducing pollutants available for runoff during storms; and managing water to reduce storm runoff.

(3) **Stream channel restoration activities should be implemented in target areas, in conjunction with stormwater retrofit BMPs, in order to improve aquatic habitat.** Before beginning stream channel restoration, a geomorphologic survey should be conducted to determine the best areas for stream channel restoration. Additionally, it would be advantageous to implement retrofit BMPs before embarking on stream channel restoration, as restoration is best designed for flows driven by reduced stormwater runoff. Costs of approximately $200 per foot of channel should be anticipated (Haupt, et al., 2002 and Weinkam, 2001). Grant funds for these retrofit projects may be available from federal sources, such as EPA Section 319 funds, or state sources including North Carolina Clean Water Management Trust Fund.

(4) Actions recommended above (e.g., stormwater quantity and quality retrofit BMPs) are likely to reduce nutrient/organic loading, and to some extent, its impacts. Activities recommended to address this loading include the identification and elimination of illicit discharges; education of homeowners, commercial applicators, and others regarding proper fertilizer use; street sweeping; catch basin clean-out practices; and the installation of additional BMPs targeting biological oxygen demand (BOD) and nutrient removal at appropriate sites.
(5) Prevention of further channel erosion and habitat degradation will require effective post-construction stormwater management for all new development in the study area.

(6) Effective enforcement of sediment and erosion control regulations will be essential to the prevention of additional sediment inputs from construction activities. Development of improved erosion and sediment control practices may also be beneficial.

(7) Watershed education programs should be implemented and continued by local governments with the goal of reducing current stream damage and preventing future degradation. At a minimum, the program should include elements to address the following issues:

(a) Redirecting downspouts to pervious areas rather than routing these flows to driveways or gutters;
(b) Protecting existing woody riparian areas on all streams;
(c) Replanting native riparian vegetation on stream channels where such vegetation is absent; and
(d) Reducing and properly managing pesticide and fertilizer use.

5.4.2 Reduce Impacts of Future Urbanization

Proactive planning efforts at the local level are needed to assure that urbanization is done in a manner that maintains water quality. These planning efforts will need to find a balance between water quality protection, natural resource management, and economic growth. Managing population growth requires planning for the needs of increased population, as well as developing and enforcing environmental protection measures. These actions are critical to water quality management and the quality of life for the residents of the basin. Public education is also needed in the Savannah River basin so that citizens can learn and understand the value of urban planning and stormwater management.

Streams in areas adjacent to high growth areas of the basin are at a high risk of loosing healthy aquatic communities. These biological communities are important to maintaining the ecological integrity in the Savannah River basin. Unimpacted streams are important sources of benthic macroinvertebrates and fish for reestablishment of biological communities in nearby streams that are recovering from past impacts or are being restored.

To prevent further impairment to aquatic life in streams in urbanizing watersheds local governments should:

(1) Identify waters that are threatened by construction activities.
(2) Protect existing riparian habitat along streams.
(3) Implement stormwater BMPs during and after construction.
(4) Develop land use plans that minimize disturbance in sensitive areas of watersheds.
(5) Minimize impervious surfaces including roads and parking lots.
(6) Develop public outreach programs to educate citizens about stormwater runoff.
(7) Enact a Stormwater Control Ordinance. EPA offers a model ordinance at: http://www.epa.gov/nps/ordinance/stormwater.htm

For more detailed information regarding recommendations for new development found in the text box, refer to EPA's website at www.epa.gov/owow/watershed/wacademy/acad2000/protection, the Center for Watershed Protection website at www.cwp.org, and the Low Impact Development Center website at www.lowimpactdevelopment.org. For an example of local community planning effort to reduce stormwater runoff, visit http://www.charmeck.org/Home.htm. For more information on stormwater programs across the state, refer to Chapter 6.

Planning Recommendations for New Development

- Minimize number and width of residential streets.
- Minimize size of parking areas (angled parking & narrower slots).
- Place sidewalks on only one side of residential streets.
- Minimize culvert pipe and hardened stormwater conveyances.
- Vegetate road right-of-ways, parking lot islands and highway dividers to increase infiltration.
- Plant and protect natural buffer zones along streams and tributaries.
- Minimize the use of curb and gutter

5.5 The Role of Homeowners and Landowners

5.5.1 Ten Simple Steps to Reduce Runoff and Pollution from Individual Homes

1. To decrease polluted runoff from paved surfaces, households can develop alternatives to areas traditionally covered by impervious surfaces. Porous pavement materials are available for driveways and sidewalks, and native vegetation and mulch can replace high maintenance grass lawns.
2. Homeowners can use fertilizers sparingly and sweep driveways, sidewalks, and roads instead of using a hose.
3. Instead of disposing of yard waste, use the materials to start a compost pile.
4. Learn to use Integrated Pest Management (IPM) in the garden and on the lawn to reduce dependence on harmful pesticides.
5. Pick up after pets.
6. Use, store, and dispose of chemicals properly.
7. Drivers should check their cars for leaks and recycle their motor oil and antifreeze when these fluids are changed.
8. Drivers can also avoid impacts from car wash runoff (e.g., detergents, grime, etc.) by using car wash facilities that recycle water.
9. Households served by septic systems should have them professionally inspected and pumped every 3 to 5 years. They should also practice water conservation measures to extend the life of their septic systems.
10. Support local government watershed planning efforts and ordinance development.

Chapter 6
Stormwater and Wastewater Programs

6.1 Federal and State Stormwater Programs

The goal of the DWQ stormwater discharge permitting regulations and programs is to prevent pollution from entering the waters of the state via stormwater runoff. These programs try to accomplish this goal by controlling the source(s) of pollutants. These programs include NPDES Phase I and II regulations, HQW/ORW stormwater requirements, and requirements associated with the Water Supply Watershed Program. Currently, there are no individual stormwater permits listed for the Savannah basin and Phase I regulations are not applicable; however, there are a few local governments and/or counties that are affected by other water quality protection programs. Those affected are listed in Table 11.

6.1.1 NPDES Phase I

Phase I of the EPA stormwater program started with Amendments to the Clean Water Act (CWA) in 1990. Phase I required NPDES permit coverage to address stormwater runoff from medium and large stormwater sewer systems serving populations of 100,000 or more people. There are no NPDES Phase I stormwater permits issued in the Savannah River basin.

Phase I also had requirements for ten categories of industrial sources to be covered under stormwater permits. Industrial activities which require permitting are defined in categories ranging from sawmills and landfills to manufacturing plants and hazardous waste treatment, storage or disposal facilities. Construction sites disturbing greater than five acres are also required to obtain an NPDES stormwater permit under Phase I of the EPA stormwater program. Excluding construction stormwater general permits, there were no general stormwater permits or individual stormwater permits issued in this basin under Phase I.

6.1.2 NPDES Phase II

The Phase II stormwater program is an extension of the Phase I program that expands permit coverage to include smaller municipalities below 100,000 populations. The local governments permitted under Phase II are required to develop and implement a comprehensive stormwater management program that includes six minimum measures.

1. Public education and outreach on stormwater impacts;
2. public involvement/participation;
3. illicit discharge detection and elimination;
4. construction site stormwater runoff control;
5. post-construction stormwater management for new development and redevelopment; and
6. pollution prevention/good housekeeping for municipal operations.

Construction sites greater than one acre will also be required to obtain an NPDES stormwater permit under Phase II of the EPA stormwater program in addition to erosion and sedimentation control approvals.

Those municipalities and counties required to obtain a NPDES stormwater permit under the Phase II rules are identified using 1990 US Census Designated Urban Areas and the results of the 2000 US Census. Based on federal census data, EPA identified 123 cities, including, and 33 counties in North Carolina that would be required to obtain permits for stormwater management.

The EPA delegated Phase II implementation to each state and then in 1999 the Division of Water Quality and the Environmental Management Commission (EMC) initiated a rulemaking process.

Stormwater Management Rule Update:

In 2002, the EMC adopted temporary stormwater rules and by 2003 had adopted permanent rules that were to become effective August 1, 2004. In early 2004, the Rules Review Commission (RRC) objected to the rules for failure to comply with the Administrative Procedures Act and lack of statutory authority. The EMC challenged the decision of the RRC in court (EMC v. RRC 04 CVS 3157). A Wake County Superior Court ruled in the EMC's favor and the RRC subsequently approved the EMC's rules. However, while the case was pending the legislature enacted a separate set of requirements in 2004 that were designed to replace the EMC rules.

These rules include NPDES stormwater rules covering owners and operators of storm sewer systems and State stormwater rules covering activities in urbanizing areas. The EMC amended the rules at their November 10, 2005 meeting to address objections raised by the RRC at their October 2005 meeting. The inconsistency between the legislative requirements and the EMC rules necessitated consideration of Senate Bill 1566 in the 2006 short session. The legislature approved Session Law 2006-246, Senate Bill 1566 in 2006.

Senate bill 1566 provides that development projects in Phase II municipalities and counties that cumulatively disturb one acre or more of land must comply with the post-construction stormwater standards set out in the bill. The bill sets out criteria whereby unincorporated areas of counties will be subject to Phase II requirements. Under these criteria 25 counties are fully covered, while 8 counties have portions that are subject to the stormwater requirements. The bill also provides a designation and petition process by which additional local governments and other entities may be required to obtain a stormwater management permit.

The bill sets out stormwater controls that are based on a project's level of density and its proximity to Shellfish Resource Waters. Shellfish Resource Waters are waters classified by the EMC as Class SA waters (shellfish growing waters) that contain an average concentration of 500 parts per million of natural chloride ion (saltwater).

The Water Quality Committee (WQC) met in November 2006 and directed DWQ Staff to return at the January 2007 WQC meeting with proposed amendments to the State Stormwater Rules. These rules will extend the coastal post-construction stormwater controls in Session Law 2006-246 to all 20 Coastal Counties (Table 10).

Low Density Projects

Development projects that are located within one-half mile of and draining to Shellfish Resource Waters are considered low density if they contain no more than 12 percent built-upon area. A project that is not located within one-half mile of Shellfish Resource Waters is a low density project if it contains no more than 24 percent built-upon area or no more than two dwelling units per acre. Low density projects must use vegetated conveyances to the maximum extent practicable to transport stormwater runoff from the project.

High Density Projects

Projects that are located within one-half mile of and draining to Shellfish Resource Waters are considered high density if they contain more than 12 percent built-upon area. A project that is not located within one-half mile of Shellfish Resource Waters is a high density project if it contains more than 24 percent built-upon area or more than two dwelling units per acre. High density projects must use structural stormwater management systems that will control and treat runoff from the first one inch of rain unless the project is in a coastal county, in which case the project must use structural stormwater management systems that will control and treat runoff from the first one and one-half inches of rain. In addition, projects that are located within one-half mile and draining to Shellfish Resource Waters must control and treat the difference in the stormwater runoff from the pre-development and post-development conditions for the one-year twenty-four hour storm as well as meet certain design standards.

Implementation

The bill provides an implementation schedule that requires regulated entities to apply for an NPDES stormwater management permit within 18 months of being notified that it is a regulated entity subject to the requirements of this act. A regulated entity must implement its post-construction program no later than 24 months from the date the permit is issued and fully implement its permitted program within five years of permit issuance. City of Jacksonville and Onslow County have both submitted applications for Phase II.

The bill authorizes the EMC to adopt Phase II stormwater management rules. If the EMC does adopt rules, the rules must be substantially identical to the provisions of this act and will be automatically subject to review by the General Assembly and not subject to review by the RRC. The bill became effective retroactively to July 1, 2006.

Table 10 Major Post-Construction Stormwater Controls in SL 2006-246

	Shellfish Resource Waters* (SA Waters w/ > 500 ppm chlorides)	**SA Designated Waters – Not Shellfish Resource Waters***	**Coastal County – Not SA Designated Waters**	**Non – Coastal County**
Low Density Threshold	12%	24%	24%	24%
Storm Design for High Density	Difference in pre and post-development for 1-yr, 24-hour storm**	Runoff from first 1.5 inches of rain	Runoff from first 1.5 inches of rain	Runoff from first 1 inch of rain
Setback	30 feet	30 feet	30 feet	30 feet
Other Controls	No new points of s/w discharge No increase in rate, volume, or capacity in existing conveyances Infiltration up to 1-yr, 24-hr storm Diffuse flow in excess of 1-yr, 24-hr storm	No new points of s/w discharge No increase in rate, volume, or capacity in existing conveyances Infiltration up to 1-yr, 24-hr storm Diffuse flow in excess of 1-yr, 24-hr storm		

*These controls apply within ½ mile and draining to these waters.

**Amount of Runoff that would need to be controlled in inches for the difference in pre- and post-development conditions for the 1-year, 24-hour storm.

For additional information on stormwater programs please go to http://h2o.enr.state.nc.us/su/

2007 Recommendations

Even though none of the municipalities were identified as federally designated urban areas, DWQ recommends that the local governments and county officials develop stormwater management programs that go beyond the six minimum measures listed for Phase II rules. Implementation of stormwater programs should help reduce future impacts to streams in the basin. Local governments, to the extent possible, should identify sites for preservation or restoration. DWQ and other NCDENR agencies will continue to provide information on funding sources and technical assistance to support local government and county stormwater programs.

6.1.3 State Stormwater Programs – Sensitive Waters

The State Stormwater Management Program was established in the late 1980s under the authority of the North Carolina Environmental Management Commission (EMC) and North Carolina General Statute 143-214.7. This program, codified in 15A NCAC 2H .1000, affects development activities that require either an Erosion and Sediment Control Plan (for disturbances of one or more acres) or a CAMA major permit within one of the 20 coastal counties and/or development draining to Outstanding Resource Waters (ORW) or High Quality Waters (HQW). The State Stormwater Management Program requires developments to protect these sensitive waters by maintaining a low density of impervious surfaces, maintaining vegetative buffers, and transporting runoff through vegetative conveyances. Low-density development thresholds vary from 12-30 percent built-upon area (impervious surface) depending on the classification of the receiving stream. If low-density design criteria cannot be met, then high-density development requires the installation of structural best management practices (BMPs) to collect and treat stormwater runoff from the project. High density BMPs must control the runoff from the 1 or 1.5-inch storm event (depending on the receiving stream classification) and remove 85 percent of the total suspended solids.

Table 11 shows the counties in the Savannah basin where permits may be required under the state stormwater management program under ORW stormwater rules. All development requiring an Erosion and Sediment Control Plan (for disturbances of one or more acres) must obtain a stormwater permit.

2007 Recommendations

DWQ will continue implementing the state stormwater program with the other NCDENR agencies and local governments. Local governments should develop local land use plans that minimize impervious surfaces in sensitive areas. Communities should integrate state stormwater program requirements, to the extent possible, with other stormwater programs in order to be more efficient and gain the most water quality benefits for protection of public health and aquatic life.

Table 11 Communities in the Savannah Subject to Stormwater and/or Water Supply Watershed Stormwater Requirements

Local Government	NPDES		State Stormwater Program HQW/ORW	Water Supply Watershed Stormwater Requirements
	Phase I	Phase II*		
Municipalities				
Cashiers				
Highlands				**X**
Counties				
Clay			**X**	
Jackson			**X**	
Macon			**X**	
Transylvania			**X**	

6.1.4 Water Supply Watershed Stormwater Rules

The purpose of the Water Supply Watershed Protection Program is to provide a proactive drinking water supply protection program for communities. Local governments administer the program based on state minimum requirements. There are restrictions on wastewater discharges, development, landfills, and residual application sites to control the impacts of point and nonpoint sources of pollution. The program attempts to minimize the impacts of stormwater runoff by utilizing low-density development or stormwater treatment in high-density areas. Currently there are no water supply watersheds in the Savannah River basin.

6.2 Federal and State Wastewater Programs

6.2.1 NPDES Wastewater Discharge Permit Summary

The primary pollutants associated with point source discharges are:

- oxygen-consuming wastes,
- nutrients,
- sediments,
- color, and
- toxic substances including chlorine, ammonia and metals.

Discharges that enter surface waters through a pipe, ditch or other well-defined point of discharge are broadly referred to as 'point sources'. Wastewater point source discharges include municipal (city and county) and industrial wastewater treatment plants and small domestic wastewater treatment systems serving schools, commercial offices, residential subdivisions and individual homes. Stormwater point source discharges include stormwater collection systems for municipalities and stormwater discharges associated with certain industrial activities. Point source dischargers in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit. Discharge permits are issued under the NPDES program, which is delegated to DWQ by the Environmental Protection Agency (EPA).

NPDES Wastewater Discharge Definitions

Major Facilities: Wastewater treatment plants with flows ≥1 MGD (million gallons per day); and some industrial facilities (depending on flow and potential impacts to public health and water quality).

Minor Facilities: Facilities not defined as Major.

100% Domestic Waste: Facilities that only treat domestic-type waste (from toilets, sinks, washers).

Municipal Facilities: Public facilities that serve a municipality. Can treat waste from homes and industries.

Nonmunicipal Facilities: Non-public facilities that provide treatment for domestic, industrial or commercial wastewater. This category includes wastewater from industrial processes such as textiles, mining, seafood processing, glass-making and power generation, and other facilities such as schools, subdivisions, nursing homes, groundwater remediation projects, water treatment plants and non-process industrial wastewater.

Currently, there are 14 permitted wastewater discharges in the Savannah River basin. Table 12 provides summary information (by type and subbasin) about the discharges. The types of dischargers listed in the table are described in the inset box. Facilities are mapped in each subbasin chapter, and a complete listing of permitted facilities is included in Appendix V.

All of the NPDES permitted facilities are minor operations, discharging less than one million gallons per day (MGD). In November 2005, the single commercial discharge ceased operation. The Tuckaseigee Water and Sewer Authority operates the single municipal discharge, Cashiers WWTP. All remaining NPDES discharges in the Savannah River basin are privately owned 100% Domestic wastewater treatment plants (WWTP). Facilities where recent data show problems with a discharge are discussed in each subbasin chapter (Chapters 1-2).

Table 12 Summary of NPDES Dischargers and Permitted Flows for the Savannah Basin (April 2006)

	Savannah River Subbasin		
Facility Categories	**03-13-01**	**03-13-02**	**TOTAL**
Total Facilities	5	9	14
Total Permitted Flow (MGD)	0.43	1.13	1.56
Facilities Grouped by Size			
Major Discharges	0	0	0
Permitted Flow (MGD)	0	0.0	0
Minor Discharges	5	9	14
Permitted Flow (MGD)	0.43	1.13	1.56
Facilities Grouped by Type			
100% Domestic Waste	4	9	13
Permitted Flow (MGD)	0.23	1.13	1.36
Municipal Facilities	1	0	1
Permitted Flow (MGD)	0.20	0	0.20
Nonmunicipal Facilities	0	0	0
Permitted Flow (MGD)	0	0	0

6.2.2 Septic Systems and Straight Piping

In the Savannah River basin, wastewater from many households is not treated at wastewater treatment plants associated with NPDES discharge permits. Instead, it is treated on-site through the use of permitted septic systems. Wastewater from some of these homes illegally discharges directly to streams through what is known as a "straight pipe". In other cases, wastewater from failing septic systems makes its way to streams or contaminates groundwater. Straight piping and failing septic systems are illegal discharges of wastewater into waters of the State.

With on-site septic systems, the septic tank unit treats some wastes, and the drainfield associated with the septic tank provides further treatment and filtration of the pollutants and pathogens found in wastewater. A septic system that is operating properly does not discharge untreated wastewater to streams and lakes or to the ground's surface where it can run into nearby surface waters. Septic systems are a safe and effective long-term method for treating wastewater if they are sited, sized and maintained properly. If the tank or drainfield are improperly located or constructed, or the systems are not maintained, nearby wells and surface waters may become contaminated, causing potential risks to human health. Septic tanks must be properly installed and maintained to ensure they function properly over the life of the system. Information about the proper installation and maintenance of septic tanks can be obtained by calling the environmental health sections of the local county health departments. See Appendix VII for contact information.

The discharge of untreated or partially treated sewage can be extremely harmful to humans and the aquatic environment. Pollutants from illegally discharged household wastewater contain chemical nutrients, disease pathogens and endocrine disrupting chemicals. Although DWQ ambient monitoring stations in the Savannah River basin do not show fecal coliform bacteria samples exceeding state standards for primary recreation, smaller streams may contain a higher concentration of bacteria and other pollutants.

Water-based recreation is a economic asset to local economies in the Savannah River basin. Swimming opportunities are strong draws for tourists and seasonal residents. Efforts must be made to ensure water is safe for bodily contact. In order to protect human health and maintain water quality, straight pipes must be eliminated and failing septic systems should be repaired. The NC Wastewater Discharge Elimination (WaDE) Program is actively helping to identify and remove straight pipes (and failing septic systems) in Western North Carolina. This program uses door-to-door surveys to locate straight pipes and failing septic systems, and offers deferred loans or grants to homeowners who have to eliminate the straight pipes by installing a septic system.

WaDE personnel conducted door-to-door septic system surveys in Graham, Macon and Swain counties between February 2003 and December 2004. Part of the Savannah River basin lies in Macon County. Projects occurred in phases, generally lasting four to six weeks in length. Survey findings indicate that approximately 93 dwellings or 13 percent of participating homes were found to have illegal or improperly functioning wastewater systems. Since the violations were identified, the local health departments have been able to repair 52 of the 93 problem systems. Four Square Community Action and Macon Program for Progress have handled financial assistance for low-income households. Table 13 contains a compilation of survey findings.

Table 13 Septic System Survey Results of Graham, Macon and Swain County Projects: February 2003 – December 2004

Total Homes Visited	1238
Completed Surveys	701
Violations	93
Violation Source Type	
Nonpoint	53
Point	40
Violation Correction Activities	
Repairs Completed	52

2007 Recommendations

The WaDE Program in collaboration with the Local Health Departments should request additional funding from the CWMTF (Chapter 11) and Section 319 Program (Chapter 11) to continue the straight pipe elimination program. Additional fecal coliform monitoring throughout tributary watersheds where straight pipes and failing septic systems are a potential problem should be conducted in order to narrow the focus of the surveys. For more information on the WaDE Program, contact the DENR On-Site Wastewater Section (OSWW), NC Division of Environmental Health, toll free at 1-866-223-5718 or visit their website at http://www.deh.enr.state.nc.us/oww/Wade/wade.htm.

Additionally, precautions should be taken by local septic system permitting authorities to ensure that new systems are sited and constructed properly and that an adequate repair area is also available. Educational information should also be provided to new septic system owners regarding the maintenance of these systems over time. DWQ has developed a booklet that discusses actions individuals can take to reduce stormwater runoff and improve stormwater quality entitled *Improving Water Quality In Your Own Backyard*. The publication includes a discussion about septic system maintenance and offers other sources of information. To obtain a free copy, call (919) 733-5083. The following website also offers good information in three easy to follow steps: http://www.wsg.washington.edu/outreach/mas/water_quality/septicsense/septicmain.html.

Chapter 7
Agriculture and Water Quality

7.1 Animal Operations

In 1992, the Environmental Management Commission (EMC) adopted a rule modification (15A NCAC 2H.0217) establishing procedures for managing and reusing animal wastes from intensive livestock operations. The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve animal populations of at least the following size: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds (chickens and turkeys) with a liquid waste system. There are no facilities meeting these specifications in the Savannah basin.

Key Animal Operation Legislation (1995-2003)

1995 Senate Bill 974 requires owners of swine facilities with 250 or more animals to hire a certified operator. Operators are required to attend a six-hour training course and pass an examination for certification. Senate Bill 1080 established buffer requirements for swine houses, lagoons and land application areas for farms sited after October 1, 1995.

1996 Senate Bill 1217 required all facilities (above threshold populations) to obtain coverage under a general permit, beginning in January 1997, for all new and expanding facilities. DWQ was directed to conduct annual inspections of all animal waste management facilities. Poultry facilities with 30,000+ birds and a liquid waste management system were required to hire a certified operator by January 1997 and facilities with dry litter animal waste management systems were required to develop an animal waste management plan by January 1998. The plan must address three specific items: 1) periodic testing of soils where waste is applied; 2) development of waste utilization plans; and 3) completion and maintenance of records on-site for three years. Additionally, anyone wishing to construct a new, or expand an existing, swine farm must notify all adjoining property owners.

1997 House Bill 515 placed a moratorium on new or existing swine farm operations and allows counties to adopt zoning ordinances for swine farms with a design capacity of 600,000 pounds (SSLW) or more. In addition, owners of potential new and expanding operations are required to notify the county (manager or chair of commission) and local health department, as well as adjoining landowners. NCDENR was required to develop and adopt economically feasible odor control standards by March 1, 1999.

1998 House Bill 1480 extended the moratorium on construction or expansion of swine farms. The bill also requires owners of swine operations to register with DWQ any contractual relationship with an integrator.

1999 House Bill 1160 extended (again) the moratorium on new construction or expansion of swine farms, required NCDENR to develop an inventory of inactive lagoons. The Bill requires owners/operators of an animal waste treatment system to notify the public in the event of a discharge to surface waters of the state of 1,000 gallons or more of untreated wastewater.

2000 Attorney General Easley reached a landmark agreement with Smithfield Foods, Inc. to phase out hog lagoons and implement new technologies that will substantially reduce pollutants from hog farms. The agreement commits Smith field to phase out all anaerobic lagoon systems on 276 company-owned farms. Legislation will be required to phase out the remaining systems statewide within a 5-year period (State of Environment Report 2000).

2001 House Bill 1216 extended (again) the moratorium on new construction or expansion of swine farms.

7.2 Impacted Streams in Agricultural Areas

There is little agricultural activity in the Savannah Basin. However, impacts to streams from even very small agricultural operations can include excessive nutrient loading, pesticide and herbicide contamination, bacterial contamination, and sedimentation.

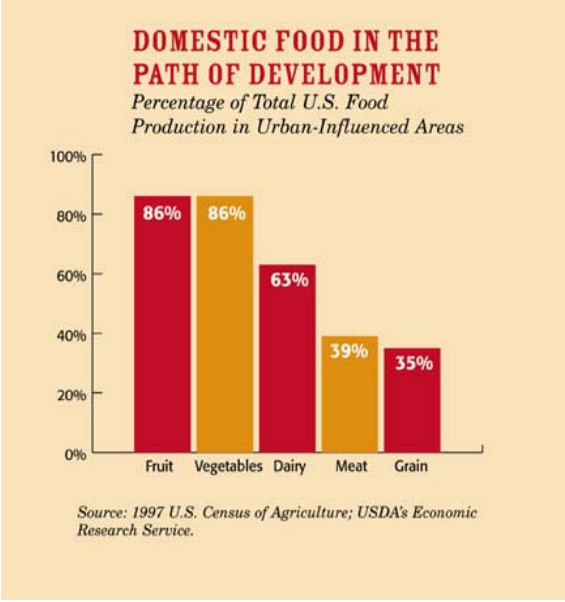
Based on the most recent information from the USDA Natural Resources Conservation Service (NRCS) National Resources Inventory (NRI), agricultural land use in the Savannah River basin is less than one percent of the total land area. Refer to Appendix III for more information related to land use changes in the Savannah River basin.

2007 Recommendations
DWQ will identify streams where agricultural land use may be impacting water quality and aquatic habitat. Local Soil and Water Conservation District (SWCD) and NRCS staff should investigate these streams to assess agricultural impacts and recommend best management practices (BMPs) to reduce the impacts. DWQ recommends that funding and technical support for agricultural BMPs continue and increase. Refer to Appendix VII for agricultural nonpoint source agency contact information.

7.3 Working Land Conservation Benefits

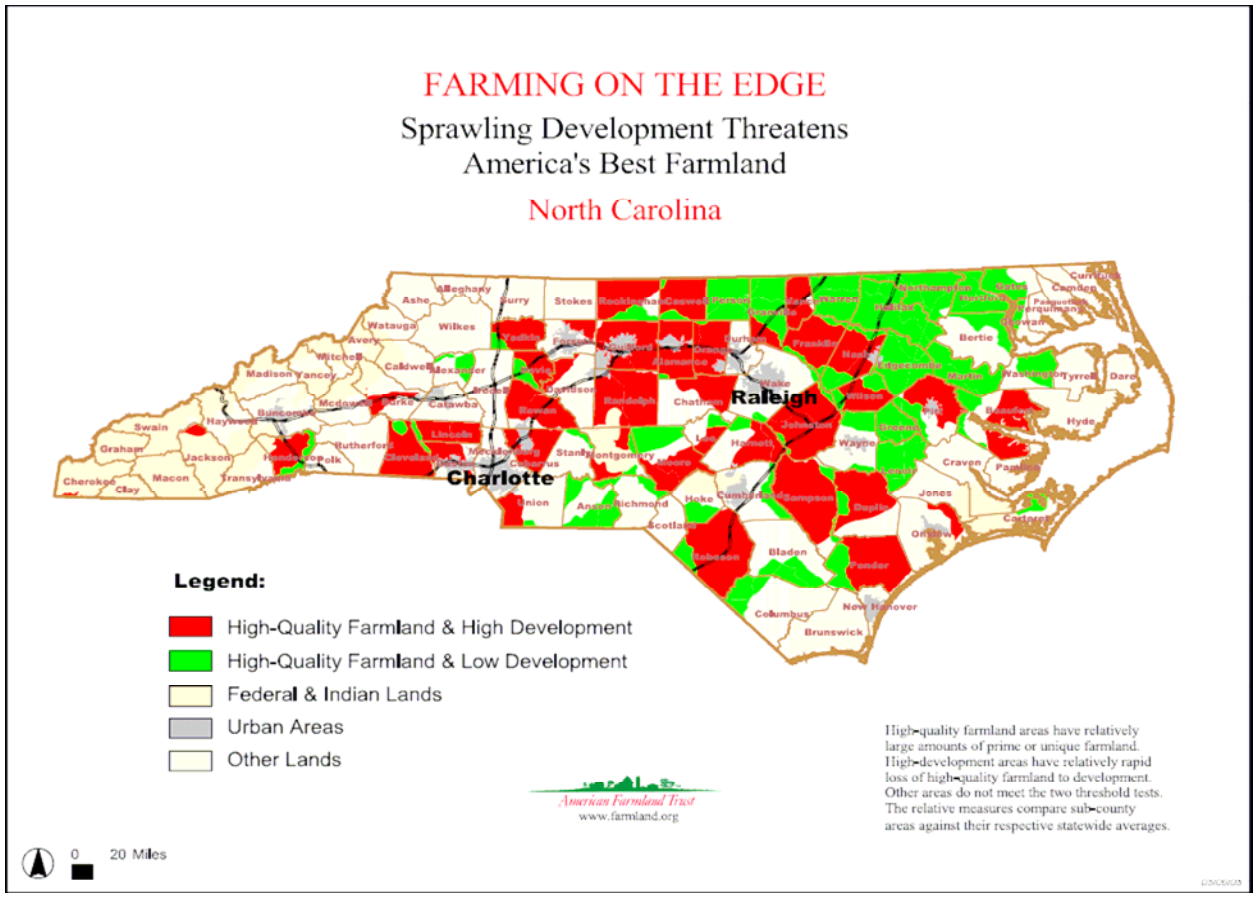
Working Lands are those used for agriculture, forestry or other natural resource industries. Well-managed working lands provide important non-market goods and services. For example, farms, ranches, and forestlands provide food and cover for wildlife, help control flooding, protect wetlands and watersheds, and maintain air quality. They can absorb and filter wastewater, runoff, and provide groundwater recharge.

Rapid urbanization is forcing the conversion of working land to developed land at an astonishing rate in North Carolina. From1992-1997, over 170,000 acres of agricultural land was converted to developed land. That was the 12th highest rate in the nation. The figures for Prime Farmland, the best land for growing crops, are even more disturbing. North Carolina is losing prime farmland at the fourth fastest rate in the nation (USDA, 2001). The 1997 U.S. Census of Agriculture shows that a large percentage of cropland is in urban-influenced areas, making them prime targets for development. It is well established that developed land negatively impacts water quality (See Section 5.1). Therefore, preserving North Carolina's working lands should be a priority.



The value of specific working lands can be calculated for any watershed by performing a Cost of Community Services (COCS) study. COCS studies are a case study approach used to determine a community's public service costs versus revenues based on current land use. Their particular niche is to evaluate the overall contribution of agricultural and other open lands on equal ground with residential, commercial and industrial development.

As of January 2002, 83 COCS studies conducted in 19 states found that tax and other revenues collected from farm, ranch and forest landowners more than covered the public service costs these lands incur. COCS studies show that on average, residential development generates significant tax revenue but requires costly public services that typically are subsidized by revenues from commercial and industrial land uses. The special contribution of COCS studies is that they show that farm, ranch, and forestlands are important commercial land uses that help balance community budgets. Working lands are not just vacant land waiting to be developed (Freedgood et.al., 2002)



A recent analysis of the fiscal impact of different land uses in Macon County, NC demonstrates the cost-saving benefits to the county of maintaining farmland and open space. Using county budget data and tax data from fiscal year 2000, the study indicates that typical residential and commercial properties cost the county budget by demanding more in tax-supported services than they contribute in property tax revenues. Such services include schools, roads, water and sewer lines, fire and police protection, and social and administrative services. On the other hand, the typical farmland/open-space parcel contributed more property tax to the county budget than it demanded in expenditures for county services. Analyzing a scenario of a 30-acre parcel of farmland/open-space, the study estimated that the county budget would gain $290 if the land remained as farmland, but would lose a net $532 if converted to ten 3-acre lots with houses on them (Jones and Kask, 2001).

The opportunities for private landowners to protect working lands are growing. North Carolina cities and counties have now begun to use the new set of farmland protection tools authorized by

the General Assembly in 2005 through Session Law 2005-390. Along with an expanded definition of agriculture and a revamped Agricultural Development and Farmland Preservation Trust Fund, this legislation authorized a new category for localities to promote the stability of their agricultural sectors. Counties and municipalities now have the authority to create an Enhanced Voluntary Agricultural District (EVAD) option, which offers an increased set of incentives for landowners to restrict development over a ten-year period. Polk County in the mountains and Wentworth in the Piedmont are amongst the first jurisdictions in the state to utilize this new tool, with the recent adoption of local EVAD ordinances. Landowners interested in working land protection should contact their local land trust; NRCS field representative, or Soil and Water Conservation District. The Farmland Information Center is also an excellent online resource: http://www.farmlandinfo.org/. Local government officials interested in the value of working land conservation should visit the Land Trust Alliance's Economic Benefits of Open Space Protection web page at: http://www.lta.org/resources/economic_benefits.htm.

7.4 Agricultural Best Management Practices and Funding Opportunities

7.4.1 USDA – NRCS Environmental Quality Improvement Program (EQIP)

The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides assistance to farmers and ranchers who face threats to soil, water, air, and related natural resources on their land. Through EQIP, the Natural Resources Conservation Service (NRCS) provides assistance to agricultural producers in a manner that will promote agricultural production and environmental quality as compatible goals, optimize environmental benefits, and help farmers and ranchers meet Federal, State, Tribal, and local environmental requirements. The 2002 Farm Bill reauthorized national EQIP funding at $6.16 billion over the six-year period of FY 2002 through FY 2007. Program priorities are as follows:

- Reduction of nonpoint source pollution including nutrients, sediment, pesticides, and excess salinity in impaired watersheds consistent with TMDLs where available; reduction of groundwater contamination; reduction of point source pollution including contamination from confined animal feeding operations
- Conservation of ground and surface water resources
- Reduction of emissions including particulate matter, nitrogen oxides (NOx), volatile organic compounds, and ozone precursors and depleters that contribute to air quality impairment violations of National Ambient Air Quality Standards
- Reduction in soil erosion and sedimentation from unacceptable levels on agricultural land
- Promotion of at-risk species habitat conservation.

EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practices and a maximum term of ten years. These contracts provide incentive payments and cost-shares to implement conservation practices. Persons who are engaged in livestock or agricultural production on eligible land may participate in the EQIP

North Carolina EQIP Funding 2000-2005

2000:	$1.1 Million
2001:	$3.5 Million
2002:	$7.1 Million
2003:	$10.0 Million
2004:	$13.2 Million
2005:	$14.3 Million

program. EQIP activities are carried out according to an environmental quality incentives program plan of operations developed in conjunction with the producer that identifies the appropriate conservation practice or practices to address the resource concerns. The practices are subject to NRCS technical standards adapted for local conditions. The local conservation district approves the plan.

EQIP may cost-share up to 75 percent of the costs of certain conservation practices. Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive. However, limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent. Farmers and ranchers may elect to use a certified third-party provider for technical assistance. An individual or entity may not receive, directly or indirectly, cost-share or incentive payments that, in the aggregate, exceed $450,000 for all EQIP contracts entered during the term of the Farm Bill.

NRCS district contacts for the Savannah River basin are provided in Appendix VII, and EQIP signup information can be found on NRCS website at http://www.nc.nrcs.usda.gov/programs/EQIP/index.html.

7.4.2 NC Agriculture Cost Share Program

The NC Agricultural Cost Share Program (NCACSP) was established in 1984 to help reduce agricultural nonpoint runoff into the state's waters. The program helps owners and renters of established agricultural operations improve their on-farm management by using best management practices. These BMPs include vegetative, structural or management systems that can improve the efficiency of farming operations while reducing the potential for surface and groundwater pollution. The NCACSP is implemented by the Division of Soil and Water (DSWC), which divides the approved BMPs into five main purposes or categories.

- *Erosion Reduction/Nutrient Loss Reduction in Fields*
  Erosion/nutrient management measures include planned systems for reducing soil erosion and nutrient runoff from cropland into streams to improve water quality. Practices include: critical area planting, cropland conversion, water diversion, long-term no-till, pastureland conversion, sod-based rotation, stripcropping, terraces, and Christmas tree conservation cover.

- *Sediment/Nutrient Delivery Reduction from Fields*
  Sediment/nutrient management measures include planned systems that prevent sediment and nutrient runoff from fields into streams. Practices include: field borders, filter strips, grassed waterways, nutrient management strategies, riparian buffers, water control structures, streambank stabilization, and road repair/stabilization.

- *Stream Protection from Animals*
  Stream protection management measures are planned systems for protecting streams and streambanks. Such measures eliminate livestock access to streams by providing an alternate watering source away from the stream itself. Other benefits include reduced soil erosion, sedimentation, pathogen contamination, and pollution from dissolved, particulate, and sediment-attached substances. Practices include: heavy use area protection, livestock

exclusion (i.e., fencing), spring development, stream crossings, trough or watering tanks, wells, and livestock feeding areas.

- *Proper Animal Waste Management*
  A waste management system is a planned system in which all necessary components are installed for managed liquid and solid waste to prevent or minimize degradation of soil and water resources. Practices include: animal waste lagoon closures, constructed wetlands, controlled livestock lounging area, dry manure stacks, heavy use area protection, insect and odor control, stormwater management, waste storage ponds/lagoons, compost, and waste application system.
- *Agricultural Chemical (agrichemical) Pollution Prevention*
  Agrichemical pollution prevention measures involve a planned system to prevent chemical runoff to streams for water quality improvement. Practices include: agrichemical handling facilities and fertigation/chemigation back flow prevention systems.

The NCACSP is a voluntary program that reimburses farmers up to 75% of the cost of installing an approved BMP. The cost share funds are paid to the farmer once the planned BMP is completed, inspected and certified to be installed according to NCACSP standards. The annual statewide budget for BMP cost sharing is approximately $6.9 million. From 2002 to 2007, there were no projects in the Savannah River basin.

County Soil and Water Conservation District (SWCD) contacts for the Savannah River basin are included in Appendix VII. BMP definitions and DSWC contact information can be found online at www.enr.state.nc.us/DSWC/pages/agcostshareprogram.html.

Chapter 8
Forestry in the Savannah Basin

8.1 Forestland Ownership and Resources

Approximately 60% of forestland in the Savannah basin is privately owned. The majority of the balance is comprised of publicly-owned land in the Nantahala National Forest. This ownership estimate comes from the most recent data published by the USDA-Forest Service *Forest Statistics for North Carolina, 2002*. (Brown, Mark J. Southern Research Station Resource Bulletin SRS-88. January 2004).

8.1.1 Christmas Tree Production

The Division of Forest Resources does not oversee regulations related to land clearing activities for Christmas tree production or the associated BMPs for tree farming operations. These activities are deemed to be an agricultural/horticultural activity and are under the oversight of the NC Department of Agriculture & Consumer Services (NCA&CS) and their recommended agricultural BMPs. The NC Cooperative Extension Service through NC State University has developed extensive guidelines and recommendations for Christmas tree operations. This material is available on-line at www.ces.ncsu.edu/fletcher/programs/xmas/.

8.1.2 Forestry Accomplishments

Since the previous basinwide plan was produced, the DFR accomplished the following tasks in an ongoing effort to improve compliance with forest regulations and, in turn, minimize nonpoint source (NPS) pollution from forestry activities:

- Replaced worn-out wood timber bridgemats in the Sylva District with new mats available for use throughout the basin.
- Established a Forestry NPS Unit that develops and oversees projects throughout the state that involves protection, restoration and education on forestry NPS issues.
- Revised and produced 10,000 copies of a pocket field guide outlining the requirements of the FPGs and suggested BMPs to implement.
- Created and published 15,000 copies of a new brochure "Call Before You Cut" for landowners promoting pre-harvest planning to insure water quality issues are addressed prior to undertaking timber harvesting.
- Continued to assist with workshops in cooperation with the N.C. Forestry Association's "ProLogger" logger training program.
- DFR continues its efforts to protect water quality through various protection, restoration, and education projects. This includes research project, on-site demonstrations, and integration of NPS topics through the DFR's network of Educational State Forests and State Forests. Progress reports and summaries are posted in the 'Water Quality' section of the DFR's Web site www.dfr.state.nc.us as they are completed.

8.2 Forestry Water Quality Regulations in North Carolina

8.2.1 Forest Practice Guidelines (FPG) for Water Quality

Forestry operations in North Carolina are subject to regulation under the Sedimentation Pollution Control Act of 1973 (G.S. Ch.113A Art.4 referred to as "SPCA"). However, forestry operations may be exempted from the permit and plan requirements of the SPCA, if the operations meet the compliance standards outlined in the *Forest Practices Guidelines Related to Water Quality* (15A NCAC 1I .0101 - .0209, referred to as "FPGs") and General Statutes regarding stream obstruction (G.S.77-13 & G.S.77-14).

The North Carolina Division of Forest Resources (DFR) is delegated the authority to monitor and evaluate forestry operations for compliance with these aforementioned laws and/or rules. In addition, the DFR works to resolve identified FPG compliance questions brought to its attention through citizen complaints. Violations of the FPG performance standards that cannot be resolved by the DFR are referred to the appropriate State agency for enforcement action

During the period September 1, 1999 through August 31, 2004 the Division of Forest Resources conducted 2 FPG inspections of forestry-related activities in the basin; both of the sites inspected were in compliance.

8.2.2 Other Forestry Related Water Quality Regulations

In addition to the State regulations noted above, DFR monitors the implementation of the following Federal rules relating to water quality and forestry operations:

- The Section 404 silviculture exemption under the Clean Water Act
- The federally-mandated 15 Best Management Practices (BMPs) related to road construction in wetlands
- The federally-mandated BMPs for mechanical site preparation activities for the establishment of pine plantations in wetlands of the southeastern U.S.

8.2.3 Water Quality Foresters

While the DFR currently has a Water Quality Forester located in ten of the DFR's thirteen Districts across the State, there are none assigned within the Hiwassee basin. However, the forester staff based in the DFR's Sylva District Office and Asheville Regional Office address water quality issues related to forestry as time permits, while also handling wildfire suppression and forest management duties.

8.2.4 Forestry Best Management Practices (BMPs)

Implementing Forestry Best Management Practices is strongly encouraged by the Division of Forest Resources in order to efficiently and effectively protect the water resources of North Carolina. During this reporting period, the DFR recorded 6 instances across 400 acres in which BMPs were either noted in use or had been recommended. The Forestry Best Management Practices Manual describes recommended techniques that should be used to help comply with the State's forestry laws and help protect water quality. This manual is currently undergoing its first revision since adoption in 1989. This revision, led by the DENR-appointed Technical Advisory Committee (TAC) has undertaken four years of effort.

To further assess BMPs, the DFR conducted a detailed, statewide BMP Implementation Survey from March 2000 through March 2003 to evaluate Forestry BMPs on *active* harvest operations. However, that survey did not capture any harvest sites within the Savannah basin. Of those survey sites taken statewide, though, the problems most often cited relate to stream crossings, skid trails, and site rehabilitation. This survey, and additional surveys to be conducted, will serve as a basis for focused efforts in the forestry community to address water quality concerns through better and more effective BMP implementation and training.

8.2.5 Bridgemats

DFR has been providing bridgemats on loan out to loggers for establishing temporary stream crossings during harvest activities. Temporary bridges are usually the best solution for stream crossings, instead of culverts or hard-surfaced 'ford' crossings. Wooden timber bridgemats have been available for use in the basin for nearly seven years, and are available upon request from the Sylva District Office. In 2005, six new 25-foot wooden bridgemats were assigned to the Sylva District; these mats were acquired with USEPA 319-Grant funds, allowing DFR to continue this successful program. More information about using bridgemats, and the above noted BMP survey, is available on the 'Water Quality' section of the DFR's Web site http://www.dfr.state.nc.us./.

8.2.6 Protection from Wildfires

The "Firewise Communities" program is a national, multi-agency effort designed to reach homeowners, community leaders, planners, developers, and others in the effort to protect people, property, and natural resources from the risk of wildfires, before a fire starts. The Firewise Communities program offers a series of practical steps that individuals and communities can take to minimize wildfire risks. The Firewise approach emphasizes community responsibility for planning in the design of a safe community as well as effective emergency response, and individual responsibility for safer home construction and design, landscaping, and maintenance. In North Carolina, the most susceptible areas for wildfires in which homes and woodlands co-exist are in the mountains and areas of the coast.

Some examples of Firewise practices include:

- Maintaining a 'defensible perimeter' around homes and structures by controlling vegetation growth
- Removing so-called 'ladder fuels' from around structures, that may allow a small fire on the ground to move upwards, and into the structure
- Constructing access roads and driveways in a way that will allow access by fire trucks and other heavy emergency response vehicles.

More information is available on the North Carolina Firewise Web site http://www.ncfirewise.org/ and the national web site http://www.firewise.org./.

Chapter 9
Water Resources

9.1 River Basin Hydrologic Units

Under the federal system, the Savannah River Basin is made up of hydrologic areas referred to as cataloging units (USGS 8-digit hydrologic units). Cataloging units are further divided into smaller watershed units (14-digit hydrologic units or local watersheds) that are used for smaller scale planning like that done by NCEEP (Chapter 11). There are two local watershed units in the basin, all of which are listed in Table 14.

Table 14 Hydrologic Subdivisions in the Savannah River Basin

Watershed Name and Major Tributaries	USGS 8-digit Hydrologic Units	DWQ 6-digit Subbasin Codes
Tugaloo River Tullulah River, Chattooga River Big Creek, Overflow Creek, Scotsman Creek, Fowler Creek	03060102	03-13-01
Seneca River Toxaway River, Horsepasture River Thompson River, Whitewater River	03060101	03-13-02

* Numbers from the 8-digit and 14-digit column make the full 14-digit HU.

9.2 Minimum Streamflow

Conditions may be placed on dam operations specifying mandatory minimum releases in order to maintain adequate quantity and quality of water in the length of a stream affected by an impoundment. One of the purposes of the Dam Safety Law is to ensure maintenance of minimum streamflows below dams. The Division of Water Resources (DWR), in conjunction with the Wildlife Resources Commission (WRC), recommends conditions related to release of flows to satisfy minimum instream flow requirements. The Division of Land Resources (DLR) issues the permits.

Under the authority of the Federal Power Act, the Federal Energy Regulatory Commission (FERC) licenses all non-federal dams located on the navigable waters in the United States that produce hydropower for the purposes of interstate commerce. The license may include requirements for flows from the project for designated in-stream or off-stream uses.

Under the authority of Section 404 of the Clean Water Act, the U.S. Army Corps of Engineers issues permits for the discharge of fill material into navigable waters. The permit may include requirements for flows for designated in-stream or off-stream uses. A 404 permit will not only apply to dams under state and federal regulatory authorities mentioned above, but will also cover structures that are not under their authority, such as weirs, diversions, and small dams. Table 15 presents minimum streamflow projects in the Savannah River basin.

Table 15 Minimum Streamflow Projects in the Savannah River Basin

Name	Waterbody	Drainage Area (sq. mi.)	Min. Release (cu.ft/sec)
Toxaway Dam	Toxaway River	7.8	12.5[a]
Fall Racquet Club Dam	Indian Creek	4.8	7.5[b]
Hogback Dam	Little Hogback Creek	1.8	0.7
Cranston Pond Dam	Green Creek	0.57	0.24
Upper Ridge Cove Dam	Unnamed Tributary of Chattooga River	0.56	0.19

[a] April through October the release is to be from the bottom siphon to provide a cold-water release for downstream trout survival
[b] USFWS, NCWRC, NCDWR requested the U.S. Army Corp of Engineers require a cold-water release in the 404 permit to protect trout downstream.

9.3 Interbasin Transfers (IBT)

In addition to water withdrawals (discussed above), water users in North Carolina are also required to register surface water transfers with the Division of Water Resources if the amount is 100,000 gallons per day or more. Also, persons wishing to transfer more than the minimum transfer quantity allowed by the IBT law (usually 2 MGD) must first obtain a certificate from the Environmental Management Commission (G.S. 143-215.22I). The river basin boundaries that apply to these requirements are designated on a map entitled *Major River Basins and Sub-Basins in North Carolina*, on file in the Office of the Secretary of State, and included as part G.S. 143-215.22G of the law. These boundaries differ slightly from the 17 major river basins delineated by DWQ.

In determining whether a certificate should be issued, the state must determine that the overall benefits of a transfer must outweigh the potential impacts. Factors used to determine whether a certificate should be issued include:

- the necessity, reasonableness and beneficial effects of the transfer;
- the detrimental effects on the source and receiving basins, including effects on water supply needs, wastewater assimilation, water quality, fish and wildlife habitat, hydroelectric power generation, navigation and recreation;
- the cumulative effect of existing transfers or water uses in the source basin;
- reasonable alternatives to the proposed transfer; and
- any other facts and circumstances necessary to evaluate the transfer request.

A provision of the interbasin transfer law requires that an environmental assessment or environmental impact statement be prepared in accordance with the State Environmental Policy Act as support documentation for a transfer petition. Currently, there are no certified or known potential interbasin transfers in the Savannah River basin.

9.3.1 Local Water Supply Planning

The North Carolina General Assembly mandated a local and state water supply planning process in 1989 to assure that communities have an adequate supply of potable water for future needs. Under this statute, all units of local government that provide, or plan to provide, public water supply service are required to prepare a Local Water Supply Plan (LWSP) and to update that

plan at least every five years. The information presented in a LWSP is an assessment of a water system's present and future water needs and its ability to meet those needs. Currently there are no LWSP systems that withdraw water from the portion of the Savannah River Basin in North Carolina.

9.3.2 Registered Water Withdrawals

Large water users are required to register their withdrawals with the Division of Water Resources. General Statute 143-215.22H requires non-agricultural users that withdraw 100,000 gallons per day or more and agricultural users that withdraw 1,000,000 gallons per day or more to report their withdrawals. Details of this program can be found on the Division's website at: www.ncwater.org. There is currently one registered water withdrawal in the North Carolina portion of the Savannah River basin (Table 16).

Table 16 Registered Water Withdrawals in the Savannah River Basin

County	1999 Average (MGD)	1999 Maximum (MGD)	Source Of Withdrawal	Facility
Jackson	0.188	0.525	Groundwater	Carolina Water Service – Fairfield Sapphire Valley

9.4 Water Quality Issues Related to Drought

Water quality problems associated with rainfall events usually involve degradation of aquatic habitats because the high flows may carry increased loadings of substances like metals, oils, herbicides, pesticides, sand, clay, organic material, bacteria and nutrients. These substances can be toxic to aquatic life (fish and insects) or may result in oxygen depletion or sedimentation. During drought conditions, these pollutants become more concentrated in streams due to reduced flow. Summer months are generally the most critical months for water quality. Dissolved oxygen is naturally lower due to higher temperatures, algae grow more due to longer periods of sunlight, and streamflows are reduced. In a long-term drought, these problems can be greatly exacerbated and the potential for water quality problems to become catastrophic is increased. This section discusses water quality problems that can be expected during low flow conditions.

The frequency of acute impacts due to nonpoint source pollution (runoff) is actually minimized during drought conditions. However, when rain events do occur, pollutants that have been collecting on the land surface are quickly delivered to streams. When streamflows are well below normal, this polluted runoff becomes a larger percentage of the water flowing in the stream. Point sources may also have water quality impacts during drought conditions even though permit limits are being met. Facilities that discharge wastewater have permit limits that are based on the historic low flow conditions. During droughts these wastewater discharges make up a larger percentage of the water flowing in streams than normal and might contribute to lowered dissolved oxygen concentrations and increased levels of other pollutants.

As streamflows decrease, there is less habitat available for aquatic insects and fish, particularly around lake shorelines. There is also less water available for irrigation and for water supplies. The dry conditions and increased removal of water for these uses further increases strain on the resource. With less habitat, naturally lower dissolved oxygen levels and higher water temperatures, the potential for large kills of fish and aquatic insects is very high. These

conditions may stress the fish to the point where they become more susceptible to disease and where stresses that normally would not harm them result in mortality.

These are also areas where longer retention times due to decreased flows allow algae to take full advantage of the nutrients present resulting in algal blooms. During the daylight hours, algae greatly increase the amount dissolved oxygen in the water, but at night algal respiration and die off can cause dissolved oxygen levels to drop low enough to cause fish kills. Besides increasing the frequency of fish kills, algae blooms can also cause problems for recreation and difficulty in water treatment resulting in taste and odor problems in finished drinking water.

9.5 Source Water Assessment of Public Water Supplies

9.5.1 Introduction

The Federal Safe Drinking Water Act (SDWA) Amendments of 1996 emphasize pollution prevention as an important strategy for the protection of ground and surface water resources. This new focus promotes the prevention of drinking water contamination as a cost-effective means to provide reliable, long-term and safe drinking water sources for public water supply (PWS) systems. In order to determine the susceptibility of public water supply sources to contamination, the amendments also required that all states establish a Source Water Assessment Program (SWAP). Specifically, Section 1453 of the SDWA Amendments require that states develop and implement a SWAP to:

- Delineate source water assessment areas;
- Inventory potential contaminants in these areas; and
- Determine the susceptibility of each public water supply to contamination.

In North Carolina, the agency responsible for the SWAP is the Public Water Supply (PWS) Section of the DENR Division of Environmental Health (DEH). The PWS Section received approval from the EPA for their SWAP Plan in November 1999. The SWAP Plan, entitled *North Carolina's Source Water Assessment Program Plan*, fully describes the methods and procedures used to delineate and assess the susceptibility of more than 9,000 wells and approximately 207 surface water intakes. To review the SWAP Plan, visit the PWS website at http://www.deh.enr.state.nc.us/pws/index.htm.

9.5.2 Delineation of Source Water Assessment Areas

The SWAP Plan builds upon existing protection programs for ground and surface water resources. These include the state's Wellhead Protection Program and the Water Supply Watershed Protection Program.

Wellhead Protection (WHP) Program

North Carolinians withdraw more than 88 million gallons of groundwater per day from more than 9,000 water supply wells across the state. In 1986, Congress passed Amendments to the SDWA requiring states to develop wellhead protection programs that reduce the threat to the quality of groundwater used for drinking water by identifying and managing recharge areas to specific wells or wellfields.

Defining a wellhead protection area (WHPA) is one of the most critical components of wellhead protection. A WHPA is defined as "the surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The SWAP uses the methods described in the state's approved WHP Program to delineate source water assessment areas for all public water supply wells. More information related to North Carolina's WHP Program can be found at http://www.deh.enr.state.nc.us/pws/swap.

Water Supply Watershed Protection (WSWP) Program
DWQ is responsible for managing the standards and classifications of all water supply watersheds. In 1992, the WSWP Rules were adopted by the EMC and require all local governments that have land use jurisdiction within water supply watersheds adopt and implement water supply watershed protection ordinances, maps and management plans. SWAP uses the established water supply watershed boundaries and methods established by the WSWP program as a basis to delineate source water assessment areas for all public water surface water intakes. Additional information regarding the WSWP Program can be found at http://h2o.enr.state.nc.us/wswp/index.html.

9.5.3 Susceptibility Determination – North Carolina's Overall Approach

The SWAP Plan contains a detailed description of the methods used to assess the susceptibility of each PWS intake in North Carolina. The following is a brief summary of the susceptibility determination approach.

Overall Susceptibility Rating
The overall susceptibility determination rates the potential for a drinking water source to become contaminated. The overall susceptibility rating for each PWS intake is based on two key components: a contaminant rating and an inherent vulnerability rating. For a PWS to be determined "susceptible", a potential contaminant source must be present and the existing conditions of the PWS intake location must be such that a water supply could become contaminated. The determination of susceptibility for each PWS intake is based on combining the results of the inherent vulnerability rating and the contaminant rating for each intake. Once combined, a PWS is given a susceptibility rating of higher, moderate or lower (H, M or L).

Inherent Vulnerability Rating
Inherent vulnerability refers to the physical characteristics and existing conditions of the watershed or aquifer. The inherent vulnerability rating of groundwater intakes is determined based on an evaluation of aquifer characteristics, unsaturated zone characteristics and well integrity and construction characteristics. The inherent vulnerability rating of surface water intakes is determined based on an evaluation of the watershed classification (WSWP Rules), intake location, raw water quality data (i.e., turbidity and total coliform) and watershed characteristics (i.e., average annual precipitation, land slope, land use, land cover, groundwater contribution).

Contaminant Rating
The contaminant rating is based on an evaluation of the density of potential contaminant sources (PCSs), their relative risk potential to cause contamination, and their proximity to the water supply intake within the delineated assessment area.

Inventory of Potential Contaminant Sources (PCSs)
In order to inventory PCSs, the SWAP conducted a review of relevant, available sources of existing data at federal, state and local levels. The SWAP selected sixteen statewide databases that were attainable and contained usable geographic information related to PCSs.

9.5.4 Source Water Protection

The PWS Section believes that the information from the source water assessments will become the basis for future initiatives and priorities for public drinking water source water protection (SWP) activities. The PWS Section encourages all PWS system owners to implement efforts to manage identified sources of contamination and to reduce or eliminate the potential threat to drinking water supplies through locally implemented programs

To encourage and support local SWP, the state offers PWS system owners assistance with local SWP as well as materials such as:

- Fact sheets outlining sources of funding and other resources for local SWP efforts.
- Success stories describing local SWP efforts in North Carolina.
- Guidance about how to incorporate SWAP and SWP information in Consumer Confidence Reports (CCRs).

Information related to SWP can be found at http://www.deh.enr.state.nc.us/pws/swap.

9.5.5 Public Water Supply Susceptibility Determinations in the Savannah River Basin

In April 2004, the PWS Section completed source water assessments for all drinking water sources and generated reports for the PWS systems using these sources. A second round of assessments were completed in April 2005. The results of the assessments can be viewed in two different ways, either through the interactive ArcIMS mapping tool or compiled in a written report for each PWS system. To access the ArcIMS mapping tool, simply click on the "NC SWAP Info" icon on the PWS web page (http://www.deh.enr.state.nc.us/pws/swap). To view a report, select the PWS System of interest by clicking on the "SWAP Reports" icon.

In the Savannah River Basin, 101 public water supply sources were identified. One is a groundwater source under the influence of surface water and 100 are groundwater sources. Of the 100 groundwater sources, one has a Higher susceptibility rating and 99 have a Moderate susceptibility rating. Table 17 identifies the one groundwater source under the influence of surface water and its overall susceptibility rating. It is important to note that a susceptibility rating of Higher does not imply poor water quality. Susceptibility is an indication of a water supply's potential to become contaminated by the identified PCSs within the assessment area.

Table 17 SWAP Results for Surface Water Sources in the Savannah River Basin

PWS ID Number	Inherent Vulnerability Rating	Contaminant Rating	Overall Susceptibility Rating	Name of Surface Water Source	PWS Name
0188537	H	L	M	Well #1	Toxaway Shores

Chapter 10
Natural Resources

10.1 Ecological Significance of the Savannah River Basin

Although small in total area compared to most of North Carolina's river basins, the Savannah River basin is one of the most ecologically diverse landscapes in the southeastern Appalachians and North Carolina. The region is located where the steep eastern face of the Blue Ridge turns and faces south, and with its relatively warm and extremely wet climate (over 80 inches of rainfall a year), creates a unique setting within the Blue Ridge. A total of 87 rare plant species are known to exist among a diversity of habitats that include spray zones of waterfalls, rock faces of outcrops and overhanging crags and cliffs, and rich coves and other forest communities.

North Carolina contains only headwaters of the Savannah River basin which, when protected, are particularly important for the proper hydrological and biological functioning of downstream waters. Headwater streams provide numerous benefits to downstream waters including: sediment and nutrient control, flood control, water and food supply, and wildlife habitat. Headwater streams can also serve as refugia for species impacted by downstream degradation. Upon improvements in downstream water quality, these species may naturally recolonize upstream habitats.

10.2 Rare Aquatic and Wetland-Dwelling Animal Species

Table 18 lists rare aquatic and wetlands-dwelling animals within the Savannah River basin. For more information on these and rare plant species, visit the NC Natural Heritage Program (NHP) website at www.ncnhp.org.

Table 18 List of Rare Aquatic and Wetland Animal Species in Savannah River Basin (April 2006).

Scientific Name	Common Name	Major Taxon	State Status	Federal Status
Drunella longicornis	A mayfly	Invertebrate	SR	
Matrioptila jeanae	A caddisfly	Invertebrate	SR	
Micrasema burksi	A caddisfly	Invertebrate	SR	
Micrasema sprulesi	A caddisfly	Invertebrate	SR	
Cambarus chaugaensis	Oconee stream crayfish	Crustacean	SC	
Cambarus reburrus	French Broad River crayfish	Crustacean	SR	FSC
Etheostoma inscriptum	Turquoise darter	Fish	SC	
Hybopsis rubrifrons	Rosyface chub	Fish	T	
Micropterus coosae	Redeye bass	Fish	SR	
Notropis lutipinnis	Yellowfin shiner	Fish	SC	
Percina nigrofasciata	Blackbanded darter	Fish	SR	
Sorex palustris punctulatus	Southern water shrew	Mammal	SC	FSC
Aneides aeneus	Green salamander	amphibian	E	FSC

Listing Abbreviations: E = Endangered; T = Threatened; SC = Special Concern; SR = Significantly Rare; FSC = Federal Species of Concern

The **rosyface chub**, **turquoise darter**, and **redeye bass** (native populations) are restricted to Horsepasture and Toxaway Rivers in North Carolina, although their distribution continues into other states, including South Carolina and Georgia. **Yellowfin shiner** occurs in the Savannah and also the Little Tennessee River basin in North Carolina. The diets of these species consist largely of aquatic insects and the redeye bass may also feed on crustaceans and other small fish. The **green salamander** is found in only two small areas in North Carolina, one which includes the Savannah River basin in Macon, Jackson, and Transylvania Counties. Because it is a nocturnal species and occupies narrow crevices in rocky outcroppings, sampling is difficult and scientists are attempting to gain more biological information on this rare salamander. The **Oconee stream crayfish** is found in North Carolina, South Carolina, and Georgia; however, it is not known to be abundant in any of these states. The **French Broad River crayfish** is endemic to North Carolina and is a fairly abundant species.

10.3 Significant Natural Heritage Areas in the Savannah River Basin

The NC NHP compiles a list of Significant Natural Heritage Areas as required by the Nature Preserves Act. The list is based on the program's inventory of natural diversity in the state. The terrestrial and aquatic natural heritage areas included on this list are the best representatives of the natural diversity of the state, and therefore, have priority for protection. Inclusion on the list does not imply that any protection or public access to the site exists. The identification of a significant natural heritage area conveys no protection; these lands are the responsibility of the landowner.

The Savannah Basin contains over 30 significant natural heritage areas (Figure 13), one of which is an aquatic significant natural heritage area: Savannah River Headwaters Aquatic Habitat. The Savannah River Headwaters Aquatic Habitat is considered state significant due to ecological resources among the highest quality occurrences in North Carolina, and is composed of several rivers and gorges including: Chattooga, Whitewater, Thompson, Horsepasture, and Toxaway Rivers. As mentioned earlier, these systems are vital for the maintenance and protection of downstream waters. Examples of other significant natural heritage areas within the Savannah include: bogs, waterfalls, cliffs, and mountains.

Two unique high-quality wetland types that are less extensive in area than the gorges (but no less significant) are spray cliffs and mountain bogs.

Spray Cliffs – In this region known for waterfalls, sloping rock faces are bathed in spray from plunging water. The resulting constant humidity and moderate temperatures support a rich plant community dominated by ferns, mosses and liverworts. The presence of species more typical of the tropics than the Southern Appalachian Mountains makes these communities unique. Sites where the spray cliff community can be found are few; known from only a few dozen occurrences, most of them are less than one acre in size. Yet the spray cliffs are home to the largest number of rare plants in North Carolina's portion of the Savannah River basin.

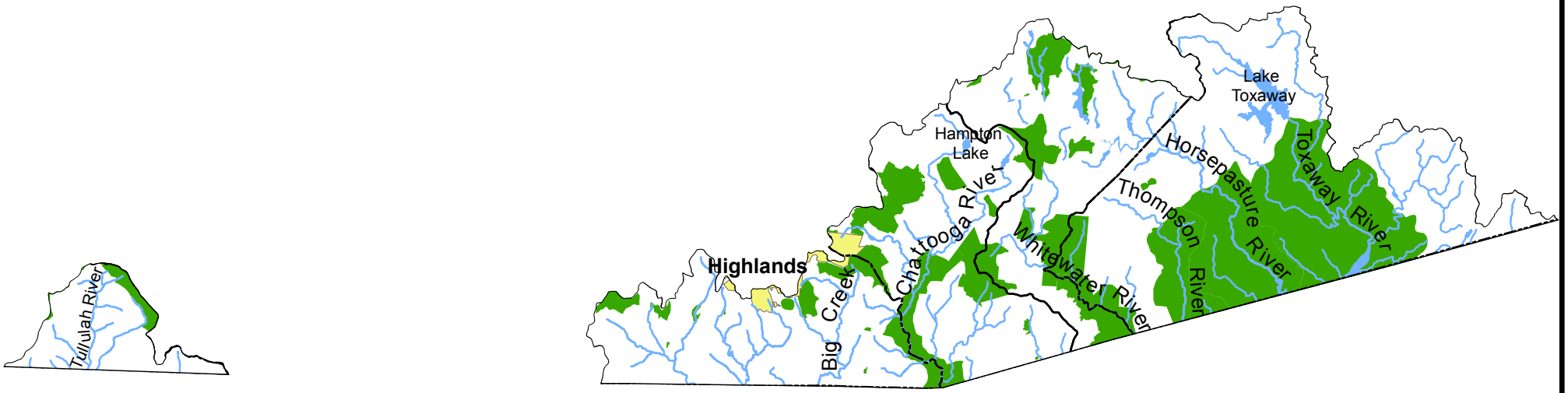
Mountain Bogs – Mountain bogs are saturated with water most of the year, and may have thick layers of sphagnum moss underlain by peat. Most mountain bogs are acidic. These areas, where water enters the system faster than it leaves, form bogs on flat, stream-bordered glades, habitat that also hosts a number of rare or unusual plants such as swamp pink and/or insectivorous plants. Dulany Bog in Jackson County is an example of this interesting community type. Bogs provide food and shelter for wildlife, as well as aid in flood control and act as natural water

purification systems. Even small bogs, most of which are located on the headwaters of trout streams, contribute to the productivity and high water quality needed by the fish downstream.

10.4 Public Lands

A large portion of the Savannah River basin is publicly owned, much of it by the U.S. Forest Service as Nantahala National Forest. Additionally, the state owns approximately 10,000 acres in Transylvania County. This land was purchased in 1999 and NC Parks and Recreation manages 7,000 acres as Gorges State Park, the western-most state park, and NC Wildlife Resources Commission manages 3,000 acres as Toxaway Game Land. The Nature Conservancy owns the Silver Run Preserve which consists of approximately 1500 acres in Jackson and Transylvania Counties. These lands are managed for multiple uses, but are afforded basic protection from developmental pressures.

Figure 13 Significant Natural Heritage Areas in the Savannah River Basin



Legend

- Municipality
- Significant Natural Heritage Area
- County Boundary
- Subbasin Boundary
- Hydrography

Planning Section
Basinwide Planning Unit
August 11, 2006

0 2 4 8 12 16
Miles

Chapter 11
Water Quality Initiatives

11.1 The Importance of Local Initiatives

As the Basinwide Planning Program completes its third cycle of plan development, there are many efforts being undertaken at the local level to improve water quality. Information about local efforts particular to a watershed or subbasin is included in Chapters 1-2. DWQ encourages local agencies and organizations to learn about and become active in their watersheds.

In an effort to provide water quality information and gain public input, DWQ partnered with local watershed associations, the National Resource Conservation Service, and Soil and Water Conservation Districts to host the Western North Carolina Basinwide Water Quality Conference in 2005. The purpose of the conference was to educate people about water quality concerns specific to the mountain region and show how participation in the Basinwide Planning process can benefit local initiatives.

An important benefit of local initiatives is that local people make decisions that affect change in their own communities. There are a variety of limitations local initiatives can overcome including: state government budgets, staff resources, lack of regulations for nonpoint sources, the rulemaking process, and many others.

These local organizations and agencies are able to combine professional expertise in a watershed. This allows groups to holistically understand the challenges and opportunities of different water quality efforts. Involving a wide array of people in water quality projects also brings together a range of knowledge and interests, and encourages others to become involved and invested in these projects. By working in coordination across jurisdictions and agency lines, more funding opportunities are available, and it is easier to generate necessary matching or leveraging funds. This will potentially allow local entities to do more work and be involved in more activities because their funding sources are diversified. The most important aspect of these local endeavors is that the more localized the project, the better the chances for success.

The collaboration of these local efforts are key to water quality improvements. There are good examples of local agencies and groups using these cooperative strategies throughout the state. Specific projects are described in the subbasin chapters (Chapters 1 – 2). Nonpoint source program descriptions and contact, Soil and Water Conservation District (SWCD), NC Cooperative Extension Service and USDA Natural Resources Conservation Service (NRCS) contact information can be found in Appendix VII.

DWQ applauds the foresight and proactive response to potential water quality problems in the watersheds listed above. Federal and State government agencies are interested in assisting local governments and citizen groups in developing their water quality management programs. The distribution of several grantors is discussed below.

11.2 Federal Initiatives

11.2.1 Clean Water Act – Section 319 Program

Section 319 of the Clean Water Act provides grant money for nonpoint source demonstration and restoration projects. Through annual base funding, there is approximately $1 million available for demonstration and education projects across the state. An additional $2 million is available annually through incremental funds for restoration projects. All projects must provide nonfederal matching funds of at least 40% of the project's total costs. Project proposals are reviewed and selected by the North Carolina Nonpoint Source Workgroup made up of state and federal agencies involved in regulation or research associated with nonpoint source pollution (NPS). Information on the North Carolina Section 319 Grant Program application process is available online at http://h2o.enr.state.nc.us/nps/application_process.htm. Descriptions of projects and general Section 319 Program information are available at http://h2o.enr.state.nc.us/nps/Section_319_Grant_Program.htm.

11.3 State Initiatives

11.3.1 North Carolina Ecosystem Enhancement Program (NCEEP)

The North Carolina Ecosystem Enhancement Program (NCEEP) is responsible for providing ecologically effective compensatory mitigation in advance of permitted impacts associated with road projects and other development activities. The fundamental mission of the program is to restore, enhance and protect key watershed functions in the 17 river basins across the state. This is accomplished through the implementation of wetlands, streams and riparian buffer projects within selected local watersheds. The vital watershed functions that NCEEP seeks to restore and protect include water quality, floodwater conveyance and storage, fisheries and wildlife habitat.

The NCEEP is not a grant program, but can implement its restoration projects cooperatively with other state or federal programs such as the Section 319 Program. Combining NCEEP-funded restoration or preservation projects with 319 or other local watershed initiatives (e.g., those funded through the Clean Water Management Trust Fund or local/regional Land Trusts) increases the potential to improve the water quality, hydrologic and habitat functions within selected watersheds.

Watershed Planning by NCEEP

The selection of optimal sites for NCEEP mitigation projects is founded on a basinwide and local watershed planning approach which results, respectively, in the development of *River Basin Restoration Priorities* and *Local Watershed Plans*.

River Basin Restoration Planning

In developing *River Basin Restoration Priorities (RBRP)* (formerly called *Watershed Restoration Plans*), the NCEEP identifies local watersheds (14-digit Hydrologic Units) with the greatest need and opportunity for restoration, enhancement or preservation projects. These high-priority watersheds are called "targeted local watersheds" (*TLW*s). Targeted local watersheds are identified, in part, using information compiled by DWQ's programmatic activities (e.g., *Basinwide Assessment Reports*). Local factors considered in the selection of *TLW*s include: water quality impairment, habitat degradation, the presence of critical habitat or significant

natural heritage areas, the presence of water supply watersheds or other high-quality waters, the status of riparian buffers, estimates of impervious cover, existing or planned transportation projects, and the opportunity for local partnerships. Recommendations from local resource agency professionals and the presence of existing or planned watershed projects are given significant weight in the selection of *TLW*s.

Targeted local watersheds represent those areas within a river basin where NCEEP resources can be focused for maximum benefit to local watershed functions. TLWs are therefore given priority by NCEEP for the implementation of new stream and wetland restoration/enhancement or preservation projects.

The 2001 *Watershed Restoration Plan* for the Savannah River basin can be found on the NCEEP website at http://www.nceep.net/services/restplans/watershedplans.html. The NCEEP is currently updating their selections of Targeted Local Watersheds within the Savannah River basin. Table 19 provides a summary of proposed TLWs for the Savannah basin as of September 2006. The NCEEP is seeking comments from local resource professionals regarding these selections.

Table 19 Proposed Targeted Local Watersheds (TLWs) for the Savannah River Basin

Name of Watershed [major streams]	Total Area	14-digit HU Code	Rationale for Selection as TLW for NCEEP Projects
Horsepasture River, including Logan Creek	[33.1 mi^2]	03060101 010020	Highest % developed area of all HUs in the basin; highest % degraded buffers in the basin; highest # of natural heritage element occurrences in the basin; high % Significant Natural Heritage Areas (SNHA); designated Trout (Tr) waters; decline in bioclassification rating from 1999-2004; increases in fecal coliform; non-point source stresses; photographic evidence of instream habitat degradation in tributary streams (e.g., Hog Back Creek near the community of Sapphire); increased land clearing and road-building activities in the watershed; NCEEP stream mitigation project on Logan Creek.
Chatooga River, including Fowler Creek and Norton Mill Creek	[33.8 mi^2]	03060102 010010	Second highest % development in basin; second highest road density; second highest # natural heritage element occurrences; high % SNHA; designated Tr and ORW streams; habitat degradation and sediment & nutrient inputs associated with land clearing, road construction and increases in impervious cover; non-point source runoff & stormwater stresses from Cashiers; decline in bioclassification for Norton Mill Creek from 1999-2004 (perhaps associated with land clearing, buffer zone degradation and new residential development in the Highlands area).

To provide comments on these proposed TLWs, please contact the NCEEP Watershed Planner for the Savannah basin, Hal Bryson, at (828) 268-2919 or via email at mailto:hal.bryson@ncmail.net. The updated *River Basin Restoration Priorities* for the Savannah is scheduled to be posted to the NCEEP website by early 2007.

Local Watershed Planning

In addition to river basin restoration planning, The NCEEP also develops *Local Watershed Plans (LWPs)*, usually within targeted local watersheds identified in the *RBRPs*. Through the local watershed planning process, NCEEP conducts watershed characterization and field assessment tasks to identify critical stressors in local watersheds. The NCEEP planners and their consultants coordinate with local resource professionals and local governments to identify optimal watershed projects and management strategies to address the major functional stressors identified. The *LWP*s prioritize restoration/enhancement projects, preservation sites, and best management practices (BMP) projects that will provide water quality improvement, habitat protection and other environmental benefits to the local watershed.

Although there is presently no NCEEP Local Watershed Planning initiative in the Savannah River basin, it is possible that such an effort will be undertaken in the future. Decisions regarding the possible need for new LWP initiatives within a given basin are made annually by NCEEP planners. These decisions are based primarily on the quantity and type of compensatory mitigation projects the Program is required to implement, as well as the opportunity for local partnerships within selected 14-digit hydrologic units within the basin.

NCEEP Projects in the Savannah River Basin

In the Savannah River basin, NCEEP has initiated one stream mitigation project to date. This is the Logan Creek project, which comprises approximately 3,300 feet of stream restoration, 1,600 feet of stream enhancement, and 3,100 feet of stream preservation. This creek is a tributary to the Horsepasture River, near the town of Cashiers in Jackson County. The project is currently in the early design phase; construction is expected to begin in 2007. Additional NCEEP project opportunities in this basin are likely to be realized in the coming months and years.

For additional information about NCEEP's Project Implementation efforts, go to: http://www.nceep.net/services/implementation/project_implementation.htm. For additional information about NCEEP in general, including its various program activities and products, visit http://www.nceep.net/.

11.3.2 Clean Water Management Trust Fund

The CWMTF offers approximately $40 million annually in grants for projects within the broadly focused areas of restoring and protecting state surface waters and establishing a network of riparian buffers and greenways. In the Savannah River basin, -- projects have been funded for a total of $875,00 (Table 20). For more information on the CWMTF or these grants, call (252) 830-3222 or visit the website at www.cwmtf.net.

Table 20 Projects in the Savannah River Basin Funded by the Clean Water Management Trust Fund

Project Number	Application Name	Proposed Project Description	Amount Funded
2004B-037	NC Div Parks & Recreation - Acq/ Gorges State Park, Toxaway River	Protect through fee simple purchase 184 acres along the Toxaway River and place under the Gorges State Parks system and management.	$875,000
		Total Funded	**$875,000**

References

American Rivers, 2006. www.americanrivers.org. *Floodplain Protection Toolkit.*

Allen, J., and K.S. Lu. 200. *Modeling and Predicting Future Uurban Growth in the Charleston Area*. Strom Thurmond Institute, Clemson University, Clemson, South Carolina. 24 Sept. 2001. http://www.charleston.net/org/greenbelt/method.html

Arnwine, D.H., Sparks, K.J., and James, R.R. 2006 *Probabilistic Monitoring of Streams Below Small Impoundments in Tennessee.* Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Beach, D. 2002. Coastal Sprawl: *The Effects of Urban Design on Aquatic Ecosystems in the United States*. Pew Oceans Commission, Arlington, Virgina.

CALFED Bay-Delta Program. 1999. *Monitoring, Research, and Assessment Components for Benthic Macroinvertebrate Communities*. Sacramento, CA. http://calfed.ca.gov/programs/cmarp/a7a13.html

Cohn-Lee, R.G., and D.M. Cameron. 1992. Urban Stormwater Runoff Contamination of the Chesapeake Bay: Sources and Mitigation. The Environmental Professional. 14:10-27.

Creager, C.S. and J.P. Baker. 1991. *North Carolina's Basinwide Approach to Water Quality Management: Program Description*. Division of Environmental Management. Water Quality Section. Raleigh, NC.

Erman, N.A. 1996. *Status of Aquatic Invertebrates in: Sierra Nevada Ecosystem Project: Final Report to Congress, Vol II, Assessments and Scientific Basis for Management Options*. University of California. Davis Centers for Water and Wildland Resources.

EPA. *Protecting Water Quality From Urban Runoff EPA 841-F-03-003.* United States Environmental Protection Agency, Washington, D.C. Feb. 2003. www.epa.gov/nps

___. April 1995. *Cleaner Water Through Conservation. EPA 841-B-95-002*

Freedgood, J., Lori Tanner, Carl Mailler, Andy Andrews, Mellisa Adams. *Cost of Community Services Studies: Making the Case for Conservation*; Northampton, MA: American Farmland Trust; AFT Publication; page(s) iv, 78; 2002; National; Reports and Studies

Galli, J. 1991. *Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices*. Metropolitan Washington Council of Governments, Maryland Department of Environment, Washington, D.C..

GRIFFITH, G.E., Omernik, J.M., Comstock, J.A., Schafele, M.P., McNab, W.H., Lenat, D.R., MacPherson, T.F., Glover, J.B., and Shelburne, N.B., 2002. Ecoregions of North Carolina

and South Carolina, (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U. S. Geological Survey (map scale 1:1,500,000).

Haupt, M., J. Jurek, L. Hobbs, J. Guidry, C. Smith and R. Ferrell. 2002. *A Preliminary Analysis of Stream Restoration Costs in the North Carolina Wetlands Restoration Program*. Paper presented at the conference *Setting the Agenda for Water Resources Research*. April 9, 2002. Raleigh, NC.

Howell, J.M., M.S. Coyne and P.L. Cornelius. 1996. *Effect of Sediment Particle Size and Temperature on Fecal Bacteria Mortality Rates and the Fecal Coliform/Fecal Streptococci Ratio*. J Environ Qual. 21:1216-1220.

Jones, J.L. and S.B. Kask. 2001. *The fiscal impact of alternative land uses in Macon County*. Land Trust for the Little Tennessee, Franklin, NC.

Kauffman, G.J., and T. Brant. *The Role of Impervious Cover as a Watershed-based Zoning Tool to Protect water Quality in the Christina River Basin of Delaware, Pennsylvania, and Maryland*. University of Delaware, Institute for Public Administration, Water Resources Agency. 2000.

Lenat, David. April 2005. *Little Brasstown Creek Restoration Project, Cherokee County, NC.* Preconstruction and Postconstruction Biological Monitoring – January 2004 and March 2005. Lenat Consulting Services, Raleigh, NC.

Line, D.E. and G.D. Jennings. 2002. *Long Creek Watershed Nonpoint source Water Quality Monitoring Project – Final Report*. North Carolina State University: Raleigh, NC. Report available online: www.bae.ncsu.edu/bae/programs/extension/wqg/section319/319_LongCreek/index.htm.

Maas, R.P., S.C. Patch, M.J. Westphal, C.S. Modlin, T.Pandolfo and R.M. Shoemaker. August 2004. *Water Quality Trends in the Savannah River Watershed: Year One*. Volunteer Water Information Network (VWIN), University of North Carolina at Asheville (UNCA), Environmental Quality Institute (EQI). Technical Report #04-133.

McGarvey, Daniel J. 1996. *Stream Channelization*. Bibliography of Environmental Literature. Wittenberg University. Environmental Geology. Springfield, Ohio. http://www4.wittenberg.edu/academics/geol/progcrs/geol220/mcgarvey/index.shtml.

Meyer, J.M., L.A. Kaplan, D. Newbold, D.L. Strayer, C.J. Woltemade, J.B. Zedler, R. Beilfuss, Q. Carpenter, R. Semlitsch, M.C. Watzin and P.H. Zedler. September 2003. *Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetlands.* American Rivers and Sierra Club. Washington, D.C.

Middle Fork Greenway Association. May 2001. *Middle Fork Greenway Trail Feasibility Study*. Prepared by the Department of Geography and Planning, Appalachian State University. Boone, NC.

National Atlas of the United States, April 28, 2006, Raw Data: Boundaries, Map References, Transportation and Water, NationalAtlas.gov, United States Department of Interior.

National Committee for the Savannah River Basin (NCNR). 2005a. *Summary of the Winkler Creek Riparian Corridor Conservation Design*. West Jefferson, NC. www.ncnr.org.

NCNR. 2005b. *Summary of the Howard Creek Riparian Corridor Conservation Design*. West Jefferson, NC.

NCNR. December 2001. *Riparian Corridor Conservation Design South Fork Savannah River Basin Planning and Protection*. Conservation Trust for North Carolina (CTNC) and the Clean Water Management Trust Fund (CWMTF). West Jefferson, NC.

New Jersey Department of Environmental Protection (NJDEP). Division of Water Quality. Bureau of Nonpoint Pollution Control. August 2002. Onsite Wastewater Management Program Question: "What are the Approval Requirements to Build 50 or More Realty Improvements on a Single Subdivision?" http://www.state.nj.us/dep/dwq/sep50mor.htm

NRI. 2001. National Resources Inventory. Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, D.C. 20 Dec. 2001. http://www.nhq.nrcs.usda.gov/NRI/1997

North Carolina Department of Environment and Natural Resources (NCDENR). Division of Land Resources (DLR). Land Quality Section. July-September 1999. *Sediments: Newsletter of the North Carolina Sediment Control Commission*. Vol. 6 No. 3. Raleigh, NC. http://www.dlr.enr.state.nc.us/.

____. DLR. Land Quality Section. 1998. *What is Erosion and Sedimentation?* Raleigh, NC.

____. DLR. Center for Geographic Information Analysis. 1997. Raleigh, NC.

____. Division of Water Quality (DWQ). August 2004. *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina*. North Carolina Administrative Code: 15A NCA 2B .0220. Raleigh, NC.

____. DWQ. Environmental Sciences Branch (ESB). Biological Assessment Unit (BAU). August 2004. *Basinwide Assessment Report: Savannah Basin*. Raleigh, NC.

____. DWQ. February 2004. *Buffers for Clean Water*. Raleigh, NC.

____. DWQ. BAU. November 2003. *Benthic Macroinvertebrate Sampling of Middle Fork South Fork Savannah, Savannah Subbasin 01, October 2003 Following a Sodium Hydroxide Spill*. Raleigh, NC.

____. Ecosystem Enhancement Program (EEP). 2004. *Little River and Laurel Branch Local Watershed Plan. Phase I: Watershed Characterization, Preliminary Findings and Recommendations Report.* Prepared by W.K. Dickson & Co., Inc. Raleigh, NC.

North Carolina Department of Environment, Health and Natural Resources (NCDEHNR). Division of Forest Resources (DFR). January 1990. *Forest Practices Guidelines Related to Water Quality*. North Carolina Administrative Code: 15A G.S. 77-13 and 77-14. Raleigh, NC.

North Carolina Department of Natural Resources and Community Development (NRCD). Division of Forest Resources (DFR). September 1989. *Forestry Best Management Practices Manual*. Raleigh, NC. www.dfr.state.nc.us.

Orr, D.M., Jr. and A.W. Stuart. 2000. *The North Carolina Atlas*. The University of North Carolina Press. Chapel Hill, NC.

Pennsylvania Association of Conservation Districts, Inc. (PACD) 2003. *Water Pollution Solutions – Septic Systems.* http://www.pacd.org/resources/

Raphals, Philip. Restructured Rivers: Hydropower in the Era of Competitive Markets. Berkeley: International Rivers Network,2001.

Roell, Michael J. June 1999. *Sand and Gravel Mining in Missouri Stream Systems: Aquatic Resource Effects and Management Alternatives*. Missouri Department of Conservation. Conservation Research Center. Columbia, MO.

Schillinger, J.E. and J.J. Gannon. 1985. *Bacterial Adsorption and Suspended Particles in Urban Stormwater*. Journal WPCF. 57:384-389.

Sherer, B.M., J.R. Miner, J.A. Moore and J.C. Buckhouse. 1992. *Indicator Bacterial Survival in Stream Sediments*. J Environ Qual. 21:591-595.

Schueler, Thomas. 1995. *Site Planning for Urban Stream Protection*. Metropolitan Washington Council of Governments: Washington D.C.. 1995

Schueler, T.R. 1992. *Mitigating the Adverse Impacts of Urbanization on Streams: A Comprehensive Strategy for Local Government*. Watershed Restoration Sourcebook. Publication #92701 of the Metropolitan Washington Council of Governments, edited by P. Kumble and T. Schueler.

Schueler, T., and H.K. Holland. 2000. The Practice of Watershed Protection. Center for Watershed Protection, Ellicott City, Maryland.

Smith, Dr. Matt, Dr. Mark Risse, and Hillary Smith Tanner. August 2004. *On-site Wastewater Management Systems and their Environmental Impacts.* Bulletin 1242-4. University of Georgia. Biological and Agricultural Engineering Department.

US Army Corps of Engineers (USACE), Huntington District and NCDENR DWQ. March 2003. *Ore Knob Aquatic Restoration Project: Draft Detailed Project Report and Environmental Assessment*. Huntington, VA. http://www.lrh.usace.army.mil/_kd/go.cfm?destination=Page&Pge_ID=1180

U.S. Census Bureau. 2000. United States Census 2000. 9 Jan. 2002. http://www.census.gov/population/projections/nation/summary/np-tl.txt

US Department of Agriculture (USDA). Natural Resources Conservation Service (NRCS). North Carolina State Office. June 2001. *1997 National Resources Inventory*. Raleigh, NC.

____. Forest Service. *Forest Statistics for North Carolina*. 1990. *North Carolina's Southeastern Forest Experimental Station Resource Bulletin SE-120*. Raleigh, NC.

US Environmental Protection Agency (EPA). 1999. Watershed Academy Website: http://www.epa.gov/OWOW/watershed/wacademy/.

Weinkam, C., R. Shea, C. Shea, C. Lein and D. Harper. October 2001. *Urban Stream Restoration Programs of Two Counties in the Baltimore-Washington DC Area*. Paper presented at the *Fourth Annual North Carolina Stream Restoration Conference, Stream Repair and Restoration: A Focus on the Urban Environment*. Raleigh, NC.

World Commission on Dams. Dams and Development: A New Framework for Decision-Making. Cape Town, 2000.

Yaggi, M.A. and W. Wegner. 2002. /*Steep Slope Development and How It Effects the Environment*/. Concerned Citizens of Southeast; Brewster, NY.

Appendix I

Population and Growth Trends in the Savannah River Basin

Population and Growth Trends

Below are three different ways of presenting population data for the Savannah River basin. The data presented by basin allow for 2000 population data to be presented by subbasin. Population data presented by county allow for analysis of projected growth trends in the basin based on information from the Office of State Planning (April-May, 2001). Data presented by municipality summarizes information on past growth of large urban areas in the basin. While the three different sets of information cannot be directly compared, general conclusions are apparent by looking at the information. Counties with the highest expected growth are associated with the largest municipal areas and the most densely populated subbasins in the basin.

Basin Population and Population Density

Information on population density at a watershed scale is useful in determining what streams are likely to have the most impacts as a result of population growth. This information is also useful in identifying stream segments that have good opportunities for preservation or restoration. This information is presented to estimate population and population density by each subbasin and for the entire basin. It is assumed that county populations are distributed evenly throughout each county; therefore, subbasins that are within counties with large urban areas may overestimate the actual population in that portion of the basin. The overall population of the basin based on 2000 Census data is 49,653, with approximately 66 persons/square mile. (See the map of hydrologic units and population density.) The overall population and persons/square mile is estimated based on the percent of the county land area that is partially or entirely within the basin.

County Population and Growth Trends

The following table and map show the projected population for 2020 and the change in growth between 1990 and 2020 for counties that are partially or entirely contained within the basin. Since river basin boundaries do not coincide with county boundaries, these numbers are not directly applicable to the Savannah River basin. This information is intended to present an estimate of expected population growth in counties that have some land area in the Savannah River basin. For more information on past, current and projected population estimates, contact the Office of State Planning at (919) 733-4131 or visit their website at http://demog.state.nc.us.

County	Percent of County in Basin ♦	County Population 1990	County Population 2000	Estimated % Growth 1990-2000	Estimated Population 2020	Estimated % Growth 2000-2020
Clay	5	7,155	8,775	22.6%	11,916	35.8%
Jackson	12	26,835	33,121	23.4%	43,630	31.7%
Macon	6	23,504	29,811	26.8%	40,288	35.1%
Transylvania	18	25,520	29,334	14.9%	32,442	10.6%
Subtotals		83,014	101,041	87.7%	128,276	113,2%

♦ Source: North Carolina Center for Geographic Information and Analysis (CGIA), 1997.

Note: The numbers reported reflect county population; however, these counties are not entirely within the basin. The intent is to demonstrate growth for counties located wholly or partially within the basin.

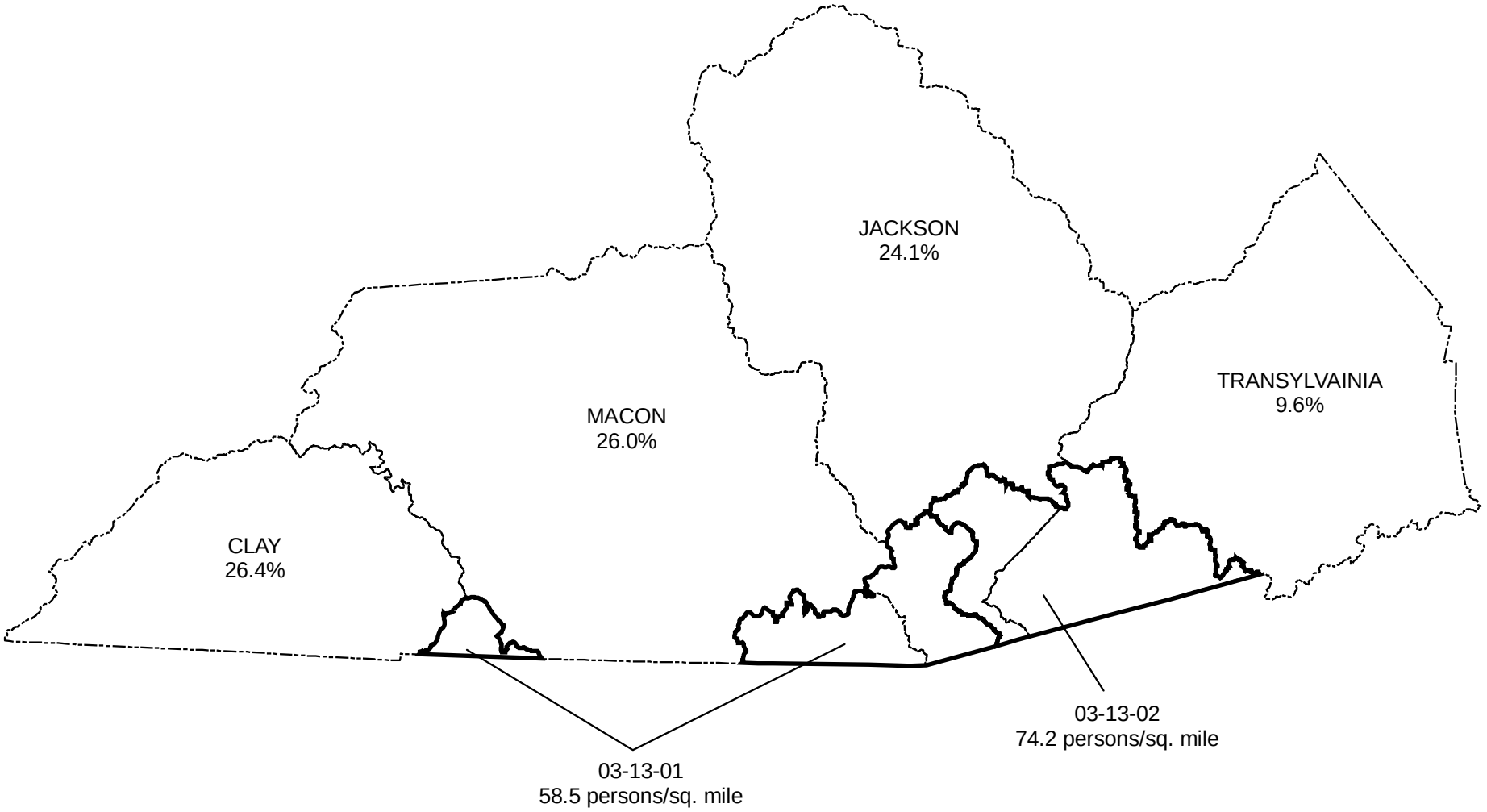
Municipal Population and Growth Trends

The table below presents population data from Office of State Planning for municipalities located partially or entirely in the basin. These data represent one municipality in the basin.

Municipality	County	April 1980	April 1990	April 2000	Percent Change (1980-1990)	Percent Change (1990-2000)
Highlands *	Jackson, Macon	653	948	909	45.2	-4.1

- * - The numbers reported reflect municipality population; however, these municipalities are not entirely within the basin. The intent is to demonstrate growth for municipalities located wholly or partially within the basin.

Projected Population Growth (2000-2020) by County and Population Density by Subbasin for the Savannah River Basin



Planning Section
Basinwide Planning Unit
November 27, 2006

0 1.25 2.5 5 7.5 10
Miles

®

Appendix II

Local Governments and Planning Jurisdictions in the Savannah River Basin

Local Governments and Planning Jurisdictions in the Basin

The Savannah River basin encompasses all or portions of four counties and 1 municipality. The following table provides a listing of these local governments, along with the regional planning jurisdiction (Council of Governments). One municipality is located in more than one county and major river basin.

County	Region	Municipalities
Clay	A	None
Jackson	A	Highlands♦*
Macon	A	Highlands♦*
Transylvania	B	None

* Located in more than one county.

♦ Located in more than one major river basin.

Note: Counties adjacent to and sharing a border with a river basin are not included as part of that basin if only a trace amount of the county (<2 percent) is located in that basin, unless a municipality is located in that county.

Region	Name	Location
A	Southwestern Commission Council of Government	Bryson City
B	Land-of-Sky Regional Council	Asheville

Appendix III

Land Cover
in the
Savannah River Basin

Land Cover

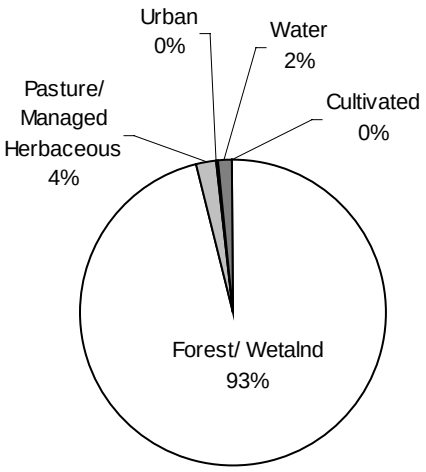
Land cover can be an important way to evaluate the effects of land use changes on water quality. Unfortunately, the tools and database to do this on a watershed scale are not available. The information below describes two different ways of presenting land cover in the Savannah River basin.

The state's Center for Geographic Information and Analysis (CGIA) land cover information is useful in providing a snapshot of land cover in the basin from 1993 to 1995. This information is also available in a GIS format so it can be manipulated to present amounts of the different land covers by subbasin or at the watershed scale. The Natural Resources Inventory (NRI) land cover information is presented only at a larger scale (8-digit hydrologic unit), but the collection methods allow for between year comparisons. The two datasets cannot be compared to evaluate land cover data. This information is presented to provide a picture of the different land covers and some idea of change in land cover over time. In the future, it is hoped that land cover information like the GIS formatted dataset will be developed to make more meaningful assessments of the effects of land use changes on water quality. This dataset would also be useful in providing reliable and small-scale information on land cover changes that can be used in water quality monitoring, modeling and restoration efforts.

CGIA Land Cover

The North Carolina Corporate Geographic Database contains land cover information for the Savannah River basin based on satellite imagery from 1993-1995. CGIA developed 24 categories of statewide land cover information. For the purposes of this report, those categories have been condensed into five broader categories as described in the following table. The chart provides an illustration of the relative amount of land area that falls into each major cover type for the Savannah River basin.

Land Cover Type	Land Cover Description
Urban	Greater than 50 percent coverage by synthetic land cover (built-upon area) and municipal areas.
Cultivated Cropland	Areas that are covered by crops that are cultivated in a distinguishable pattern.
Pasture/Managed Herbaceous	Areas used for the production of grass and other forage crops and managed areas such as golf courses and cemeteries. Also includes upland herbaceous areas not characteristic of riverine and estuarine environments.
Forest/Wetland	Includes salt and freshwater marshes, hardwood swamps, shrublands and forested areas (i.e., needleleaf evergreens, deciduous hardwoods).
Water	Areas of open surface water, areas of exposed rock and areas of sand or silt adjacent to tidal waters and lakes.



NRI Land Cover Trends

Land cover information in this section is from the most current National Resources Inventory (NRI), as developed by the Natural Resources Conservation Service (USDA, updated June 2001). The NRI is a statistically based longitudinal survey that has been designed and implemented to assess conditions and trends of soil, water and related resources on the Nation's nonfederal rural lands. The NRI provides results that are nationally and temporally consistent for four points in time -- 1982, 1987, 1992 and 1997.

In general, NRI protocols and definitions remain fixed for each inventory year. However, part of the inventory process is that the previously recorded data are carefully reviewed as determinations are made for the new inventory year. For those cases where a protocol or definition needs to be modified, all historical data must be edited and reviewed on a point-by-point basis to make sure that data for all years are consistent and properly calibrated. The following excerpt from the *Summary Report: 1997 National Resources Inventory* provides guidance for use and interpretation of current NRI data:

> The 1997 NRI database has been designed for use in detecting significant changes in resource conditions relative to the years 1982, 1987, 1992 and 1997. All comparisons for two points in time should be made using the new 1997 NRI database. Comparisons made using data previously published for the 1982, 1987 or 1992 NRI may provide erroneous results because of changes in statistical estimation protocols, and because all data collected prior to 1997 were simultaneously reviewed (edited) as 1997 NRI data were collected.

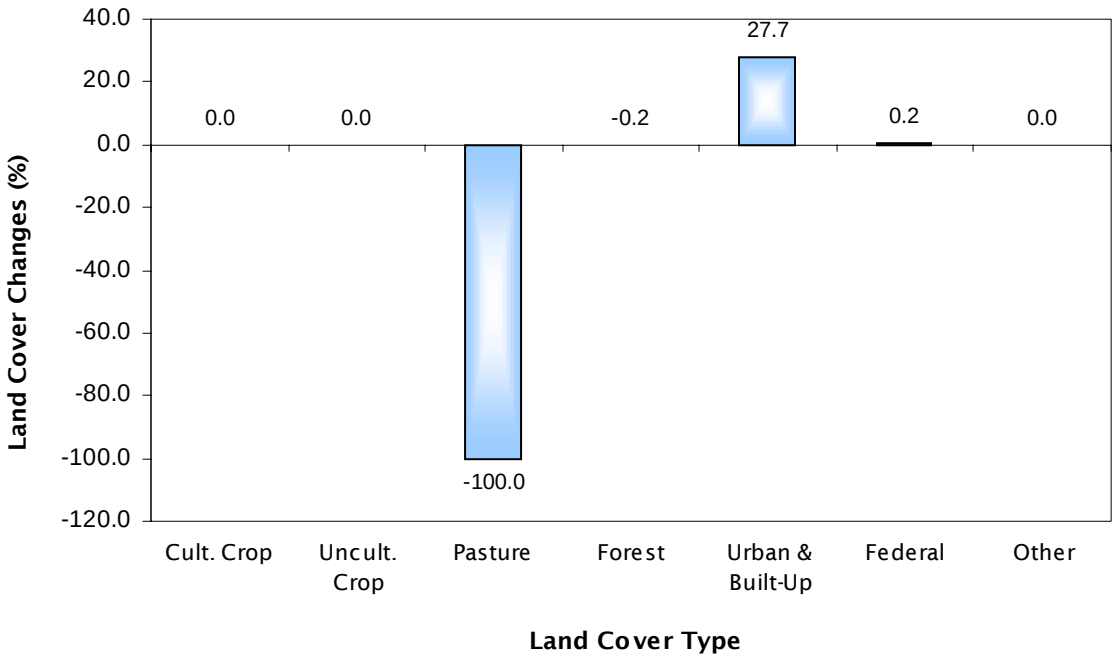
The following table summarizes acreage and percentage of land cover from the 1997 NRI for the major watersheds within the basin, as defined by the USGS 8-digit hydrologic units, and compares the land cover to 1982 land cover. Definitions of the different land cover types are also presented.

LAND COVER	MAJOR WATERSHED AREAS								
	Seneca		Tugaloo		1997 TOTALS		1982 TOTALS		% Change Since 1982
	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	
Cult. Crop	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0
Uncult. Crop	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0
Pasture	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.1	-100.0
Forest	36.0	51.0	8.5	21.6	44.5	40.5	44.6	40.6	-0.2
Urban & Built-Up	1.9	2.7	8.7	22.1	10.6	9.6	8.3	7.6	27.7
Federal	30.3	42.9	21.4	54.5	51.7	47.0	51.6	47.0	0.2
Other	2.4	3.4	0.7	1.8	3.1	2.8	3.1	2.8	0.0
Totals	70.6	100.0	39.3	100.0	109.9		109.9		
% of Total Basin		64.2		35.8		100.0		100.0	
SUBBASINS	03-13-02		03-13-01						
8-Digit Hydraulic Units	03060101		03060102						

Type	Description
Cultivated Cropland	Harvestable crops including row crops, small-grain and hay crops, nursery and orchard crops, and other specialty crops.
Uncultivated Cropland	Summer fallow or other cropland not planted.
Pastureland	Includes land that has a vegetative cover of grasses, legumes and/or forbs, regardless of whether or not it is being grazed by livestock.
Forestland	At least 10 percent stocked (a canopy cover of leaves and branches of 25 percent or greater) by single-stemmed trees of any size, which will be at least 4 meters at maturity, and land bearing evidence of natural regeneration of tree cover. The minimum area for classification of forestland is 1 acre, and the area must be at least 1,000 feet wide.
Urban and Built-up Areas	Includes airports, playgrounds with permanent structures, cemeteries, public administration sites, commercial sites, railroad yards, construction sites, residences, golf courses, sanitary landfills, industrial sites, sewage treatment plants, institutional sites, water control structure spillways and parking lots. Includes highways, railroads and other transportation facilities if surrounded by other urban and built-up areas. Tracts of less than 10 acres that are completely surrounded by urban and built-up lands.
Other	*Rural Transportation*: Consists of all highways, roads, railroads and associated rights-of-way outside urban and built-up areas, private roads to farmsteads, logging roads and other private roads (but not field lanes). *Small Water Areas*: Waterbodies less than 40 acres; streams less than 0.5 mile wide. *Census Water*: Large waterbodies consisting of lakes and estuaries greater than 40 acres and rivers greater than 0.5 mile in width. *Minor Land*: Lands that do not fall into one of the other categories.

Source: USDA, Soil Conservation Service - 1982 and 1997 NRI

Data from 1982 are also provided for a comparison of change over 15 years. During this period, urban and built-up land cover increased by over 2,000 acres (27.7 percent). Pastureland decreased by over 2,000 acres (100 percent, respectively). Forest cover decreased by 100 acres (0.2 percent). Most land cover change is accounted for in the areas surrounding the local municipalities in the Savannah River basin. Below is a graph that presents changes in land cover between 1982 and 1997.



Source: USDA-NRCS, NRI, updated June 2001

Appendix IV

DWQ Water Quality Monitoring Programs in the Savannah River Basin

DWQ Water Quality Monitoring Programs in the Savannah River Basin

Staff in the Environmental Sciences Section (ESS) and Regional Offices of DWQ collect a variety of biological, chemical and physical data. The following discussion contains a brief introduction to each program, followed by a summary of water quality data in Savannah River basin for that program. For more detailed information on sampling and assessment of streams in this basin, refer to the *Basinwide Assessment Report* for the Savannah River basin, available from the Environmental Sciences Branch website at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

DWQ monitoring programs for the Savannah River Basin include:

- Benthic Macroinvertebrates
- Aquatic Toxicity Monitoring
- Lake Assessment
- Ambient Monitoring System

Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data has proven to be a reliable monitoring tool, as benthic macroinvertebrates are sensitive to subtle changes in water quality. Since macroinvertebrates have life cycles of six months to over one year, the effects of short-term pollution (such as a spill) will generally not be overcome until the following generation appears. The benthic community also integrates the effects of a wide array of potential pollutant mixtures.

Criteria have been developed to assign a bioclassification to each benthic sample based on the number of different species present in the pollution intolerant groups of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies), commonly referred to as EPTs. A Biotic Index (BI) value gives an indication of overall community pollution tolerance. Different benthic macroinvertebrate criteria have been developed for different ecoregions (mountains, piedmont, coastal plain and swamp) within North Carolina and bioclassifications fall into five categories: Excellent, Good, Good-Fair, Fair and Poor.

Overview of Benthic Macroinvertebrate Data

Based on benthic macroinvertebrate data, water quality in the Savannah River basin is Excellent to Good. Since 1999, 14 benthic macroinvertebrate basinwide samples have been collected with three (21%) receiving Good bioclassifications and 11 (79%) resulting in Excellent bioclassifications. Comparisons of benthos data from 1999 to 2004 between repeat sites show that one site (Indian Creek at US 64) improved from Good to Excellent while two sites (Horsepasture River at NC 281 and Norton Mill Creek at SR 1107) declined in bioclassification from Excellent to Good. Overall, water quality in this basin is unchanged since 1999. The decline in the Horsepasture River may be the result of natural variation. This site has received four different bioclassifications from eight samples since 1985. This site also supports an ambient chemistry site and analysis of that data show no significant adverse trends in water quality. The decline at Norton Mill Creek is possibly related to upstream development associated with the town of Cashiers. Additional monitoring at both sites will help discern whether the changes in bioclassification from 1999 to 2004 were anthropogenic or natural.

Several rare invertebrate taxa were collected in the Savannah River basin in 2004 including the mayflies Drunella longicornis (Thompson and Whitewater Rivers), Danella lita (Thompson River), Litobrancha recurvata (Thompson River), Serratella spiculosa (Thompson and Chattooga Rivers), Rhithrogena fuscifrons (Big Creek and Whitewater River), the caddisflies Mayatrichia ayama (Horsepasture and Chattooga River), Oecetis avara (Chattooga River), and the stonefly Beloneuria (Thompson River, Big Creek, Norton Mill Creek). In addition, the Chattooga River at SR 1100 had among the highest total taxa (124) and EPT taxa (64) ever collected in North Carolina and were the highest ever recorded in the Savannah River basin. For detailed information regarding the samples collected during this assessment period, refer to the tables at the end of this appendix.

Assessing Benthic Macroinvertebrate Communities in Small Streams

The benthic macroinvertebrate community of small streams is naturally less diverse than the streams used to develop the current criteria for flowing freshwater streams. The benthic macroinvertebrate database is being evaluated and a study to systematically look at small reference streams in different ecoregions is being developed with the goal of finding a way to evaluate water quality conditions in such small streams.

Presently, a designation of Not Impaired may be used for flowing waters that are too small to be assigned a bioclassification (less than 4 meters in width) but meet the criteria for a Good-Fair or higher bioclassification using the standard qualitative and EPT criteria. This designation will translate into a use support rating of Supporting. However, DWQ will use the monitoring information from small streams to identify potential impacts to small streams even in cases when a use support rating cannot be assigned.

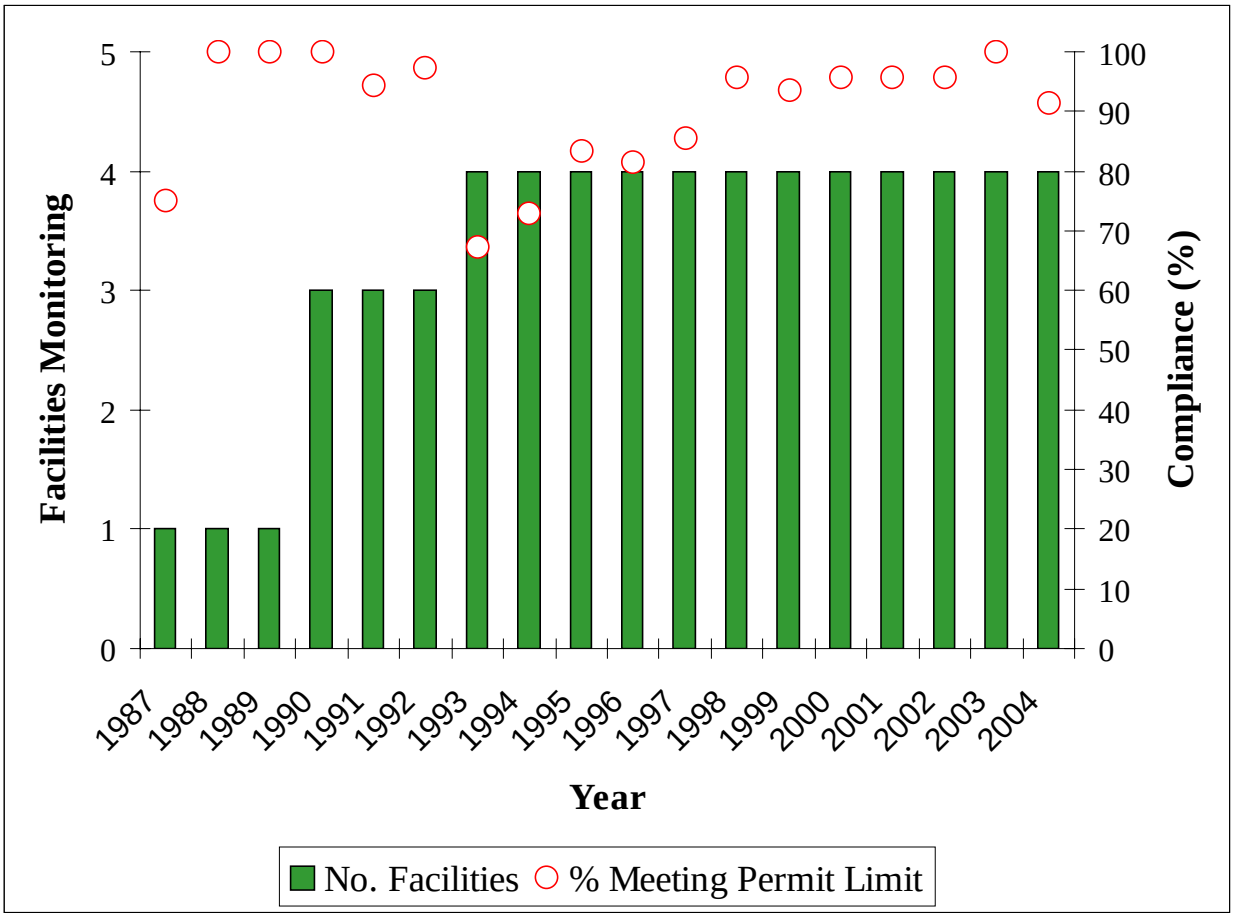
DWQ will use this monitoring information to identify potential impacts to these waters even though a use support rating is not assigned. DWQ will continue to develop criteria to assess water quality in small streams.

Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Results of these tests have been shown by several researchers to be predictive of discharge effects on receiving stream populations. Many facilities are required to monitor whole effluent toxicity (WET) by their NPDES permit or by administrative letter. Other facilities may also be tested by DWQ's Aquatic Toxicology Unit (ATU). Per Section 106 of the Clean Water Act, the ATU is required to test at least 10 percent of the major discharging facilities over the course of the federal fiscal year (FFY). However, it is ATU's target to test 20 percent of the major dischargers in the FFY. This means that each major facility would get evaluated over the course of their five-year permit. There are no requirements or targets for minor dischargers.

The ATU maintains a compliance summary for all facilities required to perform tests and provides monthly updates of this information to regional offices and DWQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

Four facility permits in the Savannah River basin currently require whole effluent toxicity (WET) monitoring. Both facility permits have a WET limit. Across the state, the number of facilities required to perform WET has increased steadily since 1987, the first year that WET limits were written into permits in North Carolina. Consequently, compliance rates have also risen. Since 1996, the compliance rate has stabilized at approximately 90 percent. The following graph summaries WET monitoring compliance in the Savannah River basin from 1987 to 2002. Facilities with toxicity problems during the most recent two-year review period are discussed in subbasin chapters.



Lakes Assessment Program

Two lakes were sampled in the Savannah River Basin during the 2004 Ambient Lakes Monitoring: Cashiers Lake and Lake Toxaway. Each of these lakes were sampled three times during the summer (June, July and August). Lakes with noted water quality impacts are discussed in the appropriate subbasin chapter.

Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine stations strategically located for the collections of physical and chemical water quality data. North Carolina has more than 378 water chemistry monitoring stations statewide, including 1 station in

the Savannah River basin. Between 23 and 32 parameters are collected monthly at each station. The locations of these stations are listed in the following table and shown on individual subbasin maps. Notable ambient water quality parameters are discussed in the subbasin chapters. Refer to *2005 Savannah Basinwide Assessment Report* at http://www.esb.enr.state.nc.us/bar.html for more detailed analysis of ambient water quality monitoring data.

Locations of Ambient Monitoring Stations in the Roanoke River Basin by Subbasin

Subbasin/ Station ID	Location	Class	Lat.	Long.	County	Map ID
01	***Chattooga River***					
	No Stations					
02	***Toxaway, Horepasture, Thompson, and Whitewater Rivers***					
H6000000	Horsepasture River at NC 281 near Union	B Tr	35.0922	-82.9764	Transylvania	A1

Benthic Macroinvertebrate Data Collected in the Savannah River Basin, 1999 – 2004
(Current basinwide sampling sites are in **bold** print.)

Waterbody	Location	County	Index No.	Date	ST	EPT	BI	EPT BI	Rating
)1									
Chattooga R	SR 1107	Jackson	3	8/04	-----	48	-----	2.2	Excellent
Chattooga R	SR 1100	Jackson	3	8/04	124	64	3.5	2.8	Excellent
				7/99	-----	48	-----	1.5	Excellent
Norton Mill Cr	SR 1107	Jackson	3-3	8/04	108	40	4.2	2.7	Good
				6/99	119	51	4.0	2.7	Excellent
Big Cr	SR 1608	Macon	3-10-3	8/04	-----	45	-----	2.4	Excellent
				7/99	118	53	3.7	2.6	Excellent
02									
Toxaway R	At Auger Hole Trail (Gorges State Park)	Transylvania	4-(4)	8/04	-----	36	-----	2.7	Excellent
Indian Cr	US 64	Transylvania	4-5-(3)	8/04	-----	40	-----	2.4	Excellent
				7/99					
Bearwallow Cr	At Auger Hole Trail (Gorges State Park)	Transylvania	4-7-(2)	8/04	-----	41	-----	2.4	Excellent
Horsepasture R	NC 281	Transylvania	4-13-(12.5)	8/04	98	41	4.1	2.9	Good
				7/99	73	36	4.4	3.5	Good
Whitewater R	NC 281	Transylvania	4-14-(1.5)	8/04	-----	46	-----	2.3	Excellent
				7/99	-----	38	-----	2.9	Excellent
Thompson R	NC 281	Transylvania	4-14-6	8/04	-----	46	-----	1.9	Excellent

Appendix V

NPDES Discharges
and
Stormwater Permits

Permit	Owner	Facility	County	Region	Type	Class	Flow	Subbasin	Receiving Stream
NC0037711	VZTOP Homeowner's Association Inc	Vztop Homeowners Association	Macon	Asheville	100% Domestic < 1MGD	Minor	28000	03-13-01	Brooks Creek
NC0061123	The Mountain Retreat & Learning Center	The Mountain Retreat & Learning Center WWTP	Macon	Asheville	100% Domestic < 1MGD	Minor	6000	03-13-01	Abes Creek
NC0061930	Mark Laurel Homeowner's Association	Mark Laurel WWTP	Macon	Asheville	100% Domestic < 1MGD	Minor	42000	03-13-01	East Fork Overflow Creek
NC0063321	Tuckaseigee Water & Sewer Authority	Cashiers WWTP	Jackson	Asheville	Municipal, < 1MGD	Minor	200000	03-13-01	CHATTOOGA RIVER (Cashiers Lake)
NC0064416	Cullasaja Homeowner's Association	Cullasaja WWTP	Jackson	Asheville	100% Domestic < 1MGD	Minor	150000	03-13-01	Norton Mill Creek
NC0022985	Carolina Water Service Inc Of NC	Jackson Utility WWTP	Jackson	Asheville	100% Domestic < 1MGD	Minor	300000	03-13-02	Trays Island Creek
NC0024376	The Wilds Christian Association Inc	The Wilds Christian Camp	Transylvania	Asheville	100% Domestic < 1MGD	Minor	80000	03-13-02	Toxaway Creek
NC0052043	Toxaway Falls Inc	Toxaway Falls WWTP	Transylvania	Asheville	100% Domestic < 1MGD	Minor	120000	03-13-02	TOXAWAY RIVER
NC0059421	Sapphire Lakes Utility Company Inc	Sapphire Lakes WWTP #1	Transylvania	Asheville	100% Domestic < 1MGD	Minor	300000	03-13-02	Horsepasture River (Lupton Lake, Sapphire Lake)
NC0059439	Sapphire Lakes Utility Company Inc	Sapphire Lakes WWTP #2	Transylvania	Asheville	100% Domestic < 1MGD	Minor	4900	03-13-02	James Creek
NC0062553	Wade Hampton Property Owners Association	Wade Hampton Golf Club WWTP	Jackson	Asheville	100% Domestic < 1MGD	Minor	125000	03-13-02	Silver Run Creek
NC0063312	McKee Development	Cedar Creek WWTP	Jackson	Asheville	100% Domestic < 1MGD	Minor	2500	03-13-02	Horsepasture River (Lupton Lake, Sapphire Lake)
NC0065889	James E. Hicks	Indian Creek Resort LLC WWTP	Transylvania	Asheville	100% Domestic < 1MGD	Minor	100000	03-13-02	Indian Creek
NC0068918	Resources Planning Corporation	Resources Planning Corporation	Jackson	Asheville	100% Domestic < 1MGD	Minor	100000	03-13-02	Horsepasture River

COC Number	Facility Name	Receiving Stream	Subbasin	County
NCG020408	LBM Whitewater Quarry	Horsepasture River	# 03-13-02	Transylvania

Appendix VI

303(d) Listing
and
Reporting Methodology

Integrated 305(b) and 303(d) Report Summary

The *North Carolina Water Quality Assessment and Impaired Waters List* is an integrated report that includes both the 305(b) and 303(d) reports of previous years. The *305(b) Report* is compiled biennially to update the assessment of water quality in North Carolina and to meet the Section 305(b) reporting requirement of the Clean Water Act. The 305(b) reports present how well waters support designated uses (e.g., swimming, aquatic life support, water supply), as well as likely causes (e.g., sediment, nutrients) and potential sources of impairment. The term "Use Support" refers to the process mandated by 305(b). The *303(d) List* is a comprehensive public accounting of all Impaired waterbodies that is derived from the 305(b) Report/Use Support. An Impaired waterbody is one that does not meet water quality uses, such as water supply, fishing or propagation of aquatic life. Best professional judgement along with numeric and narrative standards criteria and anti-degradation requirements defined in 40 CFR 131 is considered when evaluating the ability of a waterbody to serve its uses.

Section 303(d) of the federal Clean Water Act (CWA) which Congress enacted in 1972 required States, Territories and authorized Tribes to identify and establish a priority ranking for waterbodies for which technology-based effluent limitations required by Section 301 are not stringent enough to attain and maintain applicable water quality standards, establish total maximum daily loads (TMDLs) for the pollutants causing impairment in those waterbodies, and submit, from time to time, the list of Impaired waterbodies and TMDLs to the US Environmental Protection Agency (EPA). Current federal rules require states to submit 303(d) lists biennially, by April 1st of every even numbered year. EPA is required to approve or disapprove the state-developed 303(d) list within 30 days. For each water quality limited segment Impaired by a pollutant and identified in the 303(d) list, a Total Maximum Daily Load (TMDL) must be developed. TMDLs are not required for waters Impaired by pollution. Here, pollution is defined by the EPA as, “man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of the water,” and is related to water control structures (i.e., dams).

The Integrated Report includes descriptions of monitoring programs, the use support methodology, and the Impaired waters list. New guidance from EPA places all waterbody assessment units into one unique assessment category (EPA, 2001b). Although EPA specifies five unique assessment categories, North Carolina elects to use seven categories. Each category is described in detail below:

Category 1: Attaining the water quality standard and no use is threatened. This category consists of those waterbody assessment units where all applicable use support categories are rated " Supporting". Data and information are available to support a determination that the water quality standards are attained and no use is threatened. Future monitoring data will be used to determine if the water quality standard continues to be attained.

Category 2: Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened. This category consists of those waterbody assessment units where at least one of the applicable use support categories are rated " Supporting" and the other use support categories are rated "Not Rated" or “No Data”. Also included in this category are waters where at least one of the applicable use support categories, except Fish Consumption, are rated "Supporting"; the remaining applicable use support

categories, except Fish Consumption, are rated "Not Rated"; and the Fish Consumption category is rated "Impaired-Evaluated". Data and information are available to support a determination that some, but not all, uses are attained. Attainment status of the remaining uses is unknown because there are insufficient or no data or information. Future monitoring data will be used to determine if the uses previously found to be in attainment remain in attainment, and to determine the attainment status of those uses for which data and information were previously insufficient to make a determination.

Category 3: Insufficient or no data and information to determine if any designated use is attained. This category consists of those waterbody assessment units where all applicable use support categories, except Fish Consumption, are rated "Not Rated", and the Fish Consumption category is rated "Impaired-Evaluated". Measured data or information to support an attainment determination for any use are not available. Supplementary data and information, or future monitoring, will be required to assess the attainment status.

Category 4: Impaired or threatened for one or more designated uses but does not require the development of a TMDL. This category contains three distinct sub-categories:

> **Category 4a: TMDL has been completed**. This category consists of those waterbody assessment units for which EPA has approved or established a TMDL and water quality standards have not yet been achieved. Monitoring data will be considered before moving an assessment unit from Category 4a to Categories 1 or 2.
>
> **Category 4b: Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future**. This category consists of those waterbody assessment units for which TMDLs will not be attempted because other required regulatory controls (e.g., NPDES permit limits, Stormwater Program rules, etc.) are expected to attain water quality standards within a reasonable amount of time. Future monitoring will be used to verify that the water quality standard is attained as expected.
>
> **Category 4c: Impairment is not caused by a pollutant**. This category consists of assessment units that are Impaired by pollution, not by a pollutant. EPA defines pollution as "The man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of the water." EPA staff have verbally stated that this category is intended to be used for impairments related to water control structures (i.e., dams). Future monitoring will be used to confirm that there continues to be an absence of pollutant-caused impairment and to support water quality management actions necessary to address the cause(s) of the impairment.

Category 5: Impaired for one or more designated uses by a pollutant(s) and requires a TMDL. This category consists of those waterbody assessment units that are Impaired by a pollutant and the proper technical conditions exist to develop TMDLs. As defined by the EPA, the term pollutant means "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological

materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into the water." When more than one pollutant is associated with the impairment of a single waterbody assessment unit in this category, the assessment unit will remain in Category 5 until TMDLs for all listed pollutants have been completed and approved by the EPA.

Category 6: Impaired based on biological data. This category consists of waterbody assessment units historically referred to as "Biologically Impaired" waterbodies; these assessment units have no identified cause(s) of impairment although aquatic life impacts have been documented. The waterbody assessment unit will remain in Category 6 until TMDLs have been completed and approved by the EPA.

Category 7: Impaired, but the proper technical conditions do not yet exist to develop a TMDL. As described in the Federal Register, "proper technical conditions" refer to the availability of the analytical methods, modeling techniques and data base necessary to develop a technically defensible TMDL. These elements will vary in their level of sophistication depending on the nature of the pollutant and characteristics of the segment in question" (43 FR 60662, December 28, 1978). These are assessment units that would otherwise be in Category 5 of the integrated list. As previously noted, EPA has recognized that in some specific situations the data, analyses or models are not available to establish a TMDL. North Carolina seeks EPA technical guidance in developing technically defensible TMDLs for these waters. Open water and ocean hydrology fecal coliform Impaired shellfishing waters are included in this category.

For this integrated list, Categories 1 and 2 are considered fully supporting any assessed uses. This portion of the integrated list is extensive (thousands of segments); thus, a printed copy is not provided. A table of waters on Categories 1 through 3 is available for downloading on the DWQ website (http://h2o.enr.state.nc.us/tmdl/General_303d.htm). **Categories 5, 6 and 7 constitute the 2004 North Carolina 303(d) List for the State of North Carolina**.

Delisting Waters

In general, waters will move from Categories 5, 6 or 7 when data show that uses are fully supported or when a TMDL has been approved by EPA. In some cases, mistakes have been discovered in the original listing decision and the mistakes are being corrected. Waters appearing on the previously approved Impaired waters list will be moved to Categories 1, 2, 3 or 4 under the following circumstances:

- An updated 305(b) use support rating of Supporting, as described in the basinwide management plans.
- Applicable water quality standards are being met (i.e., no longer Impaired for a given pollutant) as described in either basinwide management plans or in technical memoranda.

- The basis for putting the water on the list is determined to be invalid (i.e., was mistakenly identified as Impaired in accordance with 40 CFR 130.7(b)(6)(iv) and/or National Clarifying Guidance for State and Territory 1998 Section 303(d) Listing Decisions. Robert Wayland, III, Director. Office of Wetlands, Oceans and Watersheds. Aug 27, 1997).
- A water quality variance has been issued for a specific standard (e.g., chloride).
- Removal of fish consumption advisories or modification of fish eating advice.
- Typographic listing mistakes (i.e., the wrong water was identified).
- EPA has approved a TMDL.

Scheduling TMDLs

Category 5 waters, those for which a TMDL is needed, are at many different stages on the path to an approved TMDL. Some require additional data collection to adequately define the problem in TMDL terms. Some require more outreach to increase stakeholder involvement. Others need to have a technical strategy budgeted, funded and scheduled. Some are ready for EPA submittal.

North Carolina has prioritized TMDL development for waters Impaired due to bacteria or turbidity. The approach of prioritizing TMDL development based on pollutant has been successfully used in other states. Limited resources are used more effectively with a focus on a particular pollutant. Waters Impaired by other pollutants (i.e., not bacteria) are not excluded from the schedule. However, the majority of waters prioritized for the next few years are associated with bacterial contamination. Compliance with TMDL development schedules provided in the Integrated Report depends upon DWQ and EPA resources.

North Carolina uses biological data to place the majority of waterbody assessment units on the 303(d) list. Additional consideration and data collection are necessary if the establishment of a TMDL for waters on Category 6 is to be expected. It is important to understand that the identification of waters in Category 6 does not mean that they are low priority waters. The assessment of these waters is a high priority for the State of North Carolina. However, it may take significant resources and time to determine the environmental stressors and potentially a cause of impairment. Assigning waters to Category 6 is a declaration of the need for more data and time to adequately define the problems and whether pollution, pollutants or a combination affects waters.

According to EPA guidance (EPA 2004), prioritization of waterbody assessment units for TMDLs need not be reflected in a “high, medium or low” manner. Instead, prioritization can be reflected in the TMDL development schedule. Generally, North Carolina attempts to develop TMDLs within 10 years of the original pollutant listing. Other information for each assessment unit is also utilized to determine the priority in the TMDL development schedule. This information includes the following:

- Year listed. Assessment units that have been on the 303(d) list for the longest period of time will receive priority for TMDL development and/or stressor studies.
- Reason for listing. (Applicable to Category 5 AUs only) AUs with an impairment due to a standard violation will be prioritized based on which standard was violated. Standard violations due to bacteria or turbidity currently receive priority for TMDL development.

- Classification. AUs classified for primary recreation (Class B), water supply (Class WS-I through WS-V), trout (Tr), high quality waters (HQW), and outstanding resource waters (ORW) will continue to receive a higher priority for TMDL development and/or stressor studies.
- Basinwide Planning Schedule. (Applicable to Category 6 AUs only). The basinwide schedule is utilized to establish priority for stressor studies.

Revising TMDLs

Current federal regulations do not specify when TMDLs should be revised. However, there are several circumstances under which it would seem prudent to revisit existing TMDLs. The TMDL analysis of targets and allocations is based upon the existing water quality standards, hydrology, water quality data (chemical and biological), and existing, active NPDES wastewater discharges. Conditions related to any of these factors could be used to justify a TMDL revision. Specific conditions that the Division will consider prior to revising an existing, approved TMDL include the following:

- A TMDL has been fully implemented and the water quality standards continue to be violated. If a TMDL has been implemented and water quality data indicate no improvement or a decline in overall water quality, the basis for the TMDL reduction or the allocation may need to be revised;
- A change of a water quality standard (e.g., fecal coliform to Echerichia coli). The Division will prioritize review of existing TMDLs and data to determine if a revision to TMDLs will be required;
- The addition or removal of hydraulic structures to a waterbody (e.g., dams). Substantial changes to waterbody hydrology and hydraulics have the potential to change many aspects of target setting, including the water quality standard upon which the TMDL was developed, the water quality data, and the water quality modeling;
- Incorrect assumptions were used to derive the TMDL allocations. This would include errors in calculations and omission of a permitted discharge.

Should a TMDL be revised due to needed changes in TMDL targets, the entire TMDL would be revised. This includes the TMDL target, source assessment, and load and wasteload allocations. However, the Division may elect to revise only specific portions of the TMDL. For example, changes may be justifiable to the load and wasteload allocation portions of a TMDL due to incorrect calculations or inequities. In these cases, revisions to the TMDL allocations would not necessarily include a revision of TMDL targets.

Appendix VII

Savannah River Basin Nonpoint Source Program Description and Contacts

Agriculture

USDA Natural Resources Conservation Service:

Part of the U.S. Department of Agriculture (USDA), formerly the Soil Conservation Service. Technical specialists certify waste management plans for animal operations; provide certification training for swine waste applicators; work with landowners on private lands to conserve natural resources, helping farmers and ranchers develop conservation systems unique to their land and needs; administer several federal agricultural cost share and incentive programs; provide assistance to rural and urban communities to reduce erosion, conserve and protect water, and solve other resource problems; conduct soil surveys; offer planning assistance for local landowners to install best management practices; and offer farmers technical assistance on wetlands identification. www.nc.nrcs.usda.gov/

County	Contact Person	Phone	Address
Area 1 Conservationist	Carol S. Litchfield	828-456-6341	589 Raccoon Road, Suite 246, Waynesville NC 28786
Clay	Jason D. Wheatly	828-837-6417 ext. 3	225 Valley River Ave., Suite J, Murphy, NC 28906
Jackson	Kayla B. Hudson	828-586-6344	538 Scotts Creek Road, Suite 110, Sylva, NC 28779
Macon	Vacant	828-524-3311 ext. 3	191 Thomas Heights Road, Macon Agri. Service Center, Franklin, NC 28734
Transylvania	Robert D. Twomey	828-884-3230	203 East Morgan Street, Brevard, NC 28712

Soil and Water Conservation Districts:

Boards and staff under the administration of the NC Soil and Water Conservation Commission (SWCC). Districts are responsible for: administering the *Agricultural Cost Share Program for Nonpoint Source Pollution Control* at the county level; identifying areas needing soil and/or water conservation treatment; allocating cost share resources; signing cost share contracts with landowners; providing technical assistance for the planning and implementation of BMPs; and encouraging the use of appropriate BMPs to protect water quality.

Clay County SWCD		828-837-6417	225 Valley River Ave., Suite J, Murphy, NC 28906
Jackson County SWCD		828-586-6344	538 Scotts Creek Road, Suite 110, Sylva, NC 28779
Macon County SWCD		828-524-3311	191 Thomas Heights Road, Macon Agri. Service Center, Franklin, NC 28734
Transylvania County SWCD		828-884-3230	203 East Morgan Street, Brevard, NC 28712

Division of Soil and Water Conservation:

State agency that administers the *Agricultural Cost Share Program for Nonpoint Source Pollution Control* (ACSP). Allocates ACSP funds to the Soil and Water Conservation Districts, provides administrative and technical assistance related to soil science and engineering. Distributes Wetlands Inventory maps for a small fee. www.enr.state.nc.us/DSWC/

Central Office	David B. Williams	919-733-2302	512 N Salisbury Street, Raleigh NC 27604
Asheville Region *	Davis Ferguson Area Coordinator	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778

NCDA&CS Regional Agronomists:

The NC Department of Agriculture & Consumer Services (NCDA&CS) technical specialists: certify waste management plans for animal operations; provide certification training for swine waste applicators; track, monitor, and account for use of nutrients on agricultural lands; operate the state *Pesticide Disposal Program*, and enforce the state pesticide handling and application laws with farmers. www.ncagr.com/

Central Office	J. Kent Messick	919-733-2655	4300 Reedy Creek Road, Raleigh NC 27607
Region 13	Bill Yarborough	828-456-3943	
Region 14	Steve Dillon	704-276-1989	

Education

NC Cooperative Extension Service:

Provides practical, research-based information and programs to help individuals, families, farms, businesses and communities. www.ces.ncsu.edu

Clay		828-389-6305	55 Riverside Circle, Community Serv Bldg - Room 108, Hayesville, NC 28904
Jackson		828-586-4009	538 Scotts Creek Rd/suite 205, Sylva, NC 28779
Macon		828-349-2046	193 Thomas Heights Rd, Franklin, NC 28734
Transylvania		828-884-3109	203 E Morgan St, Brevard, NC 28712

Forestry

DENR Division of Forest Resources:

Develop, protect, and manage the multiple resources of North Carolina's forests through professional stewardship, enhancing the quality of our citizens while ensuring the continuity of these vital resources. www.dfr.state.nc.us

District Office (DFR District 9)	Service Forester	828-586-4007	443 Hwy. 116, Sylva, NC 28779-8513
Region III Mountains	Regional Forester or Asst. Regional Forester	828-251-6509	14 Gaston Mountain Road, Asheville NC 28806-9101
Raleigh Central Office (Statewide)	Forest Hydrologist, NPS Unit	919-733-2162 ext. 206	1616 Mail Service Center, Raleigh NC 27699-1616
Griffiths Forestry Center (Statewide)	Water Quality & Wetlands Forester	919-553-6178 ext. 230	2411 Old U.S. Hwy 70 West, Clayton NC 27250

Construction/Mining

DENR Division of Land Resources:

Administers the NC Erosion and Sedimentation Control Program for construction and mining operations. Conducts land surveys and studies, produces maps, and protects the state's land and mineral resources. www.dlr.enr.state.nc.us

Central Office	Floyd Williams	919-733-4574	512 North Salisbury Street, Raleigh NC 27626
Asheville Region *	Janet Boyer	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778

Local Erosion and Sedimentation Control Ordinances:

Several local governments in the basin have qualified to administer their own erosion and sedimentation control ordinances. For a listing of the most recently approved local programs visit www.dlr.enr.state.nc.us/pages/sedimentlocalprograms.html

City of Highlands	Larry Gantenbein	828-526-2118	PO Box 460, Highlands, NC 28741
Jackson County	Linda Cable	828-631-2256	401 Grindstaff Cove Road, Suite 110, Sylva, NC 28779
Macon County	Josh Ward	828-349-2560	1834 Lakeside Drive, Franklin, NC 28734

General Water Quality

DENR DWQ Planning Section:

Coordinate the numerous nonpoint source programs carried out by many agencies; coordinate the Neuse and Tar-Pamlico River Nutrient Sensitive Waters Strategies; administer the Section 319 grants program statewide; conduct stormwater permitting; model water quality; conduct water quality monitoring; perform wetlands permitting; conduct animal operation permitting and enforcement; and conduct water quality classifications and standards activities. http://h2o.enr.state.nc.us/pb/index.html

Planning Section Chief	Alan Clark	919-733-5083 x 570	1617 Mail Service Center, Raleigh NC 27699
NPS Planning	Rich Gannon	919-733-5083 x 356	1617 Mail Service Center, Raleigh NC 27699
Modeling/TMDL	Michelle Woolfolk	919-733-5083 x 505	1617 Mail Service Center, Raleigh NC 27699
Classifications and Standards	Jeff Manning	919-733-5083 x 579	1617 Mail Service Center, Raleigh NC 27699
Basinwide Planning	Darlene Kucken	919-733-5083 x 354	1617 Mail Service Center, Raleigh NC 27699
Groundwater Planning	Carl Bailey	919-733-5083 x 522	1617 Mail Service Center, Raleigh NC 27699

DWQ Regional Offices:

Conduct permitting and enforcement field work on point sources, stormwater, wetlands and animal operations; conduct enforcement on water quality violations of any kind; and perform ambient water quality monitoring. http://www.enr.state.nc.us/html/regionaloffices.html

Asheville Region *	Roger Edwards	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778

NC Wildlife Resources Commission:

To manage, restore, develop, cultivate, conserve, protect and regulate the wildlife resources of the state, and to administer the laws enacted by the General Assembly relating to game, game and non-game freshwater fishes, and other wildlife resources in a sound, constructive, comprehensive, continuing and economical manner. www.ncwildlife.org

Central Office	Wildlife Management	919-707-0050	1722 Mail Service Center, Raleigh NC 27699

U.S. Army Corps of Engineers:

Responsible for: investigating, developing and maintaining the nation's water and related environmental resources; constructing and operating projects for navigation, flood control, major drainage, shore and beach restoration and protection; hydropower development; water supply; water quality control, fish and wildlife conservation and enhancement, and outdoor recreation; responding to emergency relief activities directed by other federal agencies; and administering laws for the protection and preservation of navigable waters, emergency flood control and shore protection. Responsible for wetlands and 404 Federal Permits. www.usace.army.mil

Asheville Field Office	Robert Johnson	828-271-7980	151 Patton Ave, Room 208, Asheville NC 28801

Solid Waste

DENR Division of Waste Management:

Management of solid waste in a way that protects public health and the environment. The Division includes three sections and one program -- Hazardous Waste, Solid Waste, Superfund, and the Resident Inspectors Program. http://wastenot.enr.state.nc.us

Central Office	Brad Atkinson	919-508-8409	401 Oberlin Road, Suite 150, Raleigh NC 27605
Asheville Region *	Jan Anderson	828-296-4500	2090 U.S. Highway 70, Swannanoa NC 28778

On-Site Wastewater Treatment

Division of Environmental Health and County Health Departments:

Safeguard life, promote human health, and protect the environment through the practice of modern environmental health science, the use of technology, rules, public education, and above all, dedication to the public trust. Services include: training of and delegation of authority to local environmental health specialists concerning on-site wastewater; engineering review of plans and specifications for wastewater systems 3,000 gallons or larger and industrial process wastewater systems designed to discharge below the ground surface; and technical assistance to local health departments, other state agencies, and industry on soil suitability and other site considerations for on-site wastewater systems. www.deh.enr.state.nc.us

Central Office	Andy Adams	919-715-3274	2728 Capital Boulevard, Raleigh NC 27604
Asheville Region *	Joe Lynn	828-397-5152	2090 U.S. Highway 70, Swannanoa NC 28778
Clay	Janice Patterson Health Director	828-389-8326	PO Box 55, Hayesville, NC 28904
Jackson	Paula Carden Health Director	828-586-8994	538 Scotts Creek Road, Suite 100, Sylva, NC 28779
Macon	Ken Ring Health Director	828-349-2489	1830 Lakeside Drive, Franklin, NC 28734
Transylvania	Steve Smith Health Director	828-884-3139	203 East Morgan Street, Brevard, NC 28712

* **DENR Asheville Regional Office covers the following counties:** Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Polk, Rutherford, Swain, Transylvania and Yancey

Appendix VIII

Use Support Methodology

Introduction to Use Support

All surface waters of the state are assigned a classification appropriate to the best-intended uses of that water. Waters are assessed to determine how well they are meeting the classified or best-intended uses. The assessment results in a use support rating for the use categories that apply to that water.

Use Support Categories

Beginning in 2000 with the *Roanoke River Basinwide Water Quality Plan*, DWQ assesses ecosystem health and human health risk through the use of five use support categories: aquatic life, recreation, fish consumption, water supply, and shellfish harvesting. These categories are tied to the uses associated with the primary classifications applied to NC rivers and streams. Waters are Supporting if data and information used to assign a use support rating meet the criteria for that use category. If these criteria are not met, then the waters are Impaired. Waters with inconclusive data and information are Not Rated. Waters where no data or information are available to make an assessment are No Data. The table below specifies which use support categories apply to which primary classifications.

A single body of water may have more than one use support rating corresponding to one or more of the use support categories, as shown in the following table. For many waters, a use support category will not be applicable (N/A) to the classification of that water (e.g., shellfish harvesting is only applied to Class SA waters). A full description of the classifications is available in the DWQ document titled: *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina* (15A NCAC 2b .0100 and .0200). Information can also be found within each basin plan and at http://h2o.enr.state.nc.us/csu/.

Use Support Categories

Primary Classification	Ecosystem Approach	Human Health Approach			
	Aquatic Life	Fish Consumption	Recreation	Water Supply	Shellfish Harvesting
C	X	X	X	N/A	N/A
SC	X	X	X	N/A	N/A
B	X	X	X	N/A	N/A
SB	X	X	X	N/A	N/A
SA	X	X	X	N/A	X
WS I – WS IV	X	X	X	X	N/A

Assessment Period

Data and information are used to assess water quality and assign use support ratings using a five-year data window that ends on August 31 of the year of basinwide biological sampling. For example, if biological data are collected in a basin in 2004, then the five-year data window for

use support assessments would be September 1, 1999 to August 31, 2004. There are occasionally some exceptions to this data window, especially when follow up monitoring is needed to make decisions on samples collected in the last year of the assessment period.

Data and information for assessing water quality and assigning use support ratings for lakes uses a data window of October 1 to September 30. Any data collected by DWQ during the five-year data window that ends on September 30 of the year of biological sampling will be used to develop a Weight-of-Evidence approach to lakes assessment. Refer to page 16 of this appendix for more information.

Assessment Units

DWQ identifies waters by index numbers and assessment unit numbers (AU). The AU is used to track defined stream segments or waterbodies in the water quality assessment database, for the 303(d) Impaired waters list, and in the various tables in basin plans and other water quality documents. The AU is a subset of the DWQ index number (classification identification number). A letter attached to the end of the AU indicates that the AU is smaller than the DWQ index segment. No letter indicates that the AU and the DWQ index segment are the same.

Interpretation of Data and Information

It is important to understand the associated limitations and degree of uncertainty when interpreting use support ratings. Although these use support methods are based on data analysis and other information, some best professional judgment is applied during these assessments. Use support ratings are intended to provide an assessment of water quality using a five-year data window, to describe how well surface waters support their classified uses, and to document the potential stressors contributing to water quality degradation and the sources of these contributions.

Use support methods continue to improve over time, and the information and technology used to make use support determinations also continue to become more accurate and comprehensive. These improvements sometimes make it difficult to make generalizations comparing water quality between basin plans. However, technology and methods improvements result in more scientifically sound use support assessments.

Assessment Methodology

Introduction

Many types of data and information are used to determine use support ratings and to identify stressors and sources of water quality degradation. All existing data pertaining to a stream segment for each applicable use support category are entered into a use support database. Assessments and data entries may include use support ratings for each of the five use support categories, basis of assessment, stressors and potential sources, biological, chemical/physical (ambient monitoring), and lakes assessment data, fish consumption advisories from the NC Department of Health and Human Services, swimming advisories and shellfish sanitation growing area classifications from the NC Division of Environmental Health, and available land

cover and land use information. The following describes the data and methodologies used to conduct use support assessments. These methods will continue to be refined as additional information and technology become available.

Basis of Assessment

Assessments are made on an overall basis of either monitored (M) or evaluated (E), depending on the level of information available. A monitored rating is based on the most recent five-year data window and site-specific data and is therefore treated with more confidence than an evaluated rating. Evaluated ratings are used when there are no site-specific data.

Rating Basis	Use Support Category	Assessment Applicability*
S/M	AL	Biological community data or ambient water quality parameters do not exceed criteria in AU during assessment period. Biological and ambient data are independently applied.
S/M	REC	Ambient fecal coliform bacteria levels do not exceed criteria in AU or AU with DEH sites is posted with advisories for 61 days or less during assessment period.
S/M	SH	AU is a DEH Approved shellfish growing area.
I/M	AL	Biological community data or ambient water quality parameters exceed criteria in AU during assessment period. Biological and ambient data are independently applied.
I/M	REC	Ambient fecal coliform bacteria levels exceeds criteria in AU or AU with DEH sites is posted with advisories for more than 61 days during assessment period.
I/M	FC	DHHS has established a site-specific advisory for fish consumption and fish tissue data are available.
I/M	SH	AU is a DEH Conditionally-Approved, Prohibited or Restricted shellfish growing area.
NR/M	AL	Biological community is Not Rated or inconclusive, or ambient water quality parameters are inconclusive or there are less than 10 samples in AU during assessment period. Biological and ambient data are independently applied.
NR/M	REC	Ambient fecal bacteria parameter exceeds annual screening criteria, but does not exceed assessment criteria of five samples in 30 days in AU during assessment period.
NR/M	FC	AU does not have site-specific advisory and is not under a mercury advice or drains to areas within a mercury advice; fish tissue data available.
S/E	AL	AU is a tributary to a S/M AU and land use is similar between AUs.
S/E	WS	AU is classified as WS, and DEH report notes no significant closures at time of assessment.
I/E	FC	AU is in basin under a mercury advice or drains to areas within a mercury advice. AU has a site-specific advisory and there is no fish tissue data available.
NR/E	AL	AU is tributary to I/M AU, or AU is in watershed with intensive and changing land use, or other information suggests negative water quality impacts to AU. Discharger in AU has noncompliance permit violations or has failed three or more WET tests during the last two years of the assessment period.
NR/E	REC	Discharger has noncompliance permit violations of fecal bacteria parameter during last two years of assessment period.
NR/E	FC	AU does not have site-specific advisory and is not under a mercury advice or drains to areas within a mercury advice, or has no fish tissue data.
ND	AL, REC, SH	No data available in AU during assessment period.

Note: S/M = Supporting/Monitored I/M = Impaired/Monitored NR/M = Not Rated/Monitored
S/E = Supporting/Evaluated I/E = Impaired/Evaluated NR/E = Not Rated/Evaluated
ND = No Data
AL = Aquatic Life REC = Recreation FC = Fish Consumption
SH = Shellfish Harvesting WS = Water Supply
AU = Assessment Unit WET = Whole Effluent Toxicity
DEH = Division of Environmental Health
DHHS = Department of Health and Human Services
* = for lakes assessments, see page 16

Supporting ratings are extrapolated up tributaries from monitored streams when there are no problematic dischargers with permit violations or changes in land use/cover. Supporting ratings may also be applied to unmonitored tributaries where there is little land disturbance (e.g., national forests and wildlife refuges, wilderness areas or state natural areas). Problem stressors or sources are not generally applied to unmonitored tributaries. Impaired ratings are not extrapolated to unmonitored tributaries.

Stressors

Biological and ambient samplings are useful tools to assess water quality. However, biological sampling does not typically identify the causes of impairment, and ambient sampling does not always link water quality standards to a biological response. Linking the causes of impairment and the biological response are a complex process (USEPA, 2000) that begins with an evaluation of physical, chemical or biological entities that can induce an adverse biological response. These entities are referred to as stressors. A stressor may have a measurable impact to aquatic health. Not all streams will have a primary stressor or cause of impairment. A single stressor may not be sufficient to cause impairment, but the accumulation of several stressors may result in impairment. In either case, impairment is likely to continue if the stressor or the various cumulative stressors are not addressed. Use support assessments evaluate the available information related to potential stressors impacting water quality.

A stressor identification process may be initiated after a stream appears on the 303(d) list in order to address streams that are Impaired based on biological data. Intensive studies are required to summarize and evaluate potential stressors to determine if there is evidence that a particular stressor plays a substantial role in causing the biological impacts. Intensive studies consider lines of evidence that include benthic macroinvertebrate and fish community data, habitat and riparian area assessment, chemistry and toxicity data, and information on watershed history, current watershed activities and land uses, and pollutant sources. These studies result in decisions regarding the probable stressors contributing to or causing impairment. The intensity of a stressor study may be limited due to a lack of resources. In these cases, it may still be appropriate to include stressors in use support assessments, but to also note where additional information is needed in order to evaluate other stressors.

Where an ambient parameter is identified as a potential concern, the parameter is noted in the DWQ database and use support summary table. Where habitat degradation is identified as a stressor, DWQ and others attempt to identify the type of habitat degradation (e.g., sedimentation, loss of woody habitat, loss of pools or riffles, channelization, lack of riparian vegetation, streambed scour and bank erosion).

Aquatic Life Category

The aquatic life category is an ecosystem approach to assessing the biological integrity of all surface waters of the state. The biological community data and ambient water quality data are used in making assessments in this category. These represent the most important monitoring data for making water quality assessments in the aquatic life category. Evaluation information such as compliance and whole effluent toxicity information from NPDES dischargers, land cover, and other more anecdotal information are also used to identify potential problems and to refine assessments based on the monitoring data. The following is a description of each monitoring data type and the criteria used in assigning use support ratings. Criteria used to evaluate the other information and assign use support ratings are also described. Refer to page 14 for lakes and reservoir assessment methods as applied in the aquatic life category.

Biological Data

Benthic macroinvertebrate (aquatic insects) community and fish community samples are the best way to assess the biological integrity of most waterbodies. Unfortunately, these community measures cannot be applied to every stream size and are further limited by geographic region. These community measures are designed to detect current water quality and water quality changes that may be occurring in the watershed. However, they are only directly applied to the assessment unit where the sample was collected.

Where recent data for both benthic macroinvertebrates and fish communities are available, both are assessed for use support ratings. When the data from multiple biological data types are gathered, each data type is assessed independently. Biological monitoring is typically assessed independent of ambient monitoring data and either may be used to assign a use support rating for an assessment unit.

Benthic Macroinvertebrate Criteria

Criteria have been developed to assign bioclassifications to most benthic macroinvertebrate samples based on the number of taxa present in the pollution intolerant aquatic insect groups of *Ephemeroptera, Plecoptera* and *Trichoptera* (EPTs); and the Biotic Index (BI), which summarizes tolerance data for all taxa in each sample. Because these data represent water quality conditions with a high degree of confidence, use support ratings using these data are considered monitored.

If a Fair macroinvertebrate bioclassification is obtained under conditions (such as drought or flood conditions, recent spills, etc.) that may not represent normal conditions or is borderline Fair (almost Good-Fair), a second sample should be taken within 12-24 months to validate the Fair bioclassification. Such sites will be Not Rated until the second sample is obtained.

Use support ratings are assigned to assessment units using benthic macroinvertebrate bioclassifications as follows.

Waterbody Sample Type or Criteria	Benthic Bioclassification	Use Support Rating
Mountain, piedmont, coastal A[3]	Excellent	Supporting
Mountain, piedmont, coastal A[3]	Good	Supporting
Swamp[1]	Natural	Supporting
Mountain, piedmont, coastal A	Good-Fair	Supporting
Smaller than criteria but Good-Fair[2]	Not Impaired	Supporting
Swamp[1]	Moderate Stress	Supporting
Mountain, piedmont, coastal A[3]	Fair	Impaired
Swamp[1]	Severe Stress	Impaired
Mountain, piedmont, coastal A[3]	Poor	Impaired
Criteria not appropriate to assign bioclassification	Not Rated	Not Rated

1 Swamp streams for benthos sampling are defined as streams in the coastal plain that have no visible flow for a part of the year, but do have flow during the February to early March benthic index period.

2 This designation may be used for flowing waters that are too small to be assigned a bioclassification (less than three square miles drainage area), but have a Good-Fair or higher bioclassification using the standard qualitative and EPT criteria.

3 Coastal A streams are those located in the coastal plain that have flow year round and are wadeable.

Fish Community Criteria

The North Carolina Index of Biotic Integrity (NCIBI) is a method for assessing a stream's biological integrity by examining the structure and health of its fish community. The NCIBI incorporates information about species richness and composition, indicator species, trophic function, abundance and condition, and reproductive function. Because these data represent water quality conditions with a high degree of confidence, use support ratings using these data are considered monitored. Use support ratings are assigned to assessment units using the NCIBI bioclassifications as follows:

NCIBI	Use Support Rating
Excellent	Supporting
Good	Supporting
Good-Fair	Supporting
Fair	Impaired
Poor	Impaired

The NCIBI was recently revised (NCDENR, 2001), and the bioclassifications and criteria have also been recalibrated against regional reference site data (NCDENR, 2000a, 2000b and 2001a). NCIBI criteria are applicable only to wadeable streams in the following river basins: Broad, Catawba, Savannah, Yadkin-Pee Dee, Cape Fear, Neuse, Roanoke, Tar-Pamlico, French Broad, Hiwassee, Little Tennessee, New and Watauga. Additionally, the NCIBI criteria are only applicable to streams in the piedmont portion of the Cape Fear, Neuse, Roanoke and Tar-Pamlico River basins. The definition of "piedmont" for these four river basins is based upon a map of North Carolina watersheds (Fels, 1997). Specifically:

- In the Cape Fear River basin -- all waters except for those draining the Sandhills in Moore, Lee and Harnett counties, and the entire basin upstream of Lillington, NC.
- In the Neuse River basin -- the entire basin above Smithfield and Wilson, except for the south and southwest portions of Johnston County and eastern two-thirds of Wilson County.
- In the Roanoke River basin -- the entire basin in North Carolina upstream of Roanoke Rapids, NC and a small area between Roanoke Rapids and Halifax, NC.
- In the Tar-Pamlico River basin -- the entire basin above Rocky Mount, except for the lower southeastern one-half of Halifax County and the extreme eastern portion of Nash County.

NCIBI criteria have not been developed for:

- Streams in the Broad, Catawba, Yadkin-Pee Dee, Savannah, French Broad, Hiwassee, Little Tennessee, New and Watauga River basins which are characterized as wadeable first to third order streams with small watersheds, naturally low fish species diversity, coldwater temperatures, and high gradient plunge-pool flows. Such streams are typically thought of as "Southern Appalachian Trout Streams".
- Wadeable streams in the Sandhills ecoregion of the Cape Fear, Lumber and Yadkin-Pee Dee River basins.
- Wadeable streams and swamps in the coastal plain region of the Cape Fear, Chowan, Lumber, Neuse, Pasquotank, Roanoke, Tar-Pamlico and White Oak River basins.
- All nonwadeable and large streams and rivers throughout the state.

Ambient Water Quality Monitoring Criteria

Chemical/physical water quality data are collected through the DWQ Ambient Monitoring Program statewide and NPDES discharger coalitions in some basins. All samples collected (usually monthly) during the five-year assessment period are used to assign a use support rating. Ambient water quality data are not direct measures of biological integrity, but the chemical/physical parameters collected can provide an indication of conditions that may be impacting aquatic life. Because these data represent water quality conditions with a high degree of confidence, use support ratings assigned using these data are considered monitored. Where both ambient data and biological data are available, each data type is assessed independently.

The parameters used to assess water quality in the aquatic life category include dissolved oxygen, pH, chlorophyll *a* and turbidity. Criteria for assigning use support ratings to assessment units with ambient water quality data of a minimum of ten samples are as follows:

Ratings Criteria	Rating
Numerical standard exceeded in ≤10% of samples	Supporting
Numerical standard exceeded in >10% of samples	Impaired
Less than 10 samples collected	Not Rated
DO and pH standard exceeded in swamp streams	Not Rated

Some standards are written with more specific criteria than others and these specific criteria are used to assess use support. For example, the DO standard for Class C waters is a daily average of 5 mg/l and an instantaneous value of 4 mg/l. Because DWQ does not collect daily DO levels at the ambient stations, the instantaneous value is used for assessment criteria. In areas with

continous monitoring, the daily average of 5 mg/l will also be assessed. In addition, pH has a standard of not less than 6 and not greater than 9; each level is assessed. To assess the fecal coliform bacteria standard, five samples must be collected within a 30 day period (see Recreation Category for more information).

Multiple Monitoring Sites

There are assessment units with more than one type of monitoring data. When the data from multiple biological data types are gathered, each data type is assessed independently. Biological monitoring is typically assessed independent of ambient monitoring data and either may be used to assign a use support rating for an assessment unit. Monitoring data are always used over the evaluation information; however, evaluation information can be used to lengthen or shorten monitored assessment units and to assign use support ratings on an evaluated basis to non-monitored assessment units.

NPDES Wastewater Whole Effluent Toxicity (WET) Information

Whole Effluent Toxicity (WET) tests are required for all major NPDES discharge permit holders, as well as those minor NPDES dischargers with complex effluent (defined as not being of 100 percent domestic waste). WET tests are evaluated to determine if the discharge could be having negative water quality impacts. If a stream with a WET test facility has not been sampled for instream chronic toxicity, biological community data or has no ambient water quality data, and that facility has failed three or more WET tests in the last two years of the assessment period, the assessment unit is Not Rated. Because this information is not a direct measure of water quality and the confidence is not as high as for monitoring data, this use support rating is considered evaluated rather than monitored. Problems associated with WET test failures are addressed through NPDES permits.

NPDES Discharger Daily Monitoring Report (DMR) Information

NPDES effluent data monthly averages of water quality parameters are screened for the last two years of the assessment period. If facilities exceed the effluent limits by 20 percent for two or more months during two consecutive quarters, or have chronic exceedances of permit limits for four or more months during two consecutive quarters, then the assessment unit is Not Rated if no biological or ambient monitoring data are available. Because discharger effluent data is not a direct measure of water quality and data confidence is not as high as for stream monitoring data, the assessment units are considered evaluated rather than monitored. If biological or ambient data are available, that data will be used to develop a use support rating for appropriate stream segments.

Fish Consumption Category

The fish consumption category is a human health approach to assess whether humans can safely consume fish from a waterbody. This category is applied to all waters of the state. The use support rating is assigned using fish consumption advisories or advice as issued by the NC Department of Health and Human Services (DHHS). The fish consumption category is different from other categories in that assessments are based on the existence of a DHHS fish consumption advice or advisory at the time of use support assessment. The advice and

advisories are based on DHHS epidemiological studies and on DWQ fish tissue data. DWQ fish tissue data are used to inform DHHS of potential fish tissue toxicity. DHHS is responsible for proclaiming a fish tissue advisory or advice for any waterbody. Fish tissue monitoring data are not used directly for assigning a use support rating in this category.

If a site-specific fish consumption advisory is posted at the time of assessment, the water is Impaired on either a monitored or evaluated basis dependent upon the availability of monitoring data. The DHHS has developed statewide fish consumption advice for certain fish species shown to have elevated levels of mercury in their tissue. All waters of the state are therefore Impaired/Evaluated in the fish consumption category.

Recreation Category

This human health related category evaluates waters for the support of primary recreation activities such as swimming, water-skiing, skin diving, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis. Waters of the state designated for these uses are classified as Class B, SB and SA. This category also evaluates waters used for secondary recreation activities such as wading, boating, and other uses not involving human body contact with water, and activities involving human body contact with water where such activities take place on an infrequent, unorganized or incidental basis. These waters are classified as Class C, SC and WS.

The use support ratings applied to this category are currently based on the state's fecal coliform bacteria water quality standard where ambient monitoring data are available or on the duration of local or state health agencies posted swimming advisories. Use support ratings for the recreation category may be based on other bacteriological indicators and standards in the future.

DWQ conducts monthly ambient water quality monitoring that includes fecal coliform bacteria testing. The Division of Environmental Health (DEH) tests coastal recreation waters (beaches) for bacteria levels to assess the relative safety of these waters for swimming. If an area has elevated bacteria levels, health officials will advise that people not swim in the area by posting a swimming advisory and by notifying the local media and county health department.

The North Carolina fecal coliform bacteria standard for freshwater is: 1) not to exceed the geometric mean of 200 colonies per 100 ml of at least five samples over a 30-day period; and 2) not to exceed 400 colonies per 100 ml in more than 20 percent of the samples during the same period. The AU being assessed for the five-year data window is Supporting in the recreation category if neither number (1) nor (2) of the standard are exceeded. The AU being assessed is Impaired in the recreation category if either number (1) or (2) is exceeded. Waters without sufficient fecal coliform bacteria data (five samples within 30 days) are Not Rated, and waters with no data are noted as having No Data.

Assessing the water quality standard requires significant sampling efforts beyond the monthly ambient monitoring sampling and must include at least five samples over a 30-day period. Decades of monitoring have demonstrated that bacteria concentrations may fluctuate widely in surface waters over a period of time. Thus, multiple samples over a 30-day period are needed to evaluate waters against the North Carolina water quality standard for recreational use support.

Waters classified as Class SA, SB and B are targeted for this intensive sampling effort due to the greater potential for human body contact.

Waters with beach monitoring sites will be Impaired if the area is posted with an advisory for greater than 61 days of the assessment period. Waters with beach monitoring sites with advisories posted less than 61 days will be Supporting. Other information can be used to Not Rate unmonitored waters.

DWQ Ambient Monitoring Fecal Coliform Bacteria Screening Criteria

As with other information sources, all available information and data are evaluated for the recreation category using the assessment period. However, DWQ conducts an annual screening of DWQ ambient fecal coliform bacteria data to assess the need for additional monitoring or immediate action by local or state health agencies to protect public health.

Each March, DWQ staff will review bacteria data collections from ambient monitoring stations statewide for the previous sampling year. Locations with annual geometric means greater than 200 colonies per 100 ml, or when more than 20 percent of the samples are greater than 400 colonies per 100 ml, are identified for potential follow-up monitoring conducted five times within 30 days as specified by the state fecal coliform bacteria standard. If bacteria concentrations exceed either portion of the state standard, the data are sent to DEH and the local county health director to determine the need for posting swimming advisories. DWQ regional offices will also be notified.

Due to limited resources and the higher risk to human health, Class B, SB and SA waters will be given monitoring priority for an additional five times within 30 days sampling. Follow-up water quality sampling for Class C waters will be performed as resources permit. Any waters on the 303(d) list of Impaired waters for fecal coliform will receive a low priority for additional monitoring because these waters will be further assessed for TMDL development.

DWQ attempts to determine if there are any swimming areas monitored by state, county or local health departments or by DEH. Each January, DEH, county or local health departments are asked to list those waters which were posted with swimming advisories in the previous year.

Shellfish Harvesting Use Support

The shellfish harvesting use support category is a human health approach to assess whether shellfish can be commercially harvested and is therefore applied only to Class SA waters. The following data sources are used to assign use support ratings for shellfish waters.

Division of Environmental Health (DEH) Shellfish Sanitation Surveys

DEH is required to classify all shellfish growing areas as to their suitability for shellfish harvesting. Estuarine waters are delineated according to DEH shellfish management areas (e.g., Outer Banks, Area H-5) which include Class SA, SB and SC waters. DEH samples growing areas regularly and reevaluates the areas by conducting shellfish sanitation shoreline surveys every three years to determine if their classification is still applicable. DEH classifications may be changed after the most recent sanitary survey. Classifications are based on DEH bacteria

sampling, locations of pollution sources, and the availability of the shellfish resource. Growing waters are classified as follows.

DEH Classification	DEH Criteria
Approved (APP)	**Fecal Coliform Standard for Systematic Random Sampling:** The median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of the water shall not exceed 14 per 100 milliliters (ml), and the estimated 90th percentile shall not exceed an MPN of 43 MPN per 100 ml for a 5-tube decimal dilution test. **Fecal Coliform Standard for Adverse Pollution Conditions Sampling:** The median fecal coliform or geometric mean MPN of the water shall not exceed 14 per 100 ml, and not more than 10 percent of the samples shall exceed 43 MPN per 100 ml for a 5-tube decimal dilution test.
Conditionally Approved-Open (CAO)	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time, and the pollutant event is known and predictable and can be managed by a plan. These areas tend to be open more frequently than closed.
Conditionally Approved-Closed (CAC)	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time, and the pollutant event is known and predictable and can be managed by a plan. These areas tend to be closed more frequently than open.
Restricted (RES)	Sanitary Survey indicates limited degree of pollution, and the area is not contaminated to the extent that consumption of shellfish could be hazardous after controlled depuration or relaying.
Prohibited (PRO)	No Sanitary Survey; point source discharges; marinas; data do not meet criteria for Approved, Conditionally Approved or Restricted Classification.

Assigning Use Support Ratings to Shellfish Harvesting Waters (Class SA)

DWQ use support ratings may be assigned to separate segments within DEH management areas. In assessing use support, the DEH classifications and management strategies are only applicable to DWQ Class SA (shellfish harvesting) waters. It is important to note that DEH classifies all actual and potential growing areas (which includes all saltwater and brackish water areas) for their suitability for shellfish harvesting. This will result in a difference of acreage between DEH areas classified as CAC, PRO and RES, and DWQ waters rated as Impaired. For example, if DEH classifies a 20-acre area CAC, but only 10 acres are Class SA, only those 10 acres of Class SA waters are rated as Impaired.

The DEH "Closed" polygon coverage includes CAC, RES and PRO classifications, and it is not currently possible to separate out the PRO from the RES areas. Therefore, these areas are a combined polygon coverage, and DWQ rates these waters as Impaired.

Sources of fecal coliform bacteria are more difficult to separate out for Class SA areas. DEH describes the potential sources in the sanitary surveys, but they do not describe specific areas affected by these sources. Therefore, in the past, DEH identified the same sources for all Class SA sections of an entire management area (e.g., urban runoff and septic systems). Until a better way to pinpoint sources is developed, this information will continue to be used. A point source discharge is only listed as a potential source when NPDES permit limits are exceeded.

DWQ and DEH are developing the database and expertise necessary to assess shellfish harvesting frequency of closures. In the interim, DWQ has been identifying the frequency of closures in Class SA waters using an interim methodology (see below) based on existing databases and GIS shapefiles. There will be changes in reported acreages in future assessments using the permanent methods and tools that result from this project.

Past Interim Frequency of Closure-Based Assessment Methodology

The interim method was used for the 2001 White Oak, 2002 Neuse and 2003 Lumber River basin use support assessments. Shellfish harvesting use support ratings for Class SA waters using the interim methodology are summarized below.

Percent of Time Closed within Basin Data Window	DEH Growing Area Classification	DWQ Use Support Rating
N/A	Approved*	Supporting
Closed ≤10% of data window	Portion of CAO closed ≤10% of data window	Supporting
Closed >10% of the data window	Portion of CAO closed >10% of data window	Impaired
N/A	CAC and PRO/RES**	Impaired

* Approved waters are closed only during extreme meteorological events (hurricanes).

** CAC and P/R waters are rarely opened to shellfish harvesting.

For CAO areas, DWQ worked with DEH to determine the number of days and acreages that CAO Class SA waters were closed to shellfish harvesting during the assessment period. For each growing area with CAO Class SA waters, DEH and DWQ defined subareas within the CAO area that were opened and closed at the same time. The number of days these CAO areas were closed was determined using DEH proclamation summary sheets and the original proclamations.

The number of days that APP areas in the growing area were closed due to preemptive closures because of named storms was not counted. For example, all waters in growing area E-9 were preemptively closed for Hurricane Fran on September 5, 1996. APP waters were reopened September 20, 1996. Nelson Bay (CAO) was reopened September 30, 1996. This area was considered closed for ten days after the APP waters were reopened.

Current Assessment Methodology

Use support assessment is now conducted such that only the DEH classification will be used to assign a use support rating. By definition, CAO areas are areas that DEH has determined do not, or likely do not, meet water quality standards and these areas will be rated Impaired, along with CAC and PRO/RES areas. Only APP areas will be rated Supporting.

Growing areas that have been reclassified by DEH during the assessment period from a lower classification to APP will be rated Supporting. Areas that are reclassified from APP to any other classification during the assessment period will be rated Impaired.

Over the next few years, DWQ, DEH, Division of Coastal Management (DCM) and Division of Marine Fisheries (DMF) will be engaged in developing a database with georeferenced (GIS)

shellfish harvesting areas. The new database and GIS tools will be valuable for the above agencies to continue to work together to better serve the public. Using the new database with georeferenced areas and monitoring sites, DEH will be able to report the number of days each area was closed excluding closures related to large or named storms.

Water Supply Use Support

This human health related use support category is used to assess all Class WS waters for the ability of water suppliers to provide potable drinking water. Water quality standards established for drinking water apply to water delivered to consumers after it has been treated to remove potential contaminants that may pose risks to human health. Ambient standards established by states under the Clean Water Act are not intended to ensure that water is drinkable without treatment. Modern water treatment technologies are required to purify raw water to meet drinking water standards as established by the North Carolina Division of Environmental Health.

Water supply use support is assessed by DWQ using information from the seven DEH regional water treatment plant consultant staff. Each January, the DEH staff consultants are asked to submit a spreadsheet listing closures and water intake switch-overs for all water treatment plants in their region. This spreadsheet describes the length and time of the event, contact information, and the reason for the closure or switch.

The spreadsheets are reviewed by DWQ staff to determine if any closures/switches were due to water quality concerns. Those closures/switches due to water quantity problems and reservoir turnovers are not considered for use support. The frequency and duration of closures/switches due to water quality concerns are considered when assessing use support. Using these criteria, North Carolina's surface water supplies are currently rated Supporting on an Evaluated basis. Specific criteria for rating waters Impaired are to be determined on a case-by-case basis.

Use of Outside Data

DWQ actively solicits outside data and information in the year before biological sampling in a particular basin. The solicitation allows approximately 90 days for data to be submitted. Data from sources outside DWQ are screened for data quality and quantity. If data are of sufficient quality and quantity, they may be incorporated into use support assessments. A minimum of ten samples for more than a one-year period is needed to be considered for use support assessments.

The way the solicited data are used depends on the degree of quality assurance and quality control of the collection and analysis of the data as detailed in the 303(d) report and shown in the table below. Level 1 data can be use with the same confidence as DWQ data to determine use support ratings. Level 2 or Level 3 data may be used to help identify causes of pollution and stressors. They may also be used to limit the extrapolation of use support ratings up or down a stream segment from a DWQ monitoring location. Where outside data indicate a potential problem, DWQ evaluates the existing DWQ biological and ambient monitoring site locations for adjustment as appropriate.

Criteria Levels for Use of Outside Data in Use Support Assessments			
Criteria	**Level 1**	**Level 2**	**Level 3**
Monitoring frequency of at least 10 samples for more than a one-year period	Yes	Yes/No	No
Monitoring locations appropriately sited and mapped	Yes	Yes	No
State certified laboratory used for analysis according to 15A NCAC 2B .0103	Yes	Yes/No	No
Quality assurance plan available describing sample collection and handling	Yes, rigorous scrutiny	Yes/No	No

Lakes and Reservoir Use Assessment

Like streams, lakes are classified for a variety of uses. All lakes monitored as part of North Carolina's Ambient Lakes Monitoring Program carry the Class C (aquatic life) classification, and most are classified Class B and SB (recreation) and WS-I through WS-V (water supply). The surface water quality numeric standard specifically associated with recreation is fecal coliform. For water supplies, there are 29 numeric standards based on consumption of water and fish. Narrative standards for Class B and Class WS waters include aesthetics such as no odors and no untreated wastes. There are other numeric standards that also apply to lakes for the protection of aquatic life and human health. These standards also apply to all other waters of the state and are listed under the Class C rules. One of the major problems associated with lakes and reservoirs is increasing eutrophication related to nutrient inputs. Several water quality parameters help to describe the level of eutrophication.

For nutrient enrichment, one of the main causes of impacts to lakes and reservoirs, a more holistic or weight of evidence approach is necessary since nutrient impacts are not always reflected by the parameters sampled. For instance, some lakes have taste and odor problems associated with particular algal species, yet these lakes do not have chlorophyll *a* concentrations above 40 µg/l frequently enough to impair them based on the standard. In addition, each reservoir possesses unique traits (watershed area, volume, depth, retention time, etc.) that dramatically influence its water quality, but that cannot be evaluated through standards comparisons. In such waterbodies, aquatic life may be Impaired even though a particular indicator is below the standard. Where exceedances of surface water quality standards are not sufficient to evaluate a lake or reservoir, the weight of evidence approach can take into consideration indicators and parameters not in the standards to allow a more sound and robust determination of water quality.

The weight of evidence approach uses the following sources of information to determine the eutrophication (nutrient enrichment) level as a means of assessing lake use support in the aquatic life category:

- Quantitative water quality parameters - dissolved oxygen, chlorophyll *a*, pH, etc.
- Algal bloom reports
- Fish kill reports

- Hydrologic and hydraulic characteristics – watershed size, lake volume, retention time, volume loss, etc.
- Third party reports – citizens, water treatment plant operators, state agencies, etc.
    - Taste and odor
    - Sheens
    - Odd colors
    - Other aesthetic and safety considerations

In implementing the weight of evidence approach for eutrophication, more consideration is given to parameters that have water quality standards (see table). Each parameter is assessed for percent exceedance of the state standard. Parameters with sufficient (ten or more observations), quality-assured observations are compared to surface water quality standards. When standards are exceeded in more than 10 percent of the assessment period, portions or all of the waterbody are rated Impaired.

However, in many cases, the standards based approach is incapable of characterizing the overall health of a reservoir. The eutrophication-related parameters and water quality indicators without numeric standards are reviewed based on interpretation of the narrative standards in 15A NCAC 2B .0211(2) and (3).

A modification to lake use assessment is the evaluation and rating of a lake or reservoir by assessment units (AUs). Each lake or reservoir may have one or more AU based on the classification segments (DWQ index numbers). Each sampling date is considered one sample. Multiple sampling locations within one AU are considered one sample. A minimum of ten samples is needed to assess use support for any AU. Each AU with documented problems (sufficient data, ambient data above standards, and supporting public data) will be rated as Impaired while the other portions are rated as Supporting or Not Rated. The following table lists the information considered during a lake/reservoir use assessment, as well as the criteria used to evaluate that information.

Lake/Reservoir Weight of Evidence Use Assessment for Aquatic Life Category	
Assessment Type	**Criteria**
EUTROPHICATION	
Water Quality Standards (a minimum of 10 samples is required for use support assessment)	
Chl *a*	Above standard in >10% of samples.
DO	Below or above standard in >10% of samples.
pH	Below or above standard in >10% of samples.
Turbidity	Above standard in >10% of samples.
% Total Dissolved Gases	Above standard in >10% of samples.
Temperature	Minor and infrequent excursions of temperature standards due to anthropogenic activity. No impairment of species evident.
Metals (excluding copper, iron and zinc)	Above standard in >10% of samples.
Other Data	
% Saturation DO	>10% of samples above >120%
Algae	Blooms during 2 or more sampling events in 1 year with historic blooms.
Fish	Kills related to eutrophication.
Chemically/ Biologically Treated	For algal or macrophyte control - either chemicals or biologically by fish, etc.
Aesthetics Complaints	Documented sheens, discoloration, etc. - written complaint and follow-up by a state agency.
Trophic Status Index (TSI)	Increase of 2 trophic levels from one 5-year period to next.
Historic DWQ Data	Conclusions from other reports and previous use support assessments.
AGPT	Algal Growth Potential Test ≥5 mg/L
Macrophytes	Limiting access to public ramps, docks, swimming areas; reducing access by fish and other aquatic life to habitat; clogging intakes.
Taste and Odor	Public complaints; Potential based on algal spp
Sediments	Clogging intakes - dredging program necessary.

References

Fels, J. 1997. *North Carolina Watersheds Map*. North Carolina State University Cooperative Extension Service. Raleigh, NC.

North Carolina Department of Environment and Natural Resources (NCDENR). 2000a. *Fish Community Metric Re-Calibration and Biocriteria Development for the Inner Piedmont, Foothills, and Eastern Mountains (Broad, Catawba, Savannah, and Yadkin River Basins)*. September 22, 2000. Biological Assessment Unit. Environmental Sciences Branch. Water Quality Section. Division of Water Quality. Raleigh, NC.

____. 2000b. *Fish Community Metric Re-Calibration and Biocriteria Development for the Outer Piedmont (Cape Fear, Neuse, Roanoke and Tar River Basins)*. October 17, 2000. *Ibid*.

____. 2001a. *Standard Operating Procedure*. *Biological Monitoring*. *Stream Fish Community Assessment and Fish Tissue*. Biological Assessment Unit. Environmental Sciences Branch. Water Quality Section. Division of Water Quality. Raleigh, NC.

____. 2001b. *Fish Community Metric Re-Calibration and Biocriteria Development for the Western and Northern Mountains (French Broad, Hiwassee, Little Tennessee, New and Watauga River Basins)*. January 05, 2001. *Ibid*.

USEPA. 2000. *Stressor Identification Guidance Document*. EPA/822/B-00/025. Office of Water. Washington, DC.

Appendix X

Glossary

Glossary

7Q10	The annual minimum 7-day consecutive low flow, which on average will be exceeded in 9 out of 10 years.
ACOE	United States Army Corps of Engineers.
B (Class B)	Class B Water Quality Classification. This classification denotes freshwaters protected for primary recreation and other uses suitable for Class C. Primary recreational activities include frequent and/or organized swimming and other human contact such as skin diving and water skiing.
basin	The watershed of a major river system. There are 17 major river basins in North Carolina.
benthic macroinvertebrates	Aquatic organisms, visible to the naked eye (macro) and lacking a backbone (invertebrate), that live in or on the bottom of rivers and streams (benthic). Examples include, but are not limited to, aquatic insect larvae, mollusks and various types of worms. Some of these organisms, especially aquatic insect larvae, are used to assess water quality. See EPT index and bioclassification for more information.
benthos	A term for bottom-dwelling aquatic organisms.
best management practices	Techniques that are determined to be currently effective, practical means of preventing or reducing pollutants from point and nonpoint sources, in order to protect water quality. BMPs include, but are not limited to: structural and nonstructural controls, operation and maintenance procedures, and other practices. Often, BMPs are applied as system of practices and not just one at a time.
bioclassification	A rating of water quality based on the outcome of benthic macroinvertebrate sampling of a stream. There are five levels: Poor, Fair, Good-Fair, Good and Excellent.
BMPs	See *best management practices*.
BOD	Biochemical Oxygen Demand. A measure of the amount of oxygen consumed by the decomposition of biological matter or chemical reactions in the water column. Most NPDES discharge permits include a limit on the amount of BOD that may be discharged.
C (Class C)	Class C Water Quality Classification. This classification denotes freshwaters protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, and others uses.
channelization	The physical alteration of streams and rivers by widening, deepening or straightening of the channel, large-scale removal of natural obstructions, and/or lining the bed or banks with rock or other resistant materials.
chlorophyll *a*	A chemical constituent in plants that gives them their green color. High levels of chlorophyll *a* in a waterbody, most often in a pond, lake or estuary, usually indicate a large amount of algae resulting from nutrient over enrichment or eutrophication.
coastal counties	Twenty counties in eastern NC subject to requirements of the Coastal Area Management Act (CAMA). They include: Beaufort, Bertie, Brunswick, Camden, Carteret, Chowan, Craven, Currituck, Dare, Gates, Hertford, Hyde, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell and Washington.
Coastal Plain	One of three major physiographic regions in North Carolina. Encompasses the eastern two-fifths of state east of the *fall line* (approximated by Interstate I-95).
conductivity	A measure of the ability of water to conduct an electrical current. It is dependent on the concentration of dissolved ions such as sodium, chloride, nitrates, phosphates and metals in solution.
DEH	Department of Environmental Health

degradation	The lowering of the physical, chemical or biological quality of a waterbody caused by pollution or other sources of stress.
DENR	Department of Environment and Natural Resources.
DHHS	Department of Health and Human Services.
DO	Dissolved oxygen.
drainage area	An alternate name for a watershed.
DWQ	North Carolina Division of Water Quality, an agency of DENR.
dystrophic	Naturally acidic (low pH), "black-water" lakes which are rich in organic matter. Dystrophic lakes usually have low productivity because most fish and aquatic plants are stressed by low pH water. In North Carolina, dystrophic lakes are scattered throughout the Coastal Plain and Sandhills regions and are often located in marshy areas or overlying peat deposits. NCTSI scores are not appropriate for evaluating dystrophic lakes.
EEP	Ecosystem Enhancement Program (EEP)
effluent	The treated liquid discharged from a wastewater treatment plant.
EMC	Environmental Management Commission.
EPA	United States Environmental Protection Agency.
EPT Index	This index is used to judge water quality based on the abundance and variety of three orders of pollution sensitive aquatic insect larvae: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).
eutrophic	Elevated biological productivity related to an abundance of available nutrients. Eutrophic lakes may be so productive that the potential for water quality problems such as algal blooms, nuisance aquatic plant growth and fish kills may occur.
eutrophication	The process of physical, chemical or biological changes in a lake associated with nutrient, organic matter and silt enrichment of a waterbody. The corresponding excessive algal growth can deplete dissolved oxygen and threaten certain forms of aquatic life, cause unsightly scums on the water surface and result in taste and odor problems.
fall line	A geologic landscape feature that defines the line between the piedmont and coastal plain regions. It is most evident as the last set of small rapids or rock outcroppings that occur on rivers flowing from the piedmont to the coast.
FDA	Unites States Food and Drug Administration.
GIS	Geographic Information System. An organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information.
habitat degradation	Identified where there is a notable reduction in habitat diversity or change in habitat quality. This term includes sedimentation, bank erosion, channelization, lack of riparian vegetation, loss of pools or riffles, loss of woody habitat, and streambed scour.
headwaters	Small streams that converge to form a larger stream in a watershed.
HQW	High Quality Waters. A supplemental surface water classification.
HU	Hydrologic unit. See definition below.
Hydrilla	The genus name of an aquatic plant - often considered an aquatic weed.
hydrologic unit	A watershed area defined by a national uniform hydrologic unit system that is sponsored by the Water Resources Council. This system divides the country into 21 regions, 222 subregions, 352 accounting units and 2,149 cataloging units. A hierarchical code consisting of two digits for each of the above four levels combined to form an eight-digit hydrologic unit (cataloging unit). An eight-digit hydrologic unit generally covers an average of 975

	square miles. There are 54 eight-digit hydrologic (or cataloging) units in North Carolina. These units have been further subdivided into eleven and fourteen-digit units.
hypereutrophic	Extremely elevated biological productivity related to excessive nutrient availability. Hypereutrophic lakes exhibit frequent algal blooms, episodes of low dissolved oxygen or periods when no oxygen is present in the water, fish kills and excessive aquatic plant growth.
Impaired	Term that applies to a water body that is not meeting the designated use criteria.
impervious	Incapable of being penetrated by water; non-porous.
lbs	Pounds. To change pounds to kilograms multiply by 0.4536.
loading	Mass rate of addition of pollutants to a waterbody (e.g., kg/yr)
macroinvertebrates	Animals large enough to be seen by the naked eye (macro) and lacking backbones (invertebrate).
macrophyte	An aquatic plant large enough to be seen by the naked eye.
mesotrophic	Moderate biological productivity related to intermediate concentrations of available nutrients. Mesotrophic lakes show little, if any, signs of water quality degradation while supporting a good diversity of aquatic life.
MGD	Million gallons per day.
mg/l	Milligrams per liter (approximately 0.00013 oz/gal).
NCIBI	North Carolina Index of Biotic Integrity. A measure of the community health of a population of fish in a given waterbody.
NH_3-N	Ammonia nitrogen.
nonpoint source	A source of water pollution generally associated with rainfall runoff or snowmelt. The quality and rate of runoff of NPS pollution is strongly dependent on the type of land cover and land use from which the rainfall runoff flows. For example, rainfall runoff from forested lands will generally contain much less pollution and runoff more slowly than runoff from urban lands.
NOV	Notices of Violation. An NOV serve to alert the permittee of permit infractions and request that whatever caused the violation be corrected immediately. Many times these will not include a fine. Depending upon the severity of the violation, the permittee may receive a Notice of Violation and Assessment of a Civil Penalty, which will include a fine.
NPDES	National Pollutant Discharge Elimination System.
NPS	Nonpoint source.
NR	Not rated. A waterbody that is not rated for use support due to insufficient data.
NSW	Nutrient Sensitive Waters. A supplemental surface water classification intended for waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation. Waters classified as NSW include the Neuse, Tar-Pamlico and Chowan River basins; the New River watershed in the White Oak basin; and the watershed of B. Everett Jordan Reservoir (including the entire Haw River watershed).
NTU	Nephelometric Turbidity Units. The units used to quantify turbidity using a turbidimeter. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of the light scattered by a standard reference suspension under the same conditions.
oligotrophic	Low biological productivity related to very low concentrations of available nutrients. Oligotrophic lakes in North Carolina are generally found in the mountain region or in undisturbed (natural) watersheds and have very good water quality.

ORW	Outstanding Resource Waters. A supplemental surface water classification intended to protect unique and special resource waters having excellent water quality and being of exceptional state or national ecological or recreational significance. No new or expanded wastewater treatment plants are allowed, and there are associated stormwater runoff controls enforced by DWQ.
PCBs	Polychlorinated Biphenyls. PCBs are man-made chemicals that persist in the environment. There are a number of adverse health effect associated with exposure to PCBs.
pH	A measure of the concentration of free hydrogen ions on a scale ranging from 0 to 14. Values below 7 and approaching 0 indicate increasing acidity, whereas values above 7 and approaching 14 indicate a more basic solution.
phytoplankton	Aquatic microscopic plant life, such as algae, that are common in ponds, lakes, rivers and estuaries.
Piedmont	One of three major physiographic regions in the state. Encompasses most of central North Carolina from the Coastal Plain region (near I-95) to the eastern slope of the Blue Ridge Mountains region.
riparian zone	Vegetated corridor immediately adjacent to a stream or river. See also SMZ.
river basin	The watershed of a major river system. North Carolina is divided into 17 major river basins: Broad, Cape Fear, Catawba, Chowan, French Broad, Hiwassee, Little Tennessee, Lumber, Neuse, New, Pasquotank, Roanoke, Savannah, Tar-Pamlico, Watauga, White Oak and Yadkin River basins.
river system	The main body of a river, its tributary streams and surface water impoundments.
runoff	Rainfall that does not evaporate or infiltrate the ground, but instead flows across land and into waterbodies.
SA	Class SA Water Classification. This classification denotes saltwaters that have sufficient water quality to support commercial shellfish harvesting.
SB	Class SB Water Classification. This classification denotes saltwaters with sufficient water quality for frequent and/or organized swimming or other human contact.
SC	Class SC Water Classification. This classification denotes saltwaters with sufficient water quality to support secondary recreation and aquatic life propagation and survival.
sedimentation	The sinking and deposition of waterborne particles (e.g., eroded soil, algae and dead organisms).
SOC	Special Order by Consent. An agreement between the Environmental Management Commission and a permitted discharger found responsible for causing or contributing to surface water pollution. The SOC stipulates actions to be taken to alleviate the pollution within a defined time. The SOC typically includes relaxation of permit limits for particular parameters, while the facility completes the prescribed actions. SOCs are only issued to facilities where the cause of pollution is not operational in nature (i.e., physical changes to the wastewater treatment plant are necessary to achieve compliance).
streamside management zone (SMZ)	The area left along streams to protect streams from sediment and other pollutants, protect streambeds, and provide shade and woody debris for aquatic organisms.
subbasin	A designated subunit or subwatershed area of a major river basin. Subbasins typically encompass the watersheds of significant streams or lakes within a river basin. Every river basin is subdivided into subbasins ranging from one subbasin in the Watauga River basin to 24 subbasins in the Cape Fear River basin. There are 133 subbasins statewide. These subbasins are not a part of the national uniform hydrologic unit system that is sponsored by the Water Resources Council (see *hydrologic unit*).
Sw	Swamp Waters. A supplemental surface water classification denoting waters that have naturally occurring low pH, low dissolved oxygen and low velocities. These waters are

	common in the Coastal Plain and are often naturally discolored giving rise to their nickname of “blackwater” streams.
SWCD	Soil and Water Conservation District
TMDL	Total maximum daily load. The amount of a given pollutant that a waterbody can assimilate and maintain its uses and water quality standards.
TN	Total nitrogen.
TP	Total phosphorus.
tributary	A stream that flows into a larger stream, river or other waterbody.
trophic classification	Trophic classification is a relative description of a lake's biological productivity, which is the ability of the lake to support algal growth, fish populations and aquatic plants. The productivity of a lake is determined by a number of chemical and physical characteristics, including the availability of essential plant nutrients (nitrogen and phosphorus), algal growth and the depth of light penetration. Lakes are classified according to productivity: unproductive lakes are termed "oligotrophic"; moderately productive lakes are termed "mesotrophic"; and very productive lakes are termed "eutrophic".
TSS	Total Suspended Solids.
turbidity	An expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through a sample. All particles in the water that may scatter or absorb light are measured during this procedure. Suspended sediment, aquatic organisms and organic particles such as pieces of leaves contribute to instream turbidity.
USGS	United States Geological Survey
UT	Unnamed tributary.
watershed	The region, or land area, draining into a body of water (such as a creek, stream, river, pond, lake, bay or sound). A watershed may vary in size from several acres for a small stream or pond to thousands of square miles for a major river system. The watershed of a major river system is referred to as a basin or river basin.
WET	Whole effluent toxicity. The aggregate toxic effect of a wastewater measured directly by an aquatic toxicity test.
WS	Class WS Water Supply Water Classification. This classification denotes freshwaters used as sources of water supply. There are five WS categories. These range from WS-I, which provides the highest level of protection, to WS-V, which provides no categorical restrictions on watershed development or wastewater discharges like WS-I through WS-IV.
WTP	Water Treatment Plant
WWTP	Wastewater treatment plant.