ROANOKE RIVER BASINWIDE WATER QUALITY PLAN

July 2001

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This document was approved and endorsed by the NC Environmental Management Commission on July 12, 2001 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 Roanoke River basin. This plan is the first five-year update to the Roanoke River Basinwide Water Quality Plan approved by the NC Environmental Management Commission in September 1996.

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North Carolina's Basinwide Approach to Water Quality Management

Basinwide water quality planning is a nonregulatory watershed-based approach to restoring and protecting the quality of North Carolina's surface waters. Basinwide water quality plans are prepared by the NC Division of Water Quality (DWQ) for each of the seventeen major river basins in the state. Each basinwide plan is revised at five-year intervals. While these plans are prepared by the DWQ, their implementation and the protection of water quality entails the coordinated efforts of many agencies, local governments and stakeholders in the state. The first basinwide plan for the Roanoke River basin was completed in 1996.

This document is the first five-year update of the *Roanoke River Basinwide Water Quality Plan*. The format of this plan was revised in response to comments received during the first planning cycle. DWQ replaced much of the general information in the first plan with more detailed information specific to the Roanoke River basin. A greater emphasis was placed on identifying causes and sources of pollution for individual streams in order to facilitate local restoration efforts.

DWQ seriously considered comments from three public workshops and four public meetings held in the basin during plan development. Many changes were made to the draft as a result of public review. This input will help guide continuing DWQ activities in the basin.

Goals of the Basinwide Approach

The goals of DWQ's basinwide program 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;
- develop appropriate management strategies to protect and restore water quality;
- assure equitable distribution of waste assimilative capacity for dischargers; and
- improve public awareness and involvement in the management of the state's surface waters.

Roanoke River Basin Overview

The Roanoke River begins in the Blue Ridge Mountains of northwestern Virginia and flows in a generally southeastern direction for 400 miles before emptying into the Albemarle Sound in eastern North Carolina. By the time it reaches the fall line near Roanoke Rapids, it has captured water from nearly 8,000 square miles of land. From Roanoke Rapids to the coast, the river drains another 2,000 square miles, carrying more water than any other river in North Carolina. The North Carolina portion of the basin (roughly 36 percent of the entire watershed) is composed of two major parts: the Dan River and its tributaries in the western section; and the Roanoke River from Virginia to the Sound in the eastern section. The Roanoke River enters North

Carolina through John H. Kerr Reservoir and then flows into Lake Gaston and Roanoke Rapids Lake before regaining its riverine form.

The upper Dan River is classified as trout waters and part of the area is also designated a State Water Trail by the NC Division of Parks and Recreation. The lower portion of the basin contains the largest intact and least disturbed bottomland hardwood and cypress-tupelo ecosystems on the Atlantic Coast of North America. This area is important habitat for anadromous fish, including striped bass, as well as black bear, bobcat, large populations of wild turkey, 14 species of waterfowl, and 220 additional bird species.

Sixty percent of the land in the basin is forested and about twenty-two percent is in cultivated cropland. Cotton, peanuts, tobacco and soybeans are among the most common crops grown. Only six percent of the land falls into the urban/built-up category. Despite the large amount of cultivated cropland and the relatively small amount of urban area, the basin has experienced a significant decrease (-105,300 acres) in the former and increase (+77,700 acres) in the latter over the past fifteen years.

There are 15 counties and 42 municipalities located wholly or partially within the basin. In 1990, the estimated population of the basin was 263,691 people. The most populated areas are located north of the Winston-Salem/Greensboro area and around the larger municipalities in the basin, such as Roanoke Rapids, Eden, Williamston and Plymouth. Population in Stokes and Granville counties is projected to increase 25-30 percent from 1998 to 2018. Population in many other counties along the North Carolina/Virginia border is projected to increase 15 to 20 percent over the same twenty-year period.

There are 11 major reservoirs in the North Carolina portion of the basin. Most of them are located in the upper portion of the basin on tributaries of the Dan and Roanoke Rivers (notably Belews Lake, Hyco Lake and Mayo Reservoir). Three reservoirs, Kerr, Gaston and Roanoke Rapids, are impoundments of the Roanoke River mainstem. They are managed by Dominion and the US Army Corps of Engineers for electrical energy production and flood control. Flow from these reservoirs directly influences the quality of water in the lower Roanoke River.

Assessment of Water Quality in the Roanoke River Basin

Surface waters are classified according to their best intended uses. Determining how well a water supports its designated uses (use support status) is an important method of interpreting water quality data and assessing water quality. Waters are rated fully supporting (FS), partially supporting (PS) or not supporting (NS). The terms refer to whether the classified uses of the water (i.e., aquatic life protection, recreation and water supply) are being met. For example, waters classified for aquatic life protection and secondary recreation (Class C for freshwater or SC for saltwater) are rated FS if data used to determine use support did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as PS or NS, depending on the degree of degradation. Waters rated PS or NS are considered to be impaired. Waters lacking data, or having inconclusive data, are listed as not rated (NR).

Beginning in 2000 with the *Roanoke River Basinwide Water Quality Plan*, DWQ assesses ecosystem health and human health risk through several use support categories. Six categories

are used to assess water quality under this approach: aquatic life/secondary recreation, fish consumption, shellfish harvesting, primary recreation, water supply and "other" uses. Each of these categories is related to the primary classifications applied to NC rivers and streams. A single water could have more than one use support rating corresponding to one or more of the multiple use support categories. For many waters, a use support category will not be applicable (N/A) to the best use classification of that water (e.g., drinking water supply is not the best use of a Class C water). The current method of determining use support differs from that done prior to 2000; in that, there is no longer an *overall* use support rating for a water.

The aquatic life/secondary recreation use support category is applied to all waters in North Carolina. Approximately 51,405 acres of lakes were monitored in 1999. Only Roanoke Rapids Lake (4,893 acres) is partially supporting the aquatic life/secondary recreation use support category. All other lakes are fully supporting this category. Approximately 29 percent of total stream miles (638 miles) in the Roanoke River basin were monitored for the protection of aquatic life/secondary recreation by DWQ during this basinwide cycle. Impaired waters accounted for 2.6 percent of the total stream miles (monitored and evaluated) and 8.9 percent of monitored stream miles. Habitat degradation, from a variety of sources, was the primary cause of impairment.

Aquatic life in many swamp streams in the lower portion for the Roanoke River basin was monitored during this basinwide cycle, but the aquatic life/secondary recreation category for these streams is not rated. Currently, DWQ has draft criteria for evaluating swamp streams based on benthic macroinvertebrate data; however, there has been insufficient sampling of reference sites to assign bioclassifications and use the data for use support. A summary of current aquatic life/secondary recreation use support ratings for monitored and evaluated streams in the Roanoke River basin is presented in Table 1.

Table 1 Aquatic Life/Secondary Recreation Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Aquatic Life/Secondary Recreation Use Support Ratings	**Monitored and Evaluated Streams***			**Monitored Streams Only****	
	Miles	**%**		**Miles**	**%**
Fully Supporting	**1113.7**	**50.3%**		**357.0**	**56.0%**
Impaired	**56.7**	**2.6%**		**56.7**	**8.9%**
Partially Supporting	*48.7*	*2.2%*		*48.7*	*7.6%*
Not Supporting	*8.0*	*0.4%*		*8.0*	*1.3%*
Not Rated	**1042.6**	**47.1%**		**223.9**	**35.1%**
TOTAL	**2213.0**			**637.6**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Like the aquatic life/secondary recreation use support category, the fish consumption use support category also applies to all waters in the state. Approximately 14 percent of stream miles (308.0 miles) and more than 83 percent of lake acres (42,880 acres) in the basin were monitored for the fish consumption category during this basinwide cycle. Fish consumption use support ratings are

based on fish consumption advisories issued by the NC Department of Health and Human Services (DHHS). Currently, there is a statewide advisory limiting consumption of bowfin due to excessive mercury concentrations. Because of this advisory, all waters in the state are considered partially supporting the fish consumption use. However, many waters across the state do not contain bowfin. Samples collected by DWQ in 1999 from some waters in the basin, including the Dan River, Kerr Reservoir and Lake Gaston, revealed concentrations of metals and PCBs in other fish species well below federal and state consumption criteria.

Table 2 presents a summary of current fish consumption use support ratings for monitored and evaluated streams in the Roanoke River basin.

Table 2 Fish Consumption Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Fish Consumption Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**0.0**			**0.0**	
Impaired	**2213.0**	**100%**		**308.0**	**100%**
Partially Supporting	*2199.7*	*99.4%*		*294.7*	*95.7%*
Not Supporting	*13.3*	*0.6%*		*13.3*	*4.3%*
Not Rated	**0.0**	**0%**		**0.0**	**0%**
TOTAL	**2213.0**			**308.0**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

There are 120.2 stream miles currently classified for primary recreation (Class B) in the Roanoke River basin. Approximately 15 percent were monitored by DWQ over the past five years, and all are fully supporting the primary recreation use. A basinwide summary of current primary recreation use support ratings is presented in Table 3.

Table 3 Primary Recreation Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Primary Recreation Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**18.5**	**15.4%**		**18.5**	**100%**
Impaired	**0.0**	**0%**		**0.0**	**0%**
Not Rated	**101.7**	**84.6%**		**0.0**	**0%**
TOTAL	**120.2**			**18.5**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Approximately 270 stream miles are currently classified for water supply (WS-I through WS-V) in the Roanoke River basin. All were monitored within the past five years and all are fully

supporting the water supply use. A basinwide summary of current water supply use support ratings is presented in Table 4.

Table 4 Water Supply Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Water Supply Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**270.4**	**100%**		**270.4**	**100%**
Impaired	**0.0**	**0%**		**0.0**	**0%**
Not Rated	**0.0**	**0%**		**0.0**	**0%**
TOTAL	**270.4**			**270.4**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

All lakes that were assessed by DWQ are fully supporting both the primary recreation and water supply use support categories.

Recommended Management Strategies for Restoring Impaired Waters

The long-range mission of basinwide planning is to provide a means of addressing the complex problem of planning for increased development and economic growth while maintaining, protecting and enhancing water quality and intended uses of the Roanoke River basin's surface waters.

Within this basinwide plan, DWQ presents management strategies and recommendations for those waters considered to be impaired or that exhibit some notable water quality problem. Table 5 presents impaired waters by subbasin, the potential sources of impairment and summaries of the recommended management strategies.

Major water quality problems in the basin include habitat degradation and turbidity (affecting aquatic life) and high levels of selenium, mercury and dioxin in fish tissue (affecting fish consumption). Habitat degradation, including sedimentation, streambed scour and streambank erosion, is primarily attributed to nonpoint source pollution (NPS). Sources of nonpoint source pollution include runoff from construction sites, agricultural lands and urban areas, and hydromodification. High levels of selenium and dioxin are attributed to historical point source pollution, and high levels of mercury are likely from atmospheric sources.

For streams degraded by point source pollution, the plan presents a management strategy to reduce the impacts from that pollutant source. The task of quantifying nonpoint sources of pollution and developing management strategies for these impaired waters is very resource intensive. This task is overwhelming, given the current limited resources of DWQ, other agencies (e.g., Division of Land Resources, Division of Soil and Water Conservation, Cooperative Extension Service, etc.) and local governments.

Table 5 Monitored Impaired Waters within the Roanoke River Basin (as of 1999)*

Subbasin	Name of Water	Miles or Acres	Use Support Rating – Category	Potential Pollution Sources+	Management Strategy or Recommendation
03-02-01	Town Fork Creek	8.0 miles	NS – Aquatic Life/Secondary Recreation	NP	Local initiatives are needed to address nonpoint source pollution in the watershed.
03-02-02 03-02-03	Dan River	14.2 miles	PS – Aquatic Life/Secondary Recreation	NP, P	DWQ will work with DLR to evaluate turbidity contributions of instream mining operations. Local initiatives are needed to address nonpoint source pollution in the watershed.
03-02-03	Smith River	5.4 miles	PS – Aquatic Life/Secondary Recreation	NP, P	DWQ will work with appropriate agencies to address flow fluctuation issues. Local actions needed to control stormwater.
03-02-05	Hyco Lake	3,750 acres	PS – Fish Consumption	P	DWQ will continue to monitor selenium concentrations in fish tissue and further adjust permit limits, if necessary.
03-02-05	Marlowe Creek	10.9 miles	PS – Aquatic Life/Secondary Recreation	P, NP	DWQ will work with Cogentrix to improve its discharge and the Town of Roxboro. Local actions needed to control stormwater.
03-02-06	Nutbush Creek	4.6 miles	PS – Aquatic Life/Secondary Recreation	P, NP	DWQ will work with the City of Henderson to improve the WWTP discharge. Local actions needed to control stormwater.
03-02-07	Smith Creek	10.4 miles	PS – Aquatic Life/Secondary Recreation	NP	Local initiatives are needed to address nonpoint source pollution in the watershed.
03-02-08	Quankey Creek	3.4 miles	PS – Aquatic Life/Secondary Recreation	P, NP	DWQ will work with the Town of Halifax to improve the WWTP discharge. DWQ will continue to monitor this stream.
03-02-08	Roanoke Rapids Lake	4,893 acres	PS – Aquatic Life/Secondary Recreation	NP	DWQ will work with appropriate agencies and citizens to control aquatic weeds. Local actions needed to reduce nutrients and for a boater education program.
03-02-08 03-02-09	Roanoke River	137.8 miles	PS – Fish Consumption	NP, P	DWQ will continue to monitor mercury and dioxin in fish tissue and work with point sources as needed to achieve reductions.
03-02-09	Albemarle Sound	2,586 acres	PS – Fish Consumption	NP, P	DWQ will continue to monitor mercury and dioxin in fish tissue.
03-02-09	Welch Creek	13.3 miles	NS – Fish Consumption	NP, P	DWQ will continue to monitor mercury and dioxin in fish tissue. Source of dioxin has been removed.
03-02-10	Cashie River	54.6 miles	PS – Fish Consumption	NP	DWQ will continue to monitor mercury in fish tissue.

Key: PS = Partially Supporting NP = Nonpoint Sources
NS = Not Supporting P = Point Sources

+ = Only limited progress towards developing and implementing nonpoint source reduction strategies for these impaired waters can be expected without additional resources.

* = These waters are currently, or will be placed, on the 303(d) list, and a TMDL and/or management strategy will be developed to address causes and sources of impairment.

DWQ plans to further evaluate impaired waters in the Roanoke River basin in conjunction with other agencies that deal with nonpoint source pollution issues and develop management

strategies for a portion of these impaired waters for the next *Roanoke River Basinwide Water Quality Plan* (2006).

Addressing Waters on the State's 303(d) List

For the next several years, addressing water quality impairment in waters that are on the state's 303(d) list will be a DWQ priority. Section 303(d) of the federal Clean Water Act requires states to develop a list of waters not meeting water quality standards or which have impaired uses. The waters in the Roanoke River basin that are on this list are discussed in the individual subbasin descriptions in Section B. States are also required to develop Total Maximum Daily Loads (TMDLs) or management strategies for 303(d) listed waters to address impairment. EPA issued guidance in August 1997 that called for states to develop schedules for developing TMDLs for all waters on the 303(d) list within 8-13 years.

There are approximately 2,387 impaired stream miles on the draft 2000 303(d) list in NC. The rigorous and demanding task of developing TMDLs for each listed water during a 13-year time frame will require the focus of many resources. It will be a priority for North Carolina's water quality programs over the next several years to develop TMDLs for 303(d) listed waters.

Challenges Related to Achieving Water Quality Improvements

To achieve the goal of restoring impaired waters throughout the basin, DWQ will need to work more closely with other state agencies and stakeholders to identify and control pollutants. The costs of restoration will be high, but several programs exist to provide funding for restoration efforts. These programs include the Clean Water Management Trust Fund, the NC Agricultural Cost Share Program, the Wetlands Restoration Program and the federally funded Conservation Reserve Enhancement Program.

With increased development occurring, there will be significant challenges ahead in balancing economic growth with the protection of water quality in this basin. Point source impacts on surface waters can be measured and addressed through the basinwide planning process. Nonpoint sources of pollution can be identified through the basinwide plan, but actions to address these impacts must be taken at the local level. Such actions should include: development and enforcement of local erosion control ordinances; requirement of stormwater best management practices for existing and new development; development and enforcement of buffer ordinances; and land use planning that assesses impacts 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.

Section A

General Basinwide Information

Chapter 1 -
Introduction to Basinwide Water Quality Planning

1.1 What is Basinwide Water Quality Planning?

Basinwide water quality planning is a nonregulatory, watershed-based approach to restoring and protecting the quality of North Carolina's surface waters. Basinwide water quality plans are prepared by the NC Division of Water Quality (DWQ) for each of the seventeen major river basins in the state, as shown in Figure A-1 and Table A-1. Preparation of an individual basinwide water quality plan is a five-year process, which is broken down into three major phases as presented in Table A-2. While these plans are prepared by the Division of Water Quality, their implementation and the protection of water quality entails the coordinated efforts of many agencies, local governments and stakeholder groups in the state. The first cycle of plans was completed in 1998, but each plan is updated at five-year intervals.

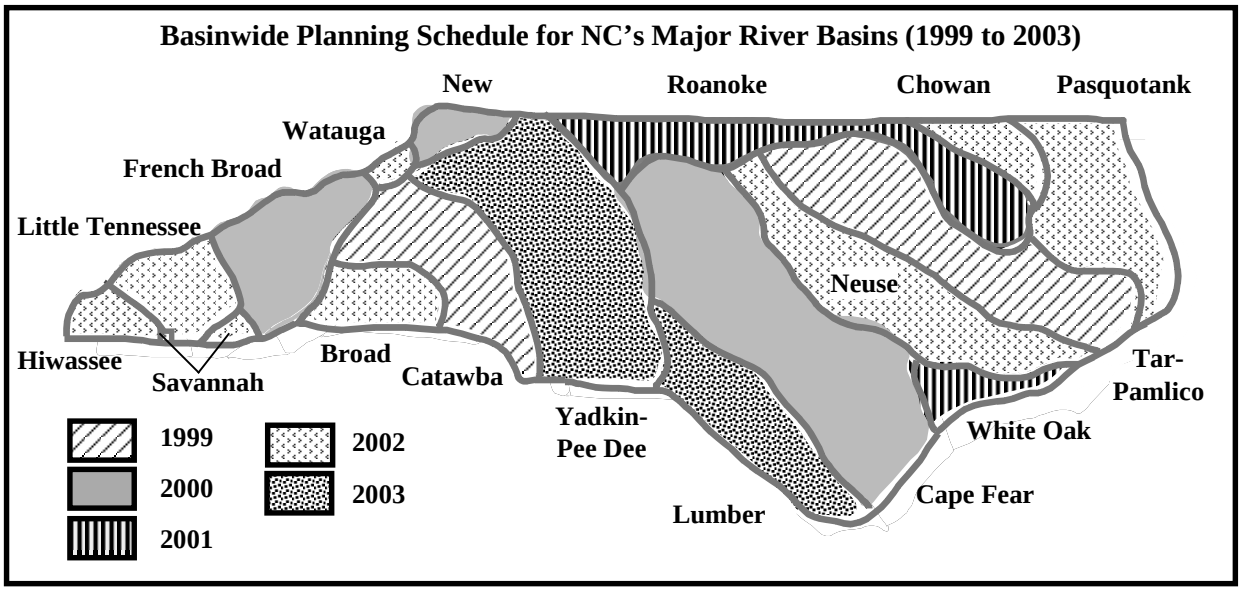

Figure A-1 Basinwide Planning Schedule (1999 to 2003)

1.2 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 while allowing for reasonable economic growth;
- develop appropriate management strategies to protect and restore water quality;
- assure equitable distribution of waste assimilative capacity for dischargers; and
- improve public awareness and involvement in the management of the state's surface waters.

Table A-1 Schedule for Second Cycle of Basinwide Planning (1998 to 2003)

Basin	DWQ Biological Data Collection	River Basin Public Workshops	Public Mtgs. and Draft Out For Review	Final Plan Receives EMC Approval	Begin NPDES Permit Issuance
Neuse	Summer 2000	6/2001	4/2002	7/2002	1/2003
Lumber	Summer 2001	12/2002	9/2003	12/2003	7/2004
Tar-Pamlico	Summer 97	6/1998	4/1999	7/1999	1/2000
Catawba	Summer 97	2/1999	10/1999	12/1999	3/2000
French Broad	Summer 97	5/1999	2/2000	5/2000	8/2000
New	Summer 98	6/1999	4/2000	7/2000	11/2000
Cape Fear	Summer 98	7/1999	4/2000	7/2000	12/2000
Roanoke	**Summer 99**	**4/2000**	**2/2001**	**7/2001**	**1/2002**
White Oak	Summer 99	10/2000	7/2001	9/2001	6/2002
Savannah	Summer 99	10/2000	12/2001	3/2002	8/2002
Watauga	Summer 99	10/2000	12/2001	2/2002	9/2002
Little Tennessee	Summer 99	3/2001	12/2001	4/2002	10/2002
Hiwassee	Summer 99	10/2000	12/2001	3/2002	8/2002
Chowan	Summer 2000	3/2001	1/2002	5/2002	11/2002
Pasquotank	Summer 2000	3/2001	1/2002	5/2002	12/2002
Broad	Summer 2000	11/2001	9/2002	12/2002	7/2003
Yadkin Pee-Dee	Summer 2001	4/2002	12/2002	3/2003	9/2003

Note: A basinwide plan was completed for all 17 basins during the first cycle (1993 to 1998).

Table A-2 Five-Year Process for Development of an Individual Basinwide Water Quality 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 Public Workshops**	• Gather and analyze data from sampling activities • Develop use support ratings • Conduct special studies and other water quality sampling activities • Conduct public workshops to establish goals and objectives and identify and prioritize issues for the next basin cycle • Develop preliminary pollution control strategies • Coordinate with local stakeholders and other 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 at public meetings • Revise plan after public review period • 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

1.3 Major Components of the Basinwide Plan

The second cycle of basinwide plans uses a different format from the earlier basinwide plans. Each plan is subdivided into three major sections. The intent of the format change is to make the plans easier to read and understand, but still comprehensive in content.

Section A: Basinwide Information

- Introduces the basinwide planning approach used by the state.
- Provides an overview of the river basin including: hydrology, land use, local government jurisdictions, population and growth trends, natural resources, wastewater discharges, animal operations and water usage.
- Presents general water quality information including summaries of water quality monitoring programs and use support ratings in the basin.

Section B: Subbasin Information

- Summarizes recommendations from first basin plan, achievements made, what wasn't achieved and why, current priority issues and concerns, and goals and recommendations for the next five years by subbasin.

Section C: Current and Future Initiatives

- Presents current and future water quality initiatives and success stories by federal, state and local agencies, and corporate, citizen and academic efforts.
- Describes DWQ goals and initiatives beyond the five-year planning cycle for the basin.

1.4 Benefits of Basinwide Water Quality Planning

Several benefits of basinwide planning and management to water quality include:

- *Improved efficiency.* The state's efforts and resources are focused on one river basin at a time.
- *Increased effectiveness.* The basinwide approach is in agreement with basic ecological principles.
- *Better consistency and equability.* By clearly defining the program's long-term goals and approaches, basinwide plans encourage *consistent* decision-making on permits and water quality improvement strategies.
- *Increased public participation in the state's water quality protection programs*. The basinwide plans are an educational tool for increasing public involvement and awareness of water quality issues.
- *Increased integration of point and nonpoint source pollution assessment and controls*. Once waste loadings from both point and nonpoint sources are established, management strategies can be developed to ensure compliance with water quality standards.

1.5 How to Get Involved

To assure that basinwide plans are accurately written and effectively implemented, it is important for citizens and other local stakeholders to participate in the planning process. DWQ offers three opportunities for the public to participate in the planning process:

- Public workshops: Held prior to writing the basinwide plans. DWQ staff present information about basinwide planning and the water quality of the basin. Participants then break into smaller groups where they can ask questions, share their concerns, and discuss potential solutions to water quality issues in the basin.
- Public meetings: Held after the draft basinwide plan has been approved by the Water Quality Committee of the Environmental Management Commission. DWQ staff present more detailed information about the draft basinwide plan and its major recommendations. Then, the public is invited to comment and ask questions.
- Public Comment Period: Held after the draft plan has been approved by the Water Quality Committee of the Environmental Management Commission. The comment period is at least thirty days in length from the date of the first public meeting.

Citizens seeking involvement in efforts to restore and protect water quality can call the DWQ Planning Branch at (919) 733-5083 and ask to speak to the basin planner for your river basin.

1.6 Other References

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

- *Roanoke River Basinwide Assessment Report*. May 2000. This technical report presents physical, chemical and biological data collected in the Roanoke River basin. 150 pages.
- *Roanoke River Basinwide Water Quality Management Plan*. September 1996. This first basinwide plan for the Roanoke River basin presents water quality data, information and recommended management strategies for the first five-year cycle. 280 pages.
- *A Citizen's Guide to Water Quality Management in North Carolina*. August 2000. 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. 156 pages.
- *NC Basinwide Wetlands and Riparian Restoration Plan for the Roanoke River Basin.* August 1998. DWQ NC Wetlands Restoration Program. 75 pages.
- *North Carolina's Basinwide Approach to Water Quality Management: Program Description*. Creager, C.S. and J.P. Baker. 1991. DWQ Water Quality Section. Raleigh, NC.
- NC Division of Water Quality Basinwide Planning website at http://h2o.enr.state.nc.us/. Click on Water Quality Section and then, under Programs, click on Basinwide Planning Program.
- NC Division of Water Quality Environmental Sciences Branch website at http://www.esb.enr.state.nc.us/.

Anyone interested in receiving these documents can contact the
DWQ Planning Branch at (919) 733-5083 or by internet:
http://h2o.enr.state.nc.us/basinwide/

1.7 Division of Water Quality Functions and Locations

The major activities coordinated by DWQ through basinwide planning are listed in Figure A-2. Information on the location, address and phone numbers for each branch and regional office are also shown in Figure A-2 and Figure A-3. Additional information can be found on the Division of Water Quality website at http://h2o.enr.state.nc.us/.

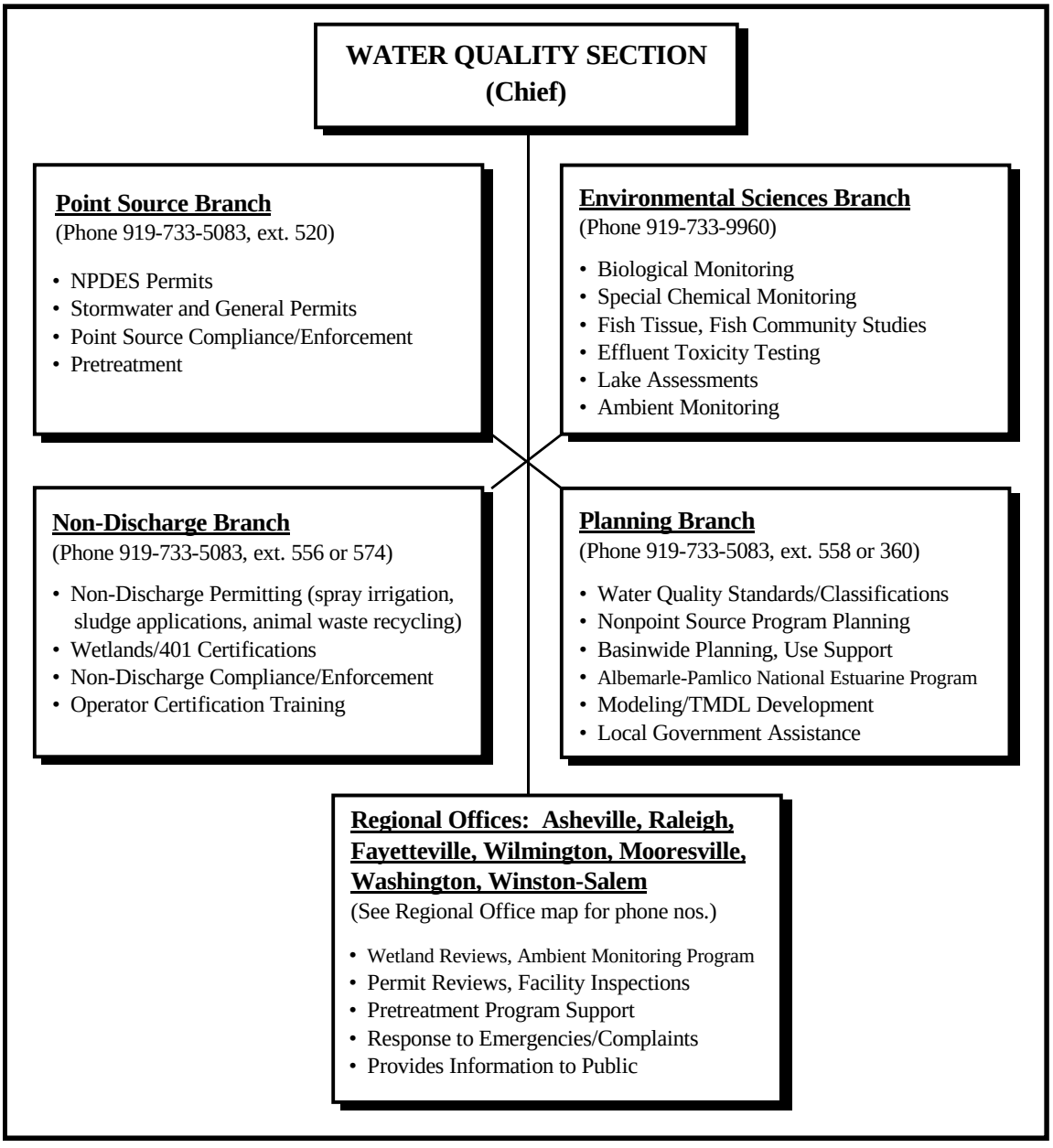

Figure A-2 Water Quality Section Organization Structure

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Figure A-3 Division of Water Quality Regional Offices

Chapter 2 -
Roanoke River Basin Overview

2.1 General Overview

The Roanoke River begins in the Blue Ridge Mountains of northwestern Virginia and flows in a generally southeastern direction for 400 miles before emptying into the Albemarle Sound in eastern North Carolina (Figure A-4). By the time it reaches the fall line near Roanoke Rapids, the river has captured water from nearly 8,000 square miles of land. From Roanoke Rapids to the coast, the river drains another 2,000 square miles and carries more water than any other river in North Carolina. In the lower portion of the basin, the river carved a floodplain up to five miles wide, where radio carbon-dating of sediment indicates that deeper soils washed down from the piedmont over 200 years ago as settlers began to clear the land.

Roanoke River Basin Statistics
(NC Portion)

Total Area: 3,503 sq. miles
Stream Miles: 2,213
No. of Counties: 15
No. of Municipalities: 42
No. of Subbasins: 10
Population (2000): 335,194*****
Estimated Pop. (2020): 356,722*****
% Increase (2000-2020): 6.4%
Pop. Density (1990): 107 persons / sq. mi.

* Based on % of county land area estimated to be within the basin (Table A-11).

The North Carolina portion of the Roanoke basin is composed of two major parts: the Dan River and its tributaries in the western section (Figure A-5); and the Roanoke River from Virginia to the Sound in the eastern section (Figure A-6). The Roanoke River enters North Carolina through John H. Kerr Reservoir and then flows into Lake Gaston and Roanoke Rapids Lake before regaining its riverine form.

There are 15 counties and 42 municipalities located wholly or partially within the basin. The most populated areas are located northeast of the Greensboro/ Winston-Salem/High Point area and around the larger municipalities in the basin such as Roanoke Rapids, Eden, Williamston and Plymouth. The overall population density is 107 persons per square mile versus a statewide average of 139 persons per square mile.

Sixty percent of the land in the basin is forested and about twenty-two percent is in cultivated cropland. Tobacco, peanuts, cotton and soybeans are among the most common crops grown. Only six percent of the land falls into the urban/built-up category. Despite the large amount of cultivated cropland and the relatively small amount of urban area, the basin has seen a significant decrease (-105,300 acres) in cultivated cropland and increase (+77,700 acres) in built-up areas over the past fifteen years (USDA, 1999).

The upper Dan River is classified as trout waters, and part of the area is also designated a State Water Trail by the NC Division of Parks and Recreation. The lower portion of the basin contains some of the largest intact and least disturbed bottomland hardwood and cypress-tupelo ecosystems on the Atlantic Coast of North America. It is also important habitat for anadromous fish, including striped bass, as well as black bear, bobcat, large populations of wild turkey, 14 species of waterfowl, and 220 additional species of birds.

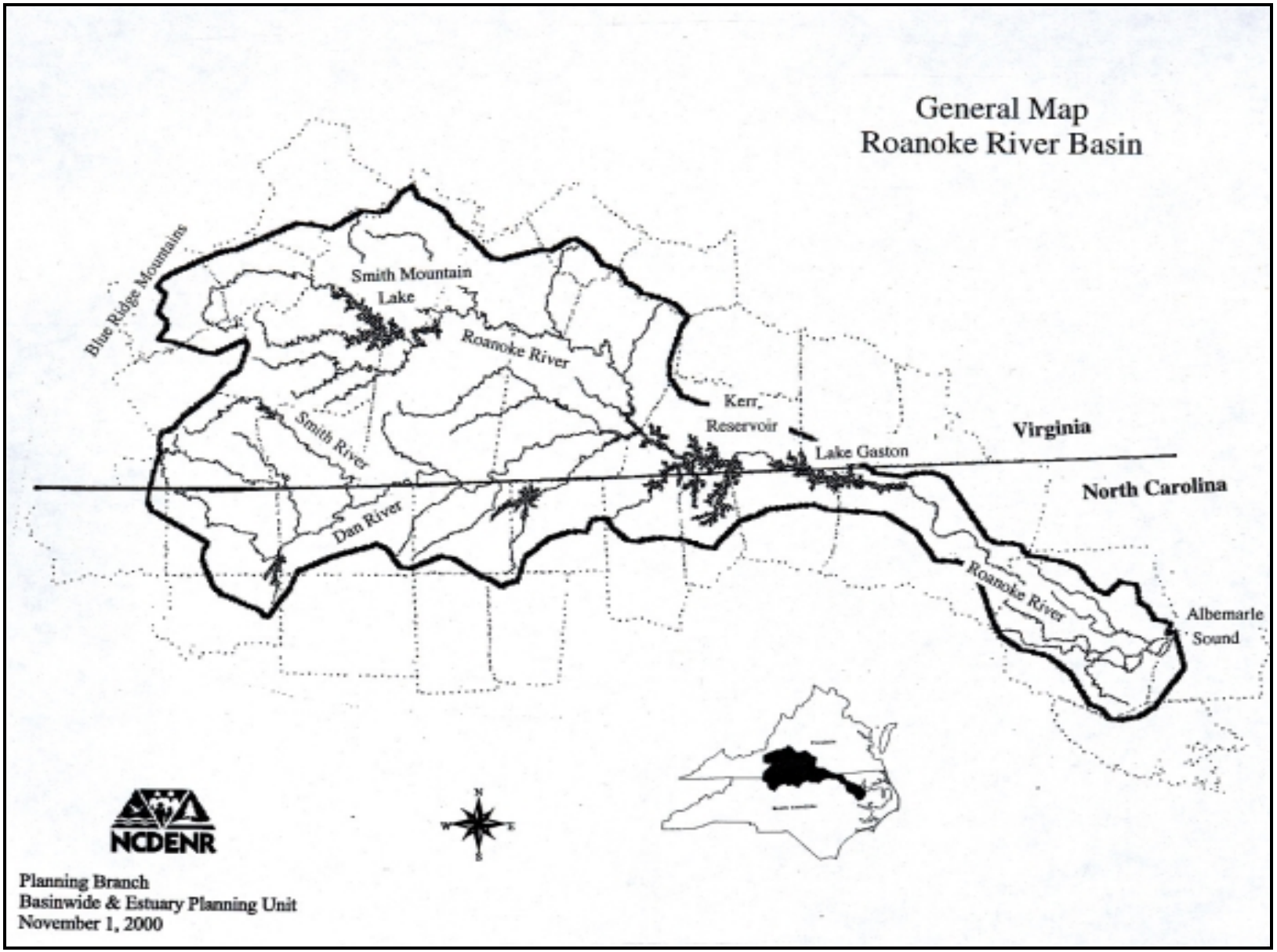
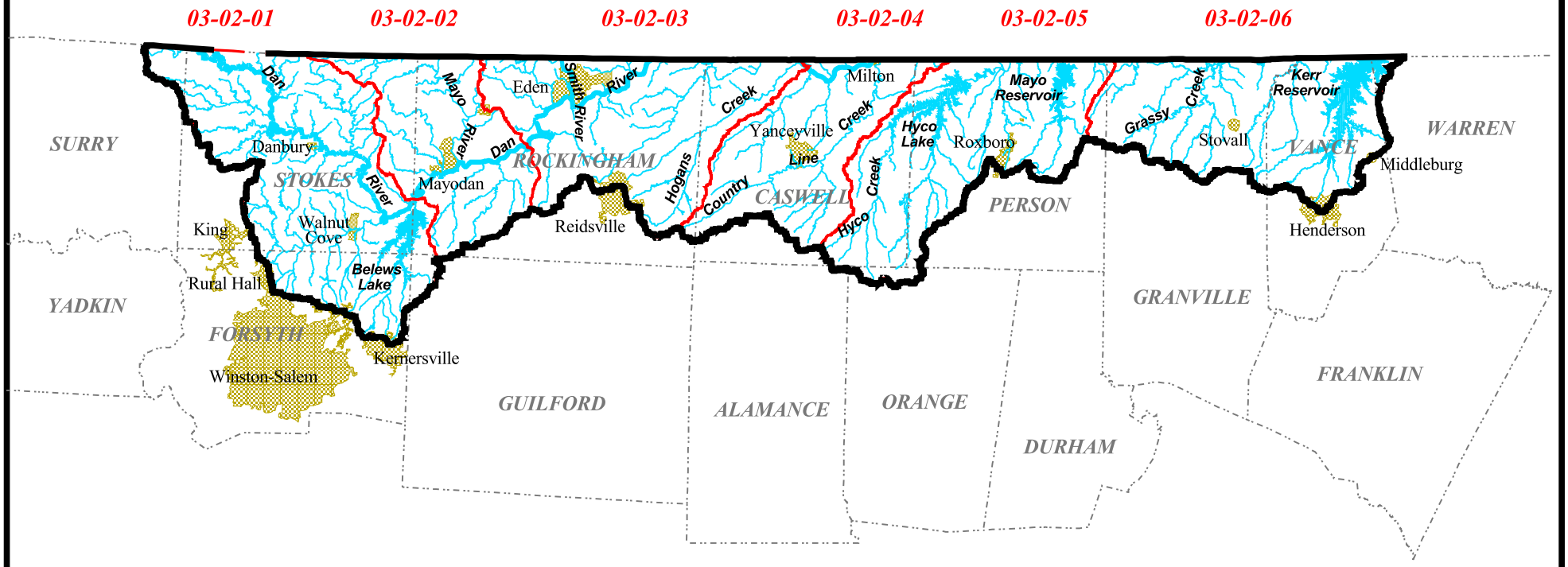
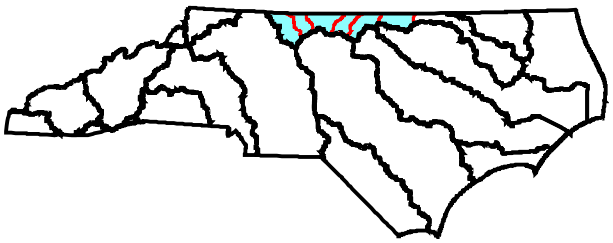


Figure A-4 General Map of the Entire Roanoke River Basin

Figure A-5 General Map of Western Portion of the Roanoke River Basin in North Carolina





Legend

- River Basin Boundary
- Subbasin Boundary
- County Boundary
- Hydrography
- Municipality

N
W E
S

20 0 20 40 Miles

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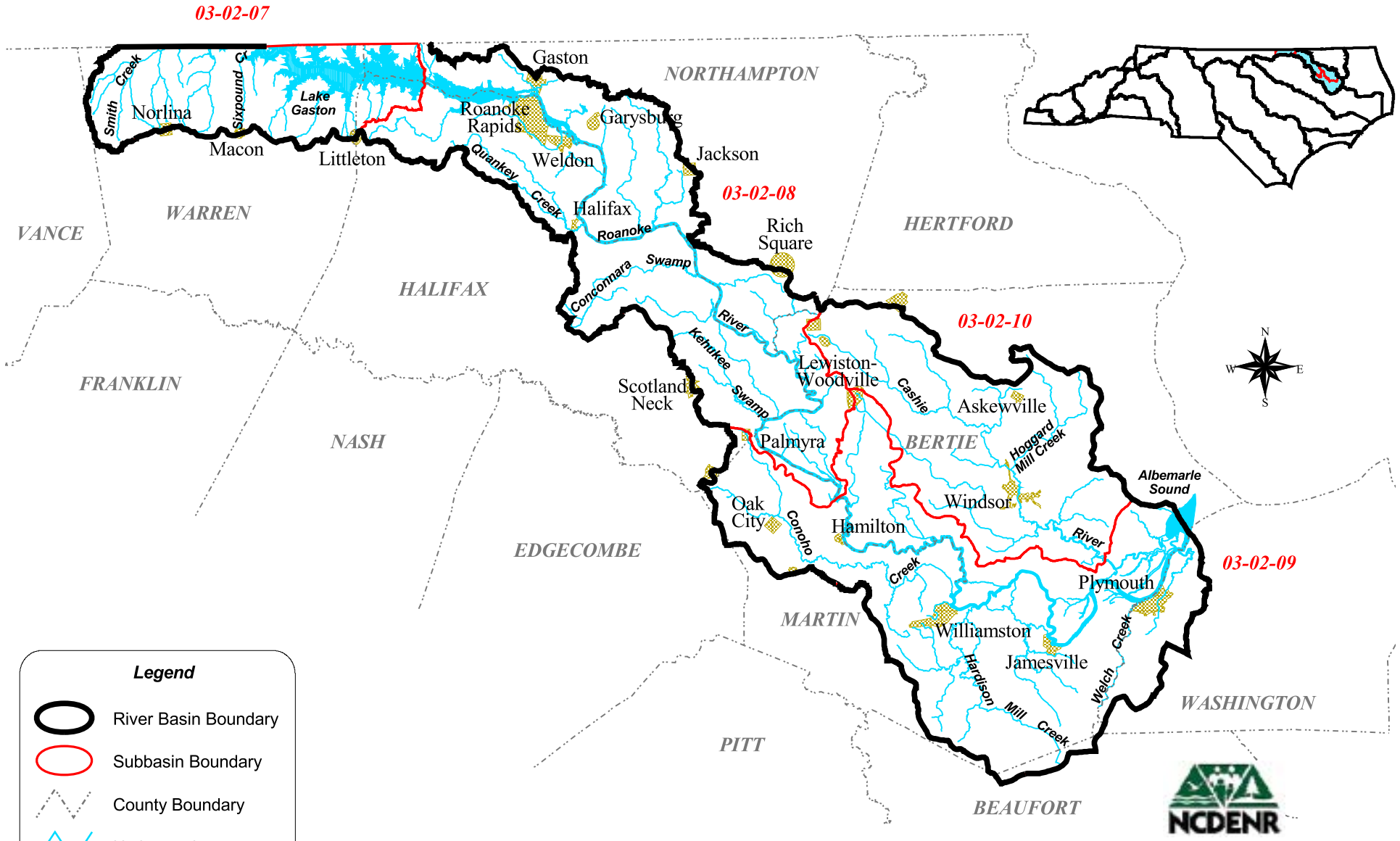
May 3, 2001

Figure A-6 General Map of the Eastern Portion of the Roanoke River Basin in North Carolina



2.2 Local Governments and Planning Jurisdictions in the Basin

The Roanoke River basin encompasses all or portions of fifteen counties and forty-two municipalities. Table A-3 provides a listing of these municipalities, along with the appropriate regional planning jurisdiction (Council of Governments), and an estimation, provided by the NC Center for Geographic Information and Analysis, of the percentage of each county's area that lies within the basin. Seventeen municipalities are located in more than one major river basin.

Table A-3 Local Governments and Planning Units within the Roanoke River Basin

County	% of County in basin	Region	Municipalities
Bertie	70%	Q	Askewville, Aulander* Kelford, Lewiston-Woodville Roxobel, Winsdor
Caswell	90%	G	Milton Yanceyville
Forsyth	21%	I	Kernersville* (♦), Rural Hall* Walkertown*
Granville	33%	K	Stovall
Guilford	<2%	G	Kernersville* (♦), Stokesdale*
Halifax	40%	L	Halifax, Hobgood* Littleton*, Roanoke Rapids Scotland Neck*, Weldon
Martin	75%	Q	Hamilton, Hassell Jamesville, Oak City Williamston
Northampton	35%	L	Garysburg, Gaston* Jackson*, Rich Square*
Orange	2%	J	None
Person	60%	K	Roxboro*
Rockingham	81%	G	Eden, Madison Mayodan, Reidsville* Stoneville, Wentworth
Stokes	85%	I	Danbury Walnut Cove
Surry	3%	I	None
Vance	52%	K	Henderson* Middleburg*
Warren	38%	K	Macon* Norlina*
Washington	13%	R	Plymouth

* Located in more than one major river basin.

♦ Located in more than one county.

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%) is located in that basin, unless a municipality is located in that county. (Note: Guilford County is included because of the municipalities, Kernersville and Stokesdale.)

Region	Name	Location
G	Piedmont Triad Council of Governments	Greensboro
I	Northwest Piedmont Council of Governments	Winston-Salem
J	Triangle J Council of Governments	Research Triangle Park
K	Kerr-Tar Regional Council of Governments	Henderson
L	Regional L Council of Governments	Rocky Mount
Q	Mid-East Commission	Washington
R	Albemarle Regional Planning and Development Commission	Hertford

2.3 Surface Water Hydrology

Most federal government agencies, including the US Geological Survey (USGS) and the US Natural Resources Conservation Service (NRCS), use a system of defining watersheds that is different from that used by the Division of Water Quality (DWQ) and many other state agencies in North Carolina. Under the federal system, the Roanoke River basin is made up of five hydrologic areas referred to as hydrologic units. These include the Dan River in North Carolina, Country Line Creek and Hyco Reservoir, Kerr Reservoir and tributaries, Lake Gaston and Smith Creek, and the Roanoke and Cashie Rivers. Each hydrologic unit is defined by an 8-digit number. DWQ has a two-tiered system in which the state is subdivided into 17 river basins with each basin further subdivided into subbasins. Table A-4 compares the two systems. The Roanoke River basin is subdivided by DWQ into ten subbasins. Maps of each subbasin are included in Section B.

Table A-4 Hydrologic Subdivisions in the Roanoke River Basin

Watershed Name and Major Tributaries	USGS 8-digit Hydrologic Units	DWQ Subbasin 6-digit Codes
Dan River (NC Portion)	03010103	03-02-01
Town Fork, Snow, Wolf Island and Hogans Creeks		03-02-02
Smith and Mayo Rivers and Belews Lake		03-02-03
Country Line Creek and Hyco Reservoir	03010104	03-02-04
Country Line, Hyco and Marlowe Creeks		03-02-05
Hyco and Mayo Reservoirs		
Kerr Reservoir and tributaries	03010102	03-02-06
Grassy, Island and Nutbush Creeks		
Lake Gaston and Smith Creek	03010106	03-02-07
Roanoke and Cashie Rivers	03010107	03-02-08
Roanoke Rapids Lake and Roquist Creek		03-02-09
Quankey, Conoho, Hardison Mill and Welch Creeks		03-02-10
Conconnara, Kehukee and Connaritsa Swamps		

The entire Roanoke River basin is approximately 9,776 square miles in size. In the North Carolina portion (roughly 36 percent of the entire watershed), 2,212 miles of freshwater streams drain 3,503 square miles of terrain. The upper portion of the basin in North Carolina lies primarily in the Piedmont Physiographic Region. This region is characterized by rolling hills and geologic formations consisting of crystalline or sedimentary rocks. Because of the moderate topography, more streams drain a smaller amount of land, increasing the drainage density. The drainage density in this portion of the basin is 0.97-0.74 compared to 0.62-0.51 in the lower portion of the basin.

Areas with high drainage density are associated with high flood peaks, high sediment production, relatively low suitability for traditional agriculture, and high development costs for the construction of buildings and the installation of roads and bridges. Within the North Carolina portion of the Roanoke River basin, subbasin 03-02-01 has the highest drainage density, while subbasin 03-02-09 has the lowest.

The lower portion of the basin lies in the Coastal Plain Physiographic Region. The geology of this area consists of alternating layers of sand, silt, clay and limestone. In this portion of the basin, the land is relatively flat. The slope dips downward at a rate of only a few feet per mile. A smaller number of streams drain a large area of land on the Coastal Plain. In addition to low drainage density, the lower portion of the basin also has the lowest potential for sustaining base flow in streams. The low flow frequency, measured by a 7Q10 (annual minimum 7-day consecutive low flow, which on average, will be exceeded 9 out of 10 years) flow calculation, is zero for all but the largest drainages. This very low flow over the warmest months of the year limits streams' ability to maintain high dissolved oxygen levels (increased temperature depletes dissolved oxygen while decreased velocity inhibits reaeration). The capacity for assimilating oxygen-consuming wastes is also limited under these conditions. DWQ limits discharges containing oxygen-consuming wastes into these low base flow streams (refer to Chapter 4 of this section for further information).

Hydrologic Features

There are 11 major reservoirs in the North Carolina portion of the Roanoke River basin. Most of them are located in the upper portion of the basin on tributaries of the Dan and Roanoke Rivers. The three largest reservoirs, Kerr, Gaston and Roanoke Rapids, are impoundments of the Roanoke mainstem. They are managed by the US Army Corps of Engineers and Dominion (formerly North Carolina Power) for electrical energy production and flood control. Flow from these reservoirs influences the quality of water in the lower Roanoke River. In addition to general protection of aquatic life and secondary recreation, seven lakes are classified for primary recreation and nine are designated drinking water supplies (Table A-5).

Table A-5 Statistics for Major Lakes (Entire Size Calculations) in the Roanoke River Basin

Subbasin/Lake	County	Classification*	Surface Area (Ac)	Mean Depth (ft)	Volume (x 10^6 m^3)	Watershed (mi^2)
03-02-01						
Hanging Rock Lake	Stokes	B	12	2	0.003	1.1
Kernersville Res.	Forsyth	WS-IV, CA	45	16	0.4	5.3
Belews Lake	Forsyth/Stokes/ Rockingham/Guilford	WS-IV, B, C	4,030	49	228	46
03-02-04						
Farmer Lake	Caswell	WS-II, CA	368	20	6.5	48
03-02-05						
Hyco Lake	Person/Caswell	WS-V, B	3,750	20	99	188
Lake Roxboro	Person	WS-II, B	195	20	10.8	24
Roxboro Lake	Person	WS-II, CA	212	12	0.3	196
Mayo Res.	Person	WS-V, B	2,800	30	105	51
03-02-06						
John H. Kerr Res.	Warren/Vance/ Granville	B, C	48,999	35	448	7,610
03-02-07						
Lake Gaston	Warren/Halifax/ Northampton	WS-V, WS-IV, B, CA	20,299	20	512	8,239
03-02-08						
Roanoke Rapids Res.	Northampton/ Halifax	WS-IV, B, CA	4,893	16	96	8,294

* An index for DWQ freshwater classifications can be found in Part 3.2 of this section (Table A-20).

The lower Roanoke River basin contains extensive wetland communities also. More than 150,000 acres of bottomland hardwood and swamp forest communities provide valuable functions in terms of hydrology and water quality including water, nutrient and sediment retention, bank stabilization, and water purification and pollutant removal (especially for nutrients). Refer to Part 2.6 of this chapter for further information about these natural resources.

2.4 Land Cover

Land cover information in this section is from the most current National Resources Inventory (NRI), as developed by the Natural Resources Conservation Service (USDA-NRCS, NRI, Updated June 2001). The NRI is a statistically-based longitudinal survey that has been designed and implemented to inventory land cover types and acreages. 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 includes reviewing previously recorded data when 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.

Table A-6 summarizes acreage and percentage of land cover from the 1997 NRI for the North Carolina portion of the basin and for the major watersheds within the basin, as defined by the USGS 8-digit hydrologic units. Data from 1982 are also provided for a comparison of change over fifteen years. During this period, the amount of cultivated cropland in the basin decreased significantly (-105,300 acres), while the amount of uncultivated cropland almost doubled (+21,600 acres). Land in the urban/built-up category increased 132.8 percent or 77,700 acres. Land in the "Other" category also increased over the 15-year time frame (+1,300 acres). Figure A-7 presents these land cover changes. Descriptions of land cover types identified by the NRI are found in Table A-7.

Table A-6 Land Cover in the Roanoke River Basin by Major Watershed - 1982 vs. 1997 (Source: USDA-NRCS, NRI, Updated June 2001)

	MAJOR WATERSHED AREAS*														
	Upper Dan		Lower Dan		Middle Roanoke		Roanoke Rapids		Lower Roanoke		1997 TOTALS		1982 TOTALS		% change
LAND COVER	Acres (1000s)	%	Acres (1000s)	%	Acres (1000s)	%	Acres (1000s)	%	Acres (1000s)	%	Acres (1000s)	% of TOTAL	Acres (1000s)	% of TOTAL	since 1982
Cult. Crop	77.2	13.9	57.5	12.1	22.3	11.3	21.0	12.4	198.7	24.4	376.7	17.0	482.0	21.8	-21.8
Uncult. Crop	29.0	5.2	10.1	2.1	2.2	1.1	5.4	3.2	0.0	0.0	46.7	2.1	25.1	1.1	86.1
Pasture	27.8	5.0	28.1	5.9	15.2	7.7	4.0	2.4	11.7	1.4	86.8	3.9	110.2	5.0	-21.2
Forest	318.0	57.3	329.0	69.0	108.0	54.6	89.2	52.8	517.0	63.4	1361.2	61.5	1363.3	61.5	-0.2
Urban & Built-Up	58.8	10.6	19.0	4.0	8.5	4.3	15.8	9.4	34.1	4.2	136.2	6.1	58.5	2.6	132.8
Federal	0.0	0.0	0.0	0.0	14.0	7.1	0.0	0.0	6.2	0.8	20.2	0.9	16.9	0.8	19.5
Other	44.4	8.0	33.4	7.0	27.7	14.0	33.4	19.8	48.3	5.9	187.2	8.5	159.0	7.2	17.7
Totals	555.2		477.1		197.9		168.8		816.0		2215.0		2215.0		
% of Total Basin		25.1		21.5		8.9		7.6		36.8		100.0		100.0	
SUBBASINS	03-02-01 03-02-02 03-02-03		03-02-03 03-02-04 03-02-05 03-02-06		03-02-06		03-02-07 03-02-08		03-02-08 03-02-09 03-02-10						
8-Digit Hydraulic Units	03010103		03010104		03010102		03010106		03010107						

* Watershed areas as defined by the 8-Digit Hydraulic Units do not necessarily coincide with subbasin numbers used by DWQ.

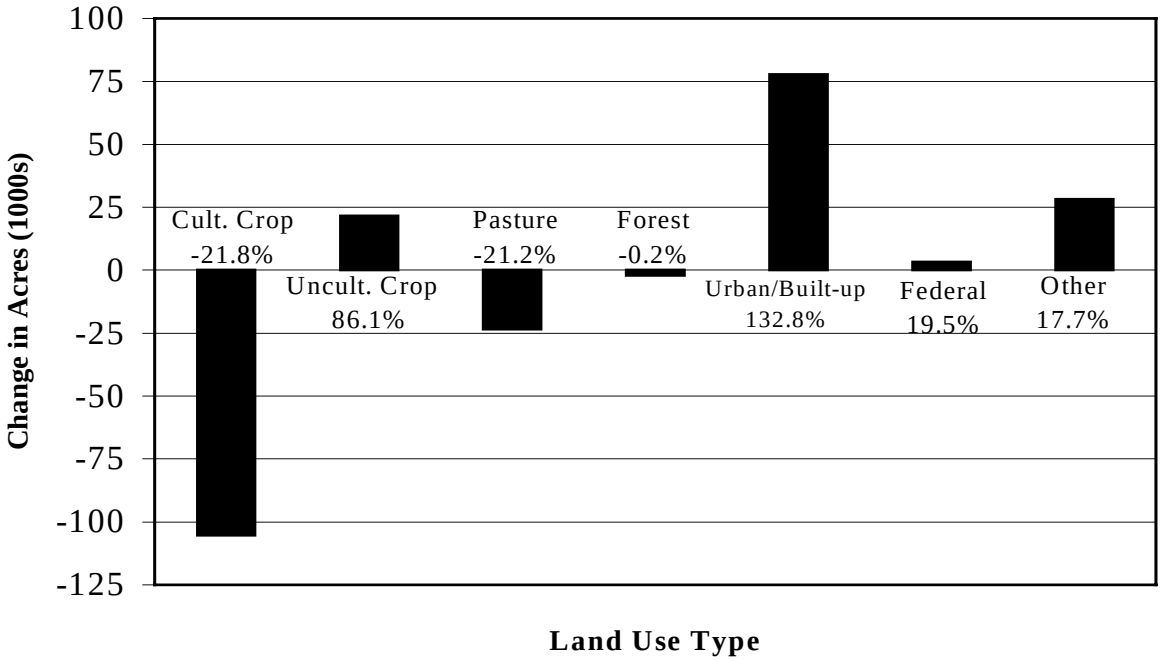


Figure A-7 Land Cover Changes from 1982 to 1997 for the Roanoke River Basin (Source: USDA-NRCS, NRI, Updated June 2001)

Table A-7 Description of Land Cover Types

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 miles wide. *Census Water*: Large waterbodies consisting of lakes and estuaries greater than 40 acres and rivers greater than 0.5 miles in width. *Minor Land*: Lands that do not fall into one of the other categories.

The North Carolina Corporate Geographic Database contains land cover information for the Roanoke River basin based on satellite imagery from 1993-1995. The state's Center for Geographic Information and Analysis (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 Table A-8. An important distinction between this land cover dataset and that of the NRI is that there is no actual groundtruthing of the satellite-generated data.

Figure A-8 provides an illustration of the relative amount of land area that falls into each major cover type for the Roanoke River basin. Section B of this plan provides land cover data specific to each subbasin.

Unfortunately, due to differences in the system of categorizing various land cover classes, it is not currently possible to establish trends in land cover changes by comparing this data set to previously attained land cover data. However, it is anticipated that comparisons will be possible with future satellite data since a strong consensus-based effort was made to develop the classification system that was used with the 1993-1995 data.

Table A-8 Description of CGIA Land Cover Categories

Land Cover Type	Land Cover Description
Urban	Greater than 50% coverage by synthetic land cover (built-upon area) and municipal areas.
Cultivated	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 other 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 all kinds of forested areas (such as 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.

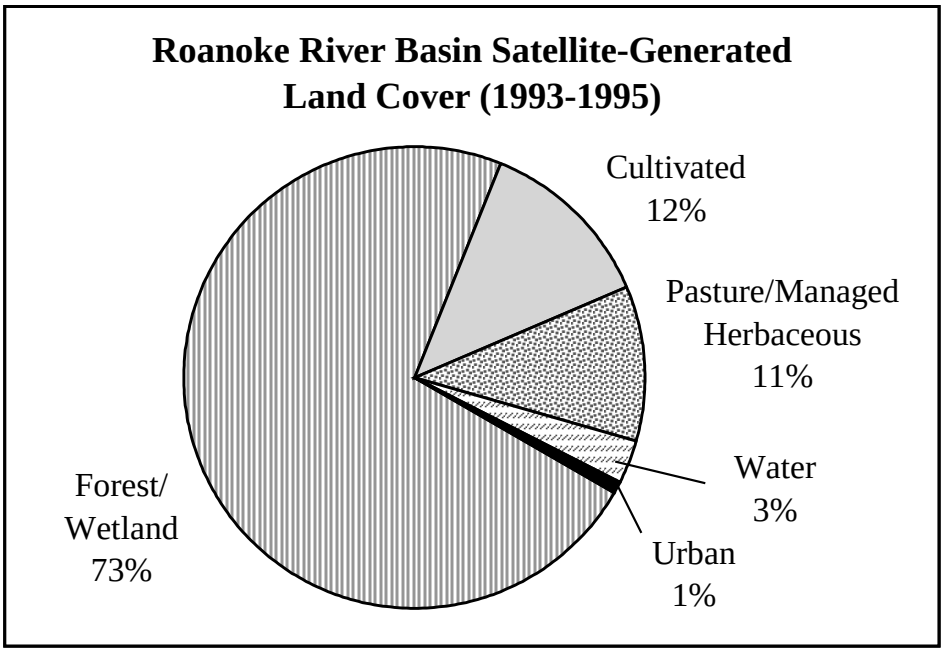


Figure A-8 Percentages within Major Land Cover Categories in the Roanoke River Basin

2.5 Population and Growth Trends

Population

The Roanoke River basin in North Carolina has an estimated population of 263,691 based on 1990 census data. Table A-9 presents census data for 1970, 1980 and 1990. It also includes population densities (persons/square mile) based on *land area* for each subbasin. Most of the basin's population (56 percent) is located in subbasins 03-02-09 (Martin, part of Bertie, and Washington counties), 03-02-01 (Stokes and Forsyth counties), and 03-02-08 (Halifax and Northampton counties). These three subbasins contain approximately 148,055 people.

Table A-9 Roanoke River Subbasin Population (1970, 1980, 1990), Percent Population Change and Land Area Summaries

SUBBASIN	POPULATION [1] (Number of Persons)			POPULATION DENSITY [2] (Persons/Square Mile)			LAND AND WATER AREAS [3]			
							Total Land and Water Area		Land Area	Water Area
	1970	1980	1990	1970	1980	1990	(Acres)	(Sq. Miles)	(Sq. Miles)	(Sq. Miles)
03-02-01	29,829	47,011	45,777	67	106	103	289,919	453	445	8
03-02-02	18,910	20,957	19,588	83	92	86	147,839	231	229	2
03-02-03	11,103	11,980	11,695	33	36	35	217,599	340	335	5
03-02-04	26,709	27,971	27,208	113	119	115	152,959	239	236	3
03-02-05	6,747	10,175	9,903	21	32	31	215,679	337	322	15
03-02-06	20,311	22,904	21,604	69	78	73	210,559	329	295	34
03-02-07	6,676	6,681	8,338	38	38	48	124,800	195	174	21
03-02-08	41,640	42,627	43,392	88	90	91	328,319	513	473	40
03-02-09	48,718	58,768	58,886	112	135	135	357,758	559	435	124
03-02-10	14,982	15,859	17,300	52	55	60	196,479	307	290	17
TOTALS	225,625	264,933	263,691	70	82	82	2,241,910	3,503	3,234	269

[1] Population estimated based on US Census data and percentage of census block that falls within the subbasin.

[2] Population density based on land area only. Large wetlands (swamps) not included in area used to calculate density.

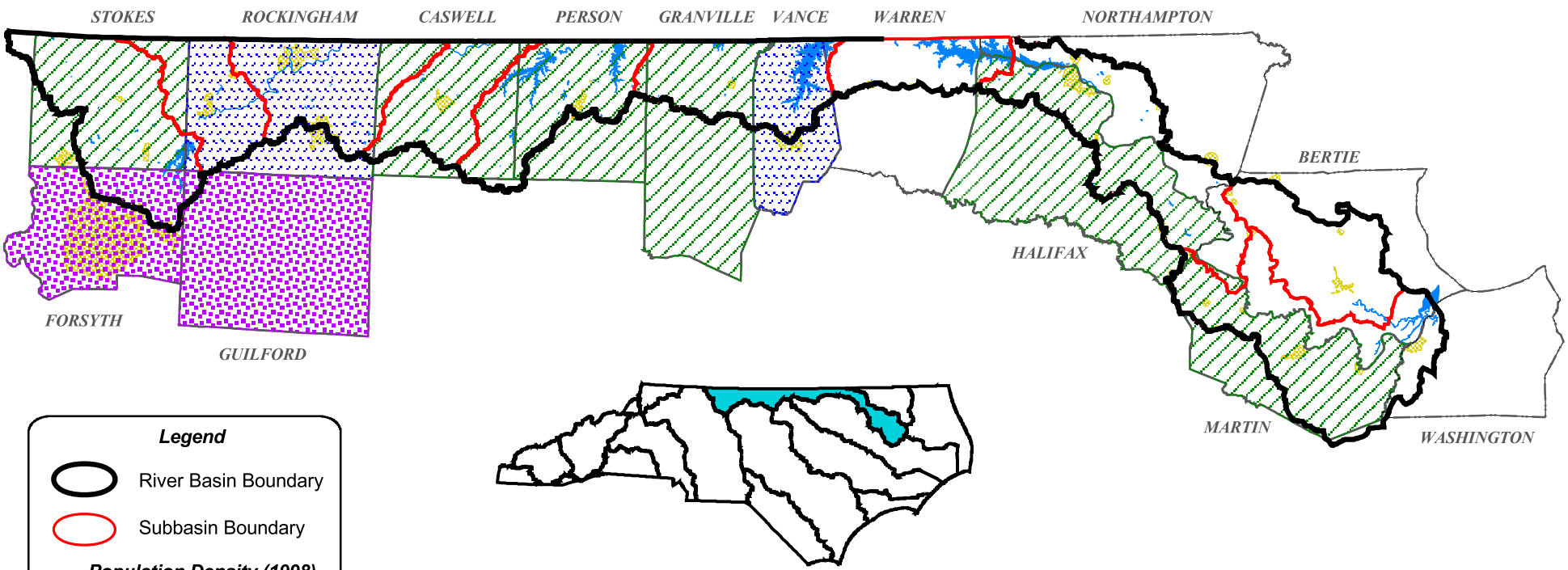
[3] Information generated by the NC Center for Geographic Information Analysis, August 2000.

In using these data, it should be noted that some of the population figures are estimates because the census block group boundaries do not generally coincide with subbasin boundaries. The census data are collected within boundaries such as counties and municipalities. By contrast, the subbasin lines are drawn along natural drainage divides separating watersheds. Therefore, where a census block group straddles a subbasin line, the percentage of the population that is located in the subbasin is estimated, assuming that population density is evenly distributed throughout a census block group. This is not always the case; however, the level of error associated with this method is not expected to be significant for the purposes of this document. It is also important to note that the census block groups change every ten years so comparisons between years must be considered approximate. Figure A-9 displays estimated 1998 population density information by county.

Growth Trends

Population in the North Carolina portion of the Roanoke River basin overall decreased slightly (1,242 people) between 1980 and 1990. Figure A-10 presents projected population growth by county (1998-2018) for the Roanoke River basin in North Carolina. Stokes and Granville counties are growing the fastest, with projections indicating a 20-40 percent increase in population. Almost all of Stokes County is contained within the basin, but only 33 percent of Granville County falls within the boundary.

Figure A-9 1998 Population Density for the Roanoke River Basin in North Carolina



Legend

- River Basin Boundary
- Subbasin Boundary

Population Density (1998)

- 0 - 50
- 50 - 100
- 100 - 250
- >500
- County Boundary
- Hydrography
- Municipality

20 0 20 40 Miles

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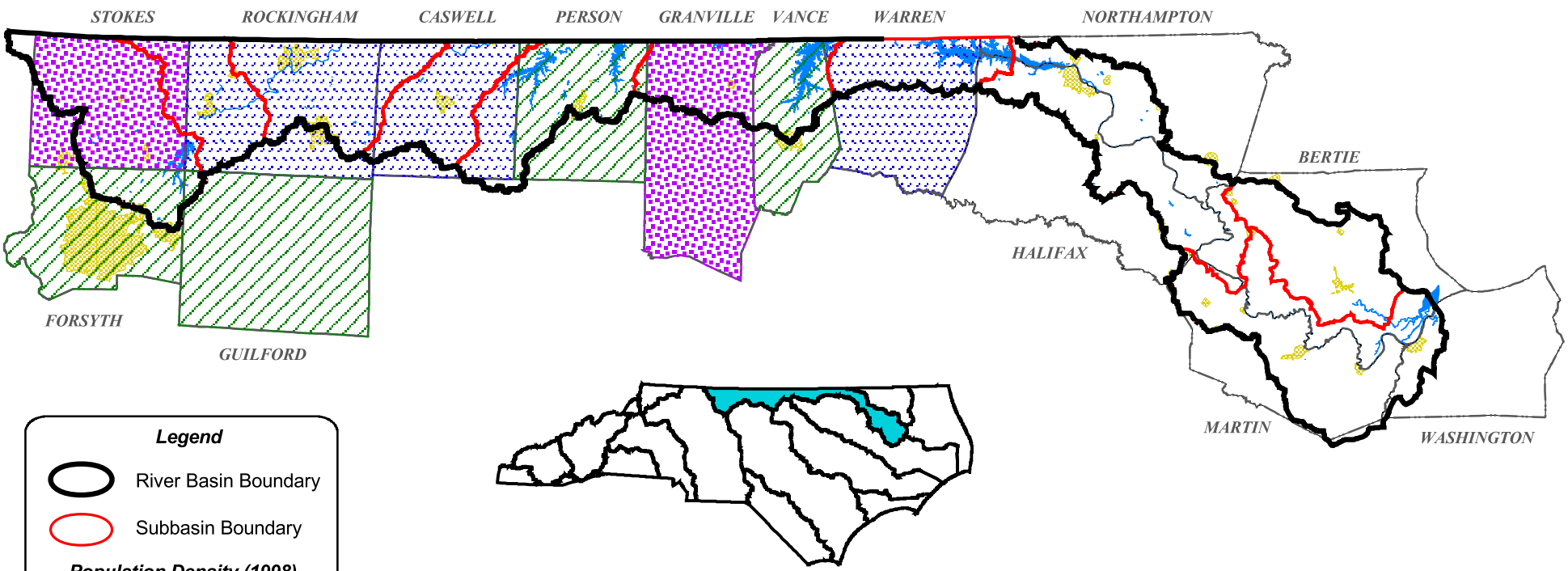
Figure A-10 Projected Population Growth (1998-2018) by County for the Roanoke River Basin in North Carolina



Legend

- River Basin Boundary
- Subbasin Boundary

Population Density (1998)

- <20 - 0%
- 0 - 10%
- 10 - 20%
- 20 - 30%
- County Boundary
- Hydrography
- Municipality

20 0 20 40 Miles

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April 26, 2001

Table A-10 presents population data for municipalities with populations greater than 2,000 persons, located wholly or partly within the basin. Figure A-11 graphically depicts population data for selected municipalities in the North Carolina portion of the Roanoke River basin.

Table A-10 Population and Percent Change for Municipalities Greater Than 2,000 Located Wholly or Partly in the Basin as of March 2001 (NC Municipal Population, 2000)

Municipality	County	Apr-80	Apr-90	Apr-2000	Percent Change (1980-90)	Percent Change (1990-2000)
Eden	Rockingham	15,672	15,238	15,908	-2.8	4.4
Henderson •	Vance	13,522	15,655	16,095	15.8	2.8
Kernersville •	Forsyth/Guilford	5,875	10,899	17,126	85.5	57.1
Madison	Rockingham	2,806	2,371	2,262	-15.5	-4.6
Mayodan	Rockingham	2,627	2,471	2,417	-5.9	-2.2
Plymouth	Washington	4,571	4,328	4,107	-5.3	-5.1
Reidsville •	Rockingham	12,492	12,183	14,485	-2.5	18.9
Roanoke Rapids	Halifax	14,702	15,722	16,957	6.9	7.9
Roxboro •	Person	7,532	7,332	8,696	-2.7	18.6
Rural Hall •	Forsyth	1,336	1,652	2,464	23.7	49.2
Scotland Neck •	Halifax	2,834	2,575	2,362	-9.1	-8.3
Stokesdale •	Guilford	1,973	2,134	3,297	8.2	54.5
Walkertown •	Forsyth	1,321	1,200	4,009	-9.2	234.1
Williamston	Martin	6,159	5,503	5,843	-10.7	6.2
Windsor	Bertie	2,126	2,209	2,283	3.9	3.3
Yanceyville	Caswell	1,869	1,973	2,091	5.6	6.0

• - 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.

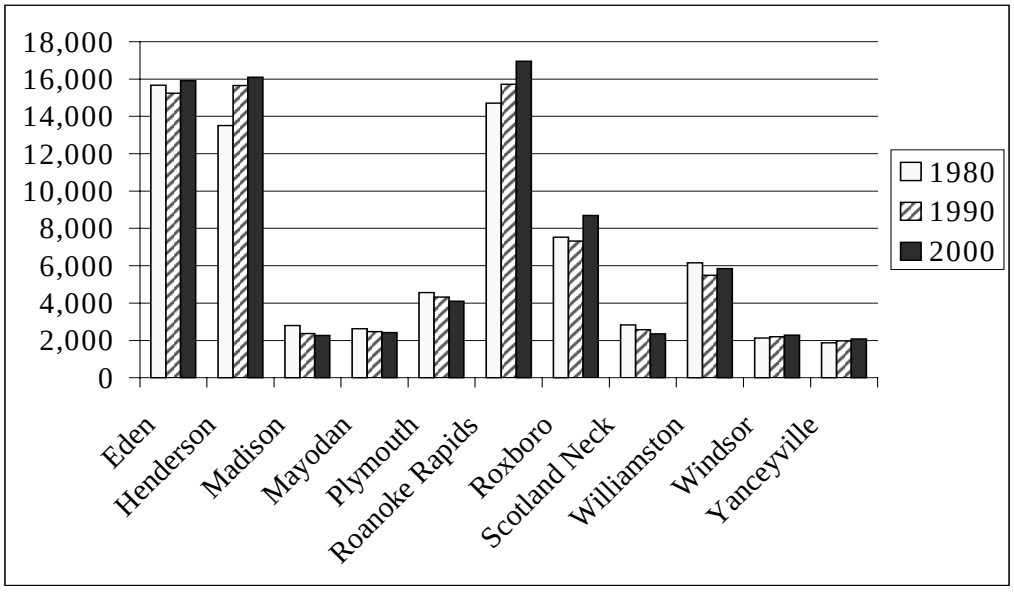


Figure A-11 Population Data for Selected Municipalities in the North Carolina Portion of the Roanoke River Basin

Table A-11 shows the projected percent change in growth between 1990 and 2020 for counties within the basin. Since river basin boundaries do not coincide with county boundaries, these numbers are not directly applicable to the Roanoke River basin. They are instead presented as an estimate of possible countywide population changes.

Table A-11 Past, Projected and Change in Population (2000 to 2020) by County as of March 2001 (Source: Office of State Planning, 2001)

County	2000	Estimated Population 2020	Estimated Population Change 2000-2020
Bertie	13,841	13,218	-623
Caswell	21,151	21,444	293
Forsyth	64,274	71,939	7,665
Granville	16,004	18,303	2,299
Halifax	22,948	21,450	-1,498
Martin	19,195	18,547	-648
Northampton	7,730	6,761	-969
Orange *	2,365	2,956	591
Person	21,374	23,149	1,775
Rockingham	74,462	75,411	949
Stokes	38,004	48,378	10,374
Surry *	2,137	2,316	179
Vance	22,336	24,138	1,802
Warren	7,589	7,312	-277
Washington	1,784	1,400	-384
Subtotal	335,194	356,722	21,528

* Less than 5% of the county is in this basin.

Note: Values have been adjusted based on the percent of county (>2%) located in the Roanoke River basin (Table A-3).

2.6 Natural Resources

2.6.1 Public Lands in the Roanoke River Basin

Figure A-12 shows public lands and significant natural heritage areas in the Roanoke River basin. Hanging Rock State Park is situated among the Sauratown Mountains, an isolated group of low elevation mountains. The most prominent feature of the park is its series of steep, quartzite-capped ridges dissected by Cascade and Indian Creeks. Three rare caddisflies (aquatic insects indicative of good water quality) are found in Cascade Creek within the park. Several rare fish species, some of which are found nowhere else in North Carolina, have been observed in a section of the Dan River which flows through the park. Refer to Part 2.6.4 for a listing of rare species.

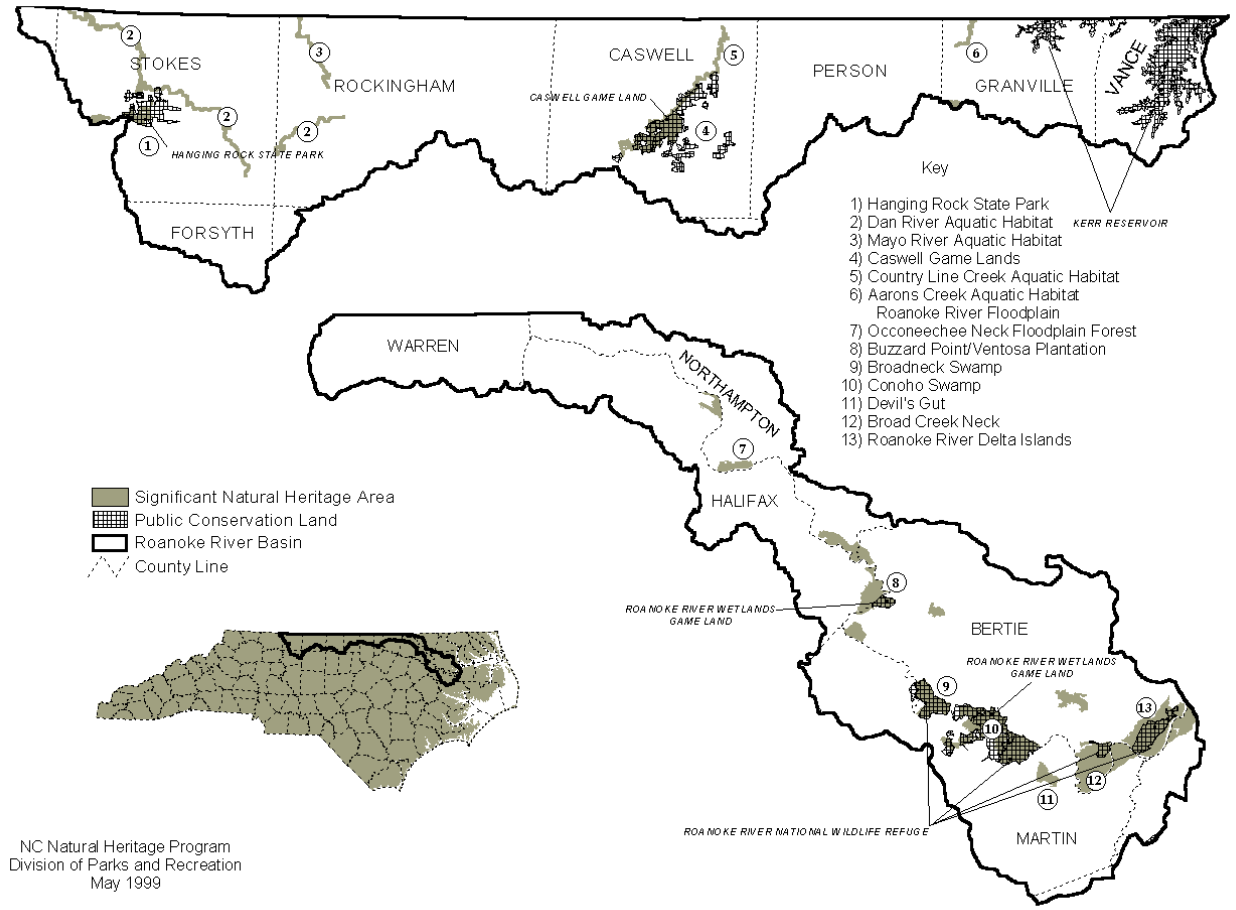


Figure A-12 Public Lands and Significant Natural Heritage Areas of the Roanoke River Basin

The Caswell Game Land protects much of one of the most extensive and high quality tracts of mature piedmont second-growth upland hardwood forest in the state. Country Line Creek flows through part of the game lands.

In the eastern portion of the basin, the Roanoke River floodplain contains the largest intact and least disturbed bottomland hardwood and cypress-tupelo ecosystems on the Atlantic Coast of North America. In 1990, the US Fish and Wildlife Service and the NC Wildlife Resources Commission began acquiring property within the floodplain. Together, the Roanoke River National Wildlife Refuge and the Roanoke River Wetlands Game Land now protect over 28,000 acres. In addition, The Nature Conservancy, a nonprofit conservation group, has a cooperative agreement to manage and protect about 21,000 acres of land, owned by Georgia-Pacific, within the floodplain. Refer to the following sections for more information regarding the extent of its ecological significance.

2.6.2 Ecological Significance of the Roanoke River Basin

Several important aquatic habitats are located in the Roanoke River basin. The section of the Dan River in Rockingham County (mentioned above) harbors several rare fish species, primarily the riverweed darter, bigeye jumprock and Roanoke hog sucker. The Mayo River, a south-flowing river tributary of the Dan River, is home to some of these same rare fish. A section of Aarons Creek in Granville County supports rare freshwater mussels including the Atlantic Pigtoe and Brook Floater; and Country Line Creek, in Caswell County, also contains an assemblage of rare mussel species, in addition to the riverweed darter.

Wetlands

Wetlands are transitional areas between land and water, such as swamps and marshes. Some are connected to streams; and others, such as low lying pine plantations and pocosins, are not. Wetlands provide a variety of benefits to society and are very important in watershed planning because of the functions they perform. Wetlands provide retention of flood waters to protect property values; streambank stabilization to prevent erosion and downstream sedimentation; water purification and pollutant removal (especially for nitrogen and phosphorus); habitat for aquatic life, and wildlife and endangered species protection. These values vary greatly with wetland type. Wetlands adjacent to intermittent and permanent streams are most important to protecting water quality in those streams, as well as downstream lakes and estuaries. However, wetlands located landward or away from streams also have important water storage capacity and pollutant removal potential.

Over the years, approximately half of North Carolina's wetlands have been lost to development, farming and forestry practices. Wetlands now only cover about 25 percent of the state's land area. The lower Roanoke River floodplain contains perhaps some of the best remaining forested wetland communities known to exist in the southeastern United States. The floodplain extends about 130 miles along the lower Roanoke River and varies in width from three to five miles. Surveys have documented 214 species of birds in the floodplain, including 88 resident breeding species (55 resident and 33 neotropical). This is the highest density of nesting birds anywhere in the state. Fourteen species of migratory waterfowl also use the wetlands in winter. Wildlife

officials have estimated as many as 2,500 nesting pairs of waterbirds on Conine Island near Williamston (NCWRC, November 1999).

Fisheries

The Roanoke River from the Roanoke Rapids dam downstream to the Albemarle Sound serves as an important spawning and nursery area for several species of anadromous fish. Anadromous fish are those that spend most of their adult lives in the ocean but migrate upstream into fresh waters to spawn. Each of these species has specific flow and water quality requirements necessary for successful spawning. In the Roanoke River, anadromous fish include striped bass, American shad, hickory shad, blueback herring and alewife. The upper portions of the Roanoke River also historically functioned as a spawning area for Atlantic sturgeon (a state and federally listed species of special concern) and possibly shortnose sturgeon (a federally listed endangered species). Juvenile Atlantic sturgeon have recently been collected in the western Albemarle Sound. Although these fish have not yet been collected from the Roanoke River, biologists suspect that the river provides the spawning and nursery area for these fish.

Anadromous fishes in the Roanoke River basin form the basis for recreational and commercial fisheries that are important on a local, state and coast-wide basis. Because these fishes are migratory and move across state jurisdictional lines, they are also regulated by federal agencies including the US Fish and Wildlife Service, the National Marine Fisheries Service, and the Atlantic States Marine Fisheries Commission. Fishery Management Plans for anadromous fish implemented by these entities require that states develop and implement measures to protect critical spawning and nursery area habitats.

To address the critical nature of maintaining flow and water quality for anadromous fishes in the upper reaches of Roanoke River, the NC Wildlife Resources Commission (NCWRC) has designated the portion of Roanoke River from the Roanoke Rapids dam downstream to the US Highway 258 bridge as an Inland Primary Nursery Area (15A NCAC 10C .0500). The Fisheries Reform Act of 1997 requires that the Marine Fisheries Commission, the Environmental Management Commission and the Coastal Resources Commission prepare comprehensive management plans for critical fisheries habitats. The Roanoke River plan will be developed within the next five-year basinwide planning cycle. In the interim, the Marine Fisheries Commission is considering designation of that portion of Roanoke River downstream of the US Highway 258 bridge as an Anadromous Fish Spawning and Nursery Area, pursuant to the Commission's statutory authority.

The Roanoke River also supports significant recreational and subsistence fisheries for resident fish species. Largemouth bass are sought by tournament anglers who travel to the Roanoke River from across the state and from other states. Largemouth bass thrive in the river as a result of the abundance of juvenile shad and herring. Tournament fishing on the Roanoke River occurs nearly every weekend, boosting local economies. The Roanoke River is also very popular for its bluegill, redear sunfish, crappie, white perch, yellow perch and catfish angling. Most anglers seeking these species eat their catch, and many residents of counties adjacent to the Roanoke River regularly supplement their diets with fish caught from it.

2.6.3 Rare Aquatic and Wetland-Dwelling Animal Species

Table A-12 Rare and Threatened Aquatic Species in the Roanoke River Basin (NC Natural Heritage Program, Division of Parks and Recreation, June 2000)

Major Taxon	Common Name	Scientific Name	State Status
fish	Orangefin madtom	*Noturus gilberti*	E
fish	Cutlips minnow	*Exoglossum maxillingua*	E
fish	Rustyside sucker	*Thoburnia hamiltoni*	E
fish	Riverweed darter	*Etheostoma podostemone*	SC
fish	Bigeye jumprock	*Scartomyzon ariommus*	SC
fish	Roanoke hog sucker	*Hypentelium roanokense*	SR
fish	Carolina darter	*Etheostoma collis*	SC
aq insect	Caddisfly	*Diplectrona metaqui*	SR
aq insect	Caddisfly	*Psilotreta labida*	SR
aq insect	Caddisfly	*Psilotreta frontalis*	SR
aq insect	Caddisfly	*Diplectrona metaqui*	SR
aq insect	Caddisfly	*Micrasema sprulesi*	SR
aq insect	Caddisfly	*Ceraclea mentiea*	SR
aq insect	Mayfly	*Ephemerella berneri*	SR
mollusk	Green Floater	*Lasmigona subviridis*	E
mollusk	James spinymussel	*Pleurobema collina*	E
mollusk	Atlantic pigtoe	*Fusconaia masoni*	T
mollusk	Squawfoot	*Strophitus undulatus*	T
mollusk	Notched rainbow	*Villosa constricta*	SR
mollusk	Brook floater	*Alasmidonta varicosa*	T
salamander	Mole salamander	*Ambystoma talpoideum*	SC

Rare Species Listing Criteria

E = Endangered (those species in danger of becoming extinct)
T = Threatened (considered likely to become endangered within the foreseeable future)
SR = Significantly Rare (those whose numbers are small and whose populations need monitoring)
SC = Species of Special Concern

2.6.4 Significant Natural Heritage Areas in the Roanoke River Basin

Occoneechee Neck Floodplain Forest

The privately-owned Occoneechee Neck Floodplain Forest contains some of the best remaining examples of mature floodplain forest along the upper Roanoke River valley. This area also contains several large beaver ponds, some of the oldest in the Roanoke floodplain and excellent examples of this community type.

Buzzard Point/Ventosa Plantation

Partly within the Roanoke River Wetland Game Land, the Buzzard Point/Ventosa Plantation is a large expanse of river floodplain with some of the best examples of typical bottomland and

swamp communities in the Roanoke system. Characteristics include levee forests, backswamps, alluvial flats, sloughs, low and high ridges, and beaver ponds.

Broadneck Swamp

Part of the Roanoke River National Wildlife Refuge, Broadneck Swamp contains one of the best mature natural levee forest communities in the Roanoke floodplain. A rare population of Virginia bluebells has been observed on the levees. Additionally, the area contains the largest swamp forest in the upper and middle portions of the floodplain of the Roanoke River. Bald cypress and water tupelo dominate the backwater swamp canopy and are associated with an understory of Carolina water ash. The swamp supports the second largest inland heron rookery in North Carolina and provides important nesting and wintering habitat for ducks.

Conoho Neck Swamp

Conoho Neck Swamp is located along the lower reaches of Conoho Creek, within the floodplain of the Roanoke River, and is protected as part of the Roanoke River Wetland Game Land. It is a classic example of a "backswamp", a swamp formed by the natural levees along the main channel of the river, which act as berms or dams, impeding drainage and holding water in during the winter and spring months. The deeply flooded cypress-gum swamp forest is the dominant natural community on this site and is influenced by both the blackwater Conoho Creek and brownwater Roanoke River. Also found here is a fine example of a "yazoo" tributary, formed when a tributary is deflected by the levee bordering the river and is forced to run parallel to the mainstem of the river for some distance.

Devil's Gut

Located in the lower floodplain of the Roanoke River, Devil's Gut contains diverse alluvial features such as filled river channels, point bars and natural levees. Long, narrow sand or loamy ridges with levee forests of laurel oak, swamp chestnut oak, willow oak and water oak alternate with parallel bands of bald cypress-water tupelo sloughs form a ridge and swale topography. An old growth (up to 160-year-old trees) loblolly pine/American beech community, located on higher slopes in the southeastern section of this site, supports the only known stand of American beech in the North Carolina Coastal Plain.

Broad Creek Neck

Broad Creek Neck contains the largest expanse of contiguous cypress-water tupelo swamp forest in the Roanoke River floodplain and probably in North Carolina. It also supports extensive river frontage and several distributary streams, cypress-gum flats and tidally-influenced blackwater stream/bayou communities. A portion of the natural area is within the Roanoke River National Wildlife Refuge.

Roanoke River Delta Islands

This community consists of a series of islands and distributary channels at the mount of the Roanoke River. An extensive tract of mature bald cypress/water/tupelo/Carolina water ash swamp forest is second in size only to the nearby Broad Creek Neck. It supports a high density of wildlife, including black bear, waterfowl and nesting neo-tropical songbirds. It also protects important aquatic habitat for a diversity of fish. Much of the natural area is within the Roanoke River National Wildlife Refuge.

Roquist Pocosin

A large example of a rare non-riverine wetland in the Roanoke River basin is the privately-owned Roquist Pocosin. The canopy contains trees averaging 17 inches in diameter, with trees 24-30 inches in diameter common. The forest is dominated by swamp black gum and red maple with abundant remnant cypress. On the north side is a small but excellent quality non-riverine, wet hardwood forest.

2.7 Permitted Wastewater and Stormwater Discharge Facilities

The primary pollutants associated with point source discharges are:

* oxygen-consuming wastes,
* nutrients,
* 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 which serve populations greater than 100,000 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.

2.7.1 Wastewater Discharges in the Roanoke River Basin

Currently, there are 88 permitted wastewater discharges in the Roanoke River basin. Table A-13 provides summary information (by type and subbasin) about the discharges. Various types of dischargers listed in the table are described in the inset box. A list of all facilities can be found in Appendix I.

Table A-13 Summary of NPDES Dischargers and Permitted Flows

	Roanoke River Subbasin										
Facility Categories	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**TOTAL**
Total Facilities	23	9	18	3	7	4	0	11	9	4	88
Total Permitted Flow (MGD)	1.3	4.1	19.8	0.5	26.03	4.2	0.0	41.7	87.5	1.3	186.3
Major Discharges	1	1	4	0	3	1	0	4	3	1	18
Total Permitted Flow (MGD)	0.0	3.0	19.2	0.0	26.02	4.1	0.0	40.5	86.0	1.15	180.05
Minor Discharges	22	8	14	3	4	3	0	7	6	3	70
Total Permitted Flow (MGD)	1.3	1.1	0.6	0.5	0.01	0.01	0.0	1.2	1.5	0.15	6.3
100% Domestic Waste	18	4	9	1	2	2	0	5	3	2	46
Total Permitted Flow (MGD)	1.3	0.8	0.08	0.02	0.01	0.01	0.0	0.4	2.2	1.3	6.1
Municipal Facilities	2	3	2	1	1	1	0	4	4	2	20
Total Permitted Flow (MGD)	0.6	4.02	14.0	0.5	5.0	4.1	0.0	9.8	3.03	1.3	42.3
Nonmunicipal Facilities	21	6	16	2	6	3	0	7	5	2	68
Total Permitted Flow (MGD)	0.7	0.07	5.8	0.03	21.03	0.01	0.0	31.9	84.5	0.0	144.06

The majority of NPDES permitted discharges in the Roanoke River basin are from wastewater treatment plants serving communities and schools. Many of them are small facilities with less than one million gallons of flow per day. However, there are a few larger discharges in the basin as well. Facilities, large or small, where recent data show problems with a discharge are listed and discussed in each subbasin chapter in Section B.

Figure A-13 shows the location of major and minor permitted wastewater discharges within the basin. The number of sites on the map depicting major discharges differs from the number of major facilities listed in Table A-13. Since some major facilities have more than one outfall point, each outfall received a symbol on the map.

Types of Wastewater Discharges:

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: Facilities serving municipalities. Can treat waste from homes and industries.

Industrial Facilities: Facilities with wastewater from industrial processes such as textiles, mining, seafood processing, glass-making and power generation.

Other Facilities: This category includes a variety of facilities such as schools, nursing homes, groundwater remediation projects, water treatment plants and non-process industrial wastewater.

2.7.2 Stormwater Discharges in the Roanoke River Basin

EPA Stormwater Rules

Phase I – December 1990

- Requires a NPDES permit for municipal separate storm sewer systems (MS4s) serving populations of 100,000 or more.
- Requires a NPDES stormwater permit for ten categories of industry.
- Requires a NPDES stormwater permit for construction sites that are 5 acres or more.

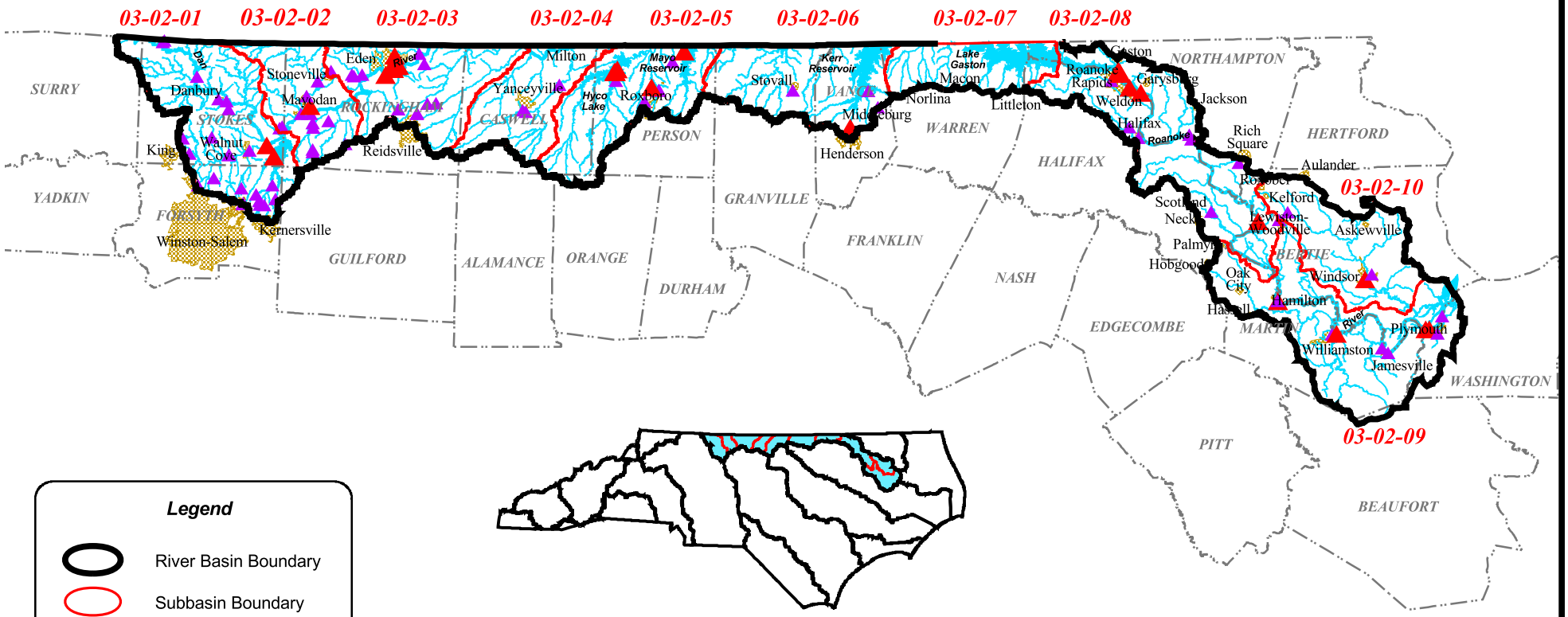
Phase II – December 1999

- Requires a NPDES permit for some municipal storm sewer systems serving populations under 100,000, located in urbanized areas.
- Provides a "no stormwater exposure" exemption to industrial facilities covered under Phase I.
- Requires a NPDES stormwater permit for construction sites that are 1-5 acres.

Amendments were made to the Clean Water Act in 1990 and most recently in 1999 pertaining to permit requirements for stormwater discharges associated with industrial activities and municipal separate storm sewer systems (MS4s). DWQ administers these regulations in North Carolina through the state's NPDES stormwater program. The goal of the DWQ stormwater discharge permitting regulations is to prevent pollution via stormwater runoff by controlling the source(s) of pollutants.

The municipal permitting requirements are designed to lead into the formation of comprehensive stormwater management programs for municipal areas. No municipalities in the Roanoke River basin were required to obtain a NPDES permit for stormwater sewer systems under the Phase I rules (population >100,000). Additionally, no municipalities in the basin are automatically required (US Census designated Urban Areas) to obtain a NPDES stormwater permit under the Phase II rules. However, Eden, Reidsville, Henderson and Roanoke Rapids will be considered for inclusion under the Phase II rules because of a population greater than 10,000 and/or a

Figure A-13 Map of NPDES Discharges in the Roanoke River Basin in North Carolina



Planning Branch
Basinwide & Estuary Planning Unit
May 4, 2001

population density greater than 1000 persons per square mile. DWQ is currently developing criteria that will be used to determine whether these and other municipalities should be required to obtain a NPDES permit.

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. Stormwater permits are granted in the form of general permits (which cover a wide variety of more common activities) or individual permits. Excluding construction stormwater general permits, there are 132 general stormwater permits and 9 individual permits active within the Roanoke River basin. Individual permit holders are presented in Appendix I.

The primary concern with runoff from industrial facilities is the contamination of stormwater from contact with exposed materials. Poor housekeeping can lead to significant contributions of sediment and other water quality pollutants. To address these issues, each NPDES stormwater permitted facility must develop a Stormwater Pollution Prevention Plan (SPPP) that addresses the facility's potential impacts on water quality. Facilities identified as having significant potential to impact water quality may also be required to conduct analytical monitoring to characterize pollutants in stormwater discharges.

The state stormwater management rules (15A NCAC 2H .1000) regulate development activities in 20 coastal counties and on lands statewide that drain to Outstanding Resource Waters (ORW) and/or High Quality Waters (HQW). Under this program, development is permitted as either low density or high density. Low density limits the impervious, or built upon, area on a project and allows natural infiltration and attenuation of stormwater runoff. High density requires installation and maintenance of structural best management practices to control and treat stormwater runoff from the site. Surface waters in the Roanoke River basin where development activities are regulated under these special rules are presented on Figures A-14 and A-15 (Part 3.2).

2.8 Animal Operations

In 1992, the Environmental Management Commission 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. Within the past five years there have been several additional pieces of legislation enacted that affect animal operations in North Carolina (see text box).

Key Animal Operation Legislation (1995-1999)

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. DENR was required to develop and adopt economically feasible odor control standards by 3/1/99.

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 DENR to develop an inventory of inactive lagoons, and 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.

Table A-14 summarizes, by subbasin, the number of registered livestock operations, total number of animals, total acres in operation, and total steady state live weight as of January 2000. These numbers reflect only operations required by law to be registered, and therefore, do not represent the total number of animals in each subbasin.

The largest subbasin, 03-07-08, contains the largest number of registered animal operations with four cattle operations, one poultry operation and fourteen swine operations. Overall the majority of registered animal operations are found in the lower portion of the basin. Registered animal operations where recent data show problems are discussed in the appropriate subbasin chapter in Section B.

Steady State Live Weight (SSLW) is the result, in pounds, after a conversion factor has been applied to the number (head count) of swine, cattle or poultry on a farm. The conversion factors, which come from the US Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) guidelines, vary depending on the type of animals on the farm and the type of operation (for example, there are five types of hog farms). Since the amount of waste produced varies by hog size, SSLW is the best way to compare the sizes of the farms.

Table A-14 Registered Animal Operations in the Roanoke River Basin (January, 2000)

Subbasin	Cattle			Poultry			Swine		
	No. of Facilities	No. of Animals	Total Steady State Live Weight	No. of Facilities	No. of Animals	Total Steady State Live Weight	No. of Facilities	No. of Animals	Total Steady State Live Weight
03-02-01	2	365	511,000	--	--	--	1	3,200	417,600
03-02-02	--	--	--	--	--	--	1	4,000	522,000
03-02-03	--	--	--	--	--	--	1	1,800	243,000
03-02-04	2	325	455,000	--	--	--	2	7,325	1,190,680
03-02-05	2	240	336,000	--	--	--	4	5,000	708,500
03-02-06	--	--	--	--	--	--	2	13,756	1,940,810
03-02-07	3	700	980,000	--	--	--	3	13,875	2,002,750
03-02-08	4	1,205	1,192,000	1	60,000	240,000	14	55,935	7,075,415
03-02-09	--	--	--	--	--	--	6	16,363	2,252,480
03-06-10	--	--	--	--	--	--	2	13,150	2,277,580
TOTALS	**13**	**2,835**	**3,474,000**	**1**	**60,000**	**240,000**	**36**	**134,404**	**18,630,815**

Information on animal capacity by subbasin (Table A-15) was provided by the USDA. Two percent of the state's total capacity for swine and poultry is found in the Roanoke River basin; however, the basin contains three percent of the state capacity for dairy, with the highest concentrations located in subbasins 03-02-07 and 03-02-01. Overall, swine and poultry production in the basin increased over the past five years by 48 and 9 percent, respectively, while dairy production decreased 18 percent.

Table A-15 Estimated Populations of Swine, Dairy and Poultry in the Roanoke River Basin (1998 and 1994)

Subbasin	Total Swine Capacity		Swine Change	Total Dairy Capacity		Dairy Change	Poultry Capacity		Poultry Change
	1998	1994	94-98 (%)	1998	1994	94-98 (%)	1998	1994	94-98 (%)
03-02-01	411	957	-57	731	901	-19	43,750	23,650	85
03-02-02	1,710	9	100+	119	119	0	71,000	0	100+
03-02-03	3,892	3,742	4	136	323	-58	22,415	280	100+
03-02-04	1,564	1,579	-1	265	581	-54	25,400	0	100+
03-02-05	4,183	4,482	-7	130	130	0	76,200	0	100+
03-02-06	448	1,485	-70	453	621	-27	38,000	48,000	-21
03-02-07	11,281	13,876	-19	845	630	34	418,861	431,200	-3
03-02-08	78,909	42,003	88	230	230	0	381,500	316,500	21
03-02-09	33,441	27,320	22	0	0	0	1,348,800	1,056,200	28
03-02-10	16,970	7,627	100+	0	0	0	2,839,500	2,945,500	-4
TOTALS	152,809	103,080	48	2,909	3,535	-18	5,265,426	4,821,330	9
% of State Total	2%	2%		3%	3%		2%	3%	

2.9 Water Quantity Issues

2.9.1 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.

Surface water is used to meet the majority of overall water needs in the North Carolina portion of the Roanoke River basin (approximately 56 percent of estimated total water use). In 1997, 43 public water systems used water from the basin providing 30.7 million gallons of water per day to 114,000 people in the basin. Water demand from these public systems is projected to increase 55 percent by 2020. Seven of the 43 systems (1.8 percent) reported that available supply was not adequate to meet estimated demand through 2020, and seventeen other systems (40 percent) report that by 2020 demand levels will exceed 80 percent of available supply.

In addition, water supply systems in other river basins are looking toward the Roanoke River basin for a water source. In 1995, the City of Virginia Beach, Virginia obtained the right to withdraw up to 60 million gallons of water per day from Lake Gaston. In 1998, following a very involved and contested Federal Energy Regulatory Commission (FERC) approval process, water withdrawal began. Urban areas within North Carolina have also discussed obtaining a permit to withdraw water from the Roanoke River basin.

Not everyone gets water from public water supply systems. Many households and some commercial and industrial operations supply their own water from both surface and groundwater sources in the basin. The US Geological Survey estimates that self-supplied users, excluding power-generating facilities, account for 58 percent of the total water used in the Roanoke River basin. Water used for industrial and irrigation purposes comprises the majority of self-supplied water use in the basin (Figure A-14).

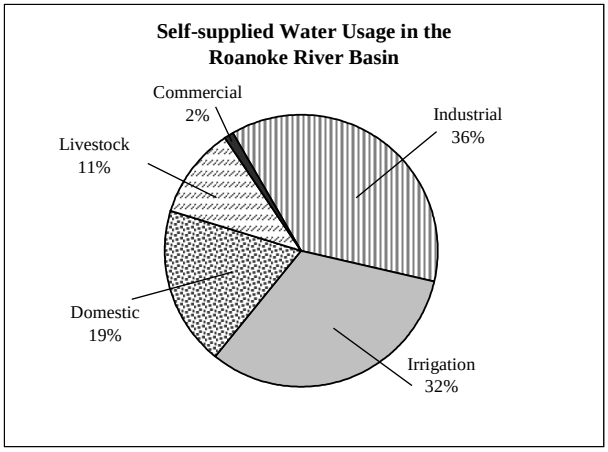


Figure A-14 Estimated Self-Supplied Water Use in the Roanoke River Basin (USGS)

The State Water Supply Plan is a compilation of over 500 LWSPs developed by local government water systems in North Carolina. More detailed information is available in the plan about water supply and water usage in the Roanoke River basin. This draft plan is available online at the Division of Water Resources website at http://www.dwr.ehnr.state.nc.us or by calling (919) 733-4064.

2.9.2 Water Withdrawals

Prior to 1999, North Carolina required water users to register their water withdrawals with the Division of Water Resources (DWR) only if the amount was 1,000,000 gallons or more of surface or ground water per day. In 1999, the registration threshold for all water users except agriculture was lowered to 100,000 gallons per day. Table A-16 presents registered withdrawals.

Table A-16 Registered Water Withdrawals in the Roanoke River Basin (August 2000)

County	1999 Average (MGD)	1999 Maximum (MGD)	Source of Withdrawal	Facility
Stokes Rockingham	1170	1459	Belews Lake	Duke Power Company
Stokes	0.0011	0.0241	Roanoke River	RJ Reynolds Tobacco Company
Stokes	0.036	0.054	Roanoke River	RJ Reynolds Tobacco Company
Rockingham	216.9	279.9	Dan River	Duke Power Company
Rockingham	Inactive	Inactive	Pit	Vulcan Materials Company
Caswell	0.008	0.016	Pit	Vulcan Materials Company
Person	1060	1102	Hyco Reservoir	Carolina Power & Light Company
Person	5.138	7.551	Mayo Reservoir	Carolina Power & Light Company
Vance	0.028	0.04	Pit	Vulcan Materials Company
Halifax	26.13	34.52	Roanoke River	Champion International Corporation
Halifax	1.8	3.6	Roanoke River	NC Dept. of Corrections, Caledonia Prison
Northampton	0.02	0.48	Groundwater	Henry B. Long, Inc.
Northampton	--	3.89	Pond	William R. Johnston
Bertie	1	1.872	Cashie River	H & H Farms
Bertie	4.6	5	Roanoke River	Ward Farms
Bertie	1.512	1.512	Cashie River	Ted Winslow
Bertie	5.56	8.3	Roanoke River	Gillam Farming, Inc./Gillam Outlaw Farms
Bertie	1.388	1.388	Cashie River	Hyman Ferry Farms, Inc. and Ted Winslow
Bertie	--	2.16	Groundwater and pond	Brinkley Farms, Inc.
Bertie	--	0.9	Pond	Brinkley Farms, Inc.
Bertie	2.46	3.59	Groundwater	Perdue Farms, Inc.
Martin	2.2	2.4	Roanoke River	C. Wesley Copeland, Jr.
Martin	2.5	2.5	Roanoke River	Fate B. Everett, Jr.
Martin	65.2	79.1	Roanoke River & Warren Neck Creek	Weyerhaeuser Plymouth Plant
Martin	1.00	6.22	Groundwater	Weyerhaeuser Plymouth Plant
Martin	--	0.144	Groundwater	Woodridge Timber, Inc.

There are 26 registered water withdrawals in the North Carolina portion of the Roanoke River basin. Sixteen of these (62 percent) are surface water withdrawals. Excluding public water systems or power generating facilities, there is a cumulative permitted capacity to withdraw 147.8 million gallons of surface water per day.

Consumption of water from the Roanoke River basin through direct withdrawals, along with interbasin transfers (discussed in the following section) and floodplain exchange (discussed in Chapter 4), has the potential to affect the salinity of the lower Roanoke River. Consideration of the cumulative effects of saltwater intrusion on the lower Roanoke River should be considered when additional water withdrawals are proposed.

2.9.3 Interbasin Transfers

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. In addition, persons wishing to transfer two million gallons per day (MGD) or more, or increase an existing transfer by 25 percent or more, 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. 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 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 supporting documentation for a transfer petition.

Currently, there are no certified interbasin transfers in the Roanoke River basin. However, Kerr Lake Regional Water System (KLRWS) was allowed to continue transferring up to 10 MGD out of the Roanoke River basin under the new law without having to undergo the certification process. The system only currently transfers about 5.5 MGD into the Tar-Pamlico River basin. KLRWS has indicated that it will exceed its 10 MGD capacity before 2010 and will be required to obtain a certificate in order to increase the transfer amount. The Town of Henderson, which is a partner in KLRWS, has contracted to sell a maximum of 3 MGD to Franklin. This transaction will be a transfer from the Roanoke River basin into the Tar-Pamlico River basin.

Table A-17 lists eight known potential transfers involving the North Carolina portion of the Roanoke River basin (not required to be certified). Approximately 3.41 MGD is transferred out of the basin and a relatively small unknown quantity is transferred into the basin for an estimated net loss of water. Please note that all local water systems are now required to report existing and anticipated interbasin transfers as part of the Local Water Supply Planning process. This information will be available for future updates of this basinwide plan and will allow for a better assessment of cumulative impacts.

Table A-17 Interbasin Transfers in the Roanoke River Basin (1997)

Supplying System	Receiving System	Source Subbasin	Receiving Subbasin	Estimated Transfer (MGD)
Kerr Lake Regional WS	Henderson	Roanoke	Tar-Pamlico	0.06
Kerr Lake Regional WS	Oxford	Roanoke	Tar-Pamlico	2.0
Kerr Lake Regional WS	Warren County	Roanoke	Tar-Pamlico	1.3
Henderson	Franklin	Roanoke	Tar-Pamlico	3.0 (proposed)
Roanoke Rapids	Northampton-Gaston	Roanoke	Chowan	0.05
Roxboro	Roxboro	Roanoke	Tar-Pamlico	Unknown
Winston-Salem	Winston-Salem	Yadkin-Pee Dee	Roanoke	Unknown
Reidsville	Reidsville	Cape Fear	Roanoke	Unknown
King	King	Yadkin-Pee Dee	Roanoke	Unknown

The most significant interbasin transfer in the Roanoke River basin is not reflected in Table A-17 because it takes place primarily in the State of Virginia. In 1995, the City of Virginia Beach obtained the right to withdraw up to 60 MGD from Lake Gaston. Between January 1998 and April 2000, withdrawals ranged from 44.8 MGD to 0.6 MGD. The average withdrawal during 1999 was 17 MGD.

2.9.4 Minimum Streamflow

One of the purposes of the Dam Safety Law is to ensure maintenance of minimum streamflows below dams. 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. The Division of Water Resources, in conjunction with the Wildlife Resources Commission, recommends conditions relating to release of flows to satisfy minimum instream flow requirements. The permits are issued by the Division of Land Resources. Table A-18 summarizes minimum flow requirements in the Roanoke River basin.

Table A-18 Minimum Streamflow Projects in the Roanoke River Basin

Name	Location	Waterbody	Drainage Area (sq. mi.)	Min. Release (cu.ft/sec)
Dams associated with Power Production				
Roanoke Rapids Dam	Near the NC/VA state line at Roanoke Rapids, NC	Roanoke River	8,371	1000-2000[1]
Hyco Reservoir Afterbay	Near the NC/VA state line north of Roxboro, NC	Hyco River	202	10[2]
Pinnacles Dam	Near Meadow of Dan, VA	Dan River	32.9	30 or inflow[3]
Avalon Dam*	1.5 miles NE of the Town of Mayodan, NC	Mayo River	310	79 or inflow[3]
Mayo Dam*	At the Town of Mayodan, NC	Mayo River	312	85 or inflow[3]
Other Impoundments				
Fullers Creek Reservoir	Near the Town of Yanceyville in NC	Fullers Creek	1.71	0.3

* Project is not yet complete.

Notes

[1] Roanoke Rapids and Gaston are operated in coordination with peak flow releases from Kerr Reservoir upstream. The minimum flow requirements are at times not sufficient for successful spawning of striped bass; therefore, flow regimes vary between April 1 and June 15 (Table A-19).

[2] Under severe hydrologic conditions (water level below 375 feet), minimum flow requirement drops to 2 cfs.

[3] If inflow is less than the specified minimum release, the release must be equal to the inflow. In other words, the project must operate in a run-of-river mode (i.e., instantaneous inflow equals instantaneous outflow) until the inflow becomes greater than the specified minimum release.

Flow Augmentation to Support Fish Communities

Striped bass, American shad, hickory shad and other anadromous fish migrate up the Roanoke River each spring to spawn. These species support recreational and commercial fisheries that are economically important on a local, statewide and an Atlantic coast-wide basis (refer to Part 2.6.2 of this section for more information). These migratory species need flowing water to create suitable habitat for successful spawning and/or to keep their eggs suspended. The minimum flow requirements shown in Table A-18 are insufficient for these species to successfully reproduce. An agreement, entered into by Dominion (formerly North Carolina Power), the US Army Corps of Engineers and the NC Wildlife Resources Commission (WRC), establishes a plan for the springtime storage of water in John H. Kerr Reservoir and flow releases through Lake Gaston and Roanoke Rapids Lake.

The original agreement between these three parties was signed in 1971, but it only addressed minimum flows during the spawning season. In 1987, a multiagency team known as the Roanoke River Water Flow Committee analyzed flow data for the river and recommended the current flow regime (Table A-19) (Manooch, 1989; Rulifson, 1991). The rationale for the recommended flows was to provide flow conditions that would mimic pre-impoundment flows.

Table A-19 Flow Augmentation Regime

Dates	Target Average Daily Flow (cfs)	Lower Limit (cfs)	Upper Limit (cfs)
April 1-15	8,500	6,600	13,700
April 16-30	7,800	5,800	11,000
May 1-15	6,500	4,700	9,500
May 16-31	5,900	4,400	9,500
June 1-15	5,300	4,000	9,500

In 1989, the WRC requested an amendment of the flow agreement based upon the recommendations of the Flow Committee. As part of this amendment, Dominion agreed to cease hydropower peaking operations during the spawning period. Since implementation, striped bass have successfully reproduced to the extent that the population has been declared "recovered" by federal regulatory agencies. Hickory shad populations have increased beyond historical levels as well. Because state and federal resource agencies believe that flow management has been critical to the viability of these fish populations, the three-party agreement was extended indefinitely in 2001.

Hydroelectric Project Relicensing

The license issued by the Federal Energy Regulatory Commission (FERC) to Dominion (formerly North Carolina Power) for the operation of the Roanoke Rapids and Gaston Hydropower Project expired on January 31, 2001. The relicensing process began in early 1995 and includes an assessment of how current and future project operations will affect environmental resources in the Roanoke River basin. Several studies related to instream flow and water quality are at various stages of completion. Three technical work groups, including a water quality subcommittee, are analyzing the results of these studies. Refer to Chapter 4, Part 4.6.2 for further information.

The Pinnacles Hydro-Electric Project is also undergoing relicensing at this time. It is owned by the City of Danville, but is located on the headwaters of the Dan River near Meadow of Dan, Virginia. The project consists of two impoundments: Talbott and Townes Reservoirs. Talbott is used as storage and supplies water to Townes downstream. From Townes Reservoir, water bypasses a stretch of the Dan River channel to the powerhouse where water is returned to the river. Changes in the flow regimes or general operation of this project have the potential to impact water quality in the North Carolina portion of the Dan River.

2.10 Physical Impacts to Wetlands and Streams

DWQ has issued approvals for wetland filling activities since the mid-1980s; however, in 1989, the Environmental Management Commission directed DWQ to begin reviewing wetland fill and stream alteration activities using a review sequence of (1) avoidance, (2) minimization and (3) mitigation of wetland impacts. Rules finalized in 1996, required that wetland values, such as

whether or not the wetland is providing significant uses or whether the filling activity would remove or degrade those uses, be considered. The rules also specify wetland and stream mitigation ratios and type and location of projects to make the mitigation process more predictable and manageable for the regulated community. DWQ's emphasis continues to be on water quality and the essential role that wetlands play in maintaining water quality. The issuance of a 401 Water Quality Certification by DWQ is required before the US Army Corps of Engineers can issue a Section 404 Permit authorizing the fill or alteration of wetlands and/or streams in North Carolina.

Despite efforts to protect and restore wetland and stream functions on the part of DWQ and many other agencies and organizations in North Carolina, there is still an annual net loss of wetlands and streams statewide. DWQ and Division of Land Resources (DLR) regulate construction activities near streams and wetlands. These regulatory programs ensure that construction projects cause minimal damage to these resources and that unavoidable impacts are addressed through mitigation projects. Restoration projects are also funded through the Wetland Restoration Program (WRP), Section 319 Program, Clean Water Management Trust Fund and Division of Water Resources Grant Program that can help offset stream and wetland impacts.

DWQ tracks wetland and stream losses that are authorized through the issuance of a 401 Water Quality Certification. In addition to the permitted wetland and stream impacts that are tracked by DWQ, an unknown amount of permanent wetland and stream losses also occurs. Projects that affect less than one-third of an acre of wetland or less than 150 linear feet of stream are not required to receive written confirmation from DWQ, and therefore, might not be reported. The magnitude of unauthorized impacts to wetlands and streams is not known.

Over the past five years (1995-1999), DWQ issued permits for approximately 76 acres of wetland fill activities and alteration activities that affected at least 1,804 linear feet of stream in the Roanoke River basin. A significant percentage of stream impacts statewide are associated with highway construction projects.

In June 1998, a federal court declared that the US Army Corps of Engineers' Tulloch Rule, which prohibited the ditching and draining of wetlands, was illegal. As a result, during FY 1999-2000, approximately 9,220 acres of wetlands on about 80 sites (mostly in southeastern NC) were ditched and drained. This activity stopped in March 1999 when DWQ began to enforce its wetland standards. DWQ, EPA and DLR have spent an extensive amount of time visiting each of these sites to check for compliance with environmental rules. Most of these wetlands were slated to be restored by December 2000.

Chapter 3 -
Summary of Water Quality Information for the Roanoke River Basin

3.1 General Sources of Pollution

Human activities can negatively impact surface water quality, even when the activity is far removed from the waterbody. With proper management of wastes and land use activities, these impacts can be minimized. Pollutants that enter waters can be grouped into two general categories: *point sources* and *nonpoint sources*.

Point Sources

Piped discharges from:

- Municipal wastewater treatment plants
- Industrial facilities
- Small package treatment plants
- Large urban and industrial stormwater systems

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.

Nonpoint Sources

- Construction activities
- Roads, parking lots and roof tops
- Agriculture
- Failing septic systems and straight pipes
- Timber havesting
- Hydrologic modifications

Nonpoint sources are from a broad range of land use activities. Nonpoint source pollutants are typically carried to waters by rainfall, runoff or 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 the diffuse nature of nonpoint source pollution, it is difficult and resource intensive to quantify nonpoint contributions to water quality degradation in a given watershed. While nonpoint source pollution control often relies on voluntary actions, the state has many programs designed to reduce nonpoint source pollution.

Every person living in or visiting a watershed contributes to impacts on water quality. Therefore, each individual should be aware of these contributions and take actions to reduce them.

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.

3.2 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.

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 A-20 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, including a database of North Carolina's stream classifications, is also available on DWQ's website at http://h2o.enr.state.nc.us/csu/.

Table A-20 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 uses.
SA	Waters classified for commercial shellfish harvesting.
WS	*Water Supply watershed*. There are five WS classes ranging from WS-I through WS-V. WS classifications are assigned to watersheds based on land use characteristics of the area. Each water supply classification has a set of management strategies to protect the surface water supply. WS-I provides the highest level of protection and WS-IV provides the least protection. A Critical Area (CA) designation is also listed for watershed areas within a half-mile and draining to the water supply intake or reservoir where an intake is located.
SUPPLEMENTAL CLASSIFICATIONS	
Class	**Best Uses**
Sw	*Swamp Waters*: Recognizes waters that will naturally be more acidic (have lower pH values) and have 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 possessing special qualities including excellent water quality, Native or Special Native Trout Waters, Critical Habitat areas, or WS-I and WS-II water supplies.
ORW	*Outstanding Resource Waters*: Unique and special surface waters which are unimpacted by pollution and have some outstanding resource values.
NSW	*Nutrient Sensitive Waters*: Areas with water quality problems associated with excessive plant growth resulting from nutrient enrichment.

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

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. With the exception of Sw, all of 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.

Trout Waters

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 (Tr). There are no watershed development restrictions associated with the Tr classification. However, the NC Division of Land Resources does require a 25-foot vegetated buffer between Tr waters and graded construction sites.

A state fishery management classification, Designated Public Mountain Trout Waters, is administered by the NC Wildlife Resources Commission. 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.

High Quality Waters

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.

Criteria for HQW Classification

- Waters rated as Excellent based on DWQ's chemical and/or biological sampling.
- Streams designated as native and special native trout waters or primary nursery areas by the Wildlife Resources Commission (WRC).
- Waters classified by DWQ as WS-I and WS-II are HQW by definition, but these waters are not specifically assigned the HQW classification because the standards for WS-I and WS-II waters are sometimes more stringent than those classified HQW.

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 one 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 requires more stringent erosion controls for land-disturbing projects within one mile and draining to HQWs.

Outstanding Resource Waters

A small percentage of North Carolina's surface 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.

Water Supply Watersheds

The purpose of the Water Supply Watershed Protection Program is to provide an opportunity for communities to work with the state to strengthen protection of their water supplies. There are five water supply classifications (WS-I to WS-V) that are defined according to the amount and types of permitted point source discharges, as well as requirements to control nonpoint sources of pollution (Table A-20). Watersheds draining to waters classified WS carry some restrictions on point source discharges and on many land use activities including urban development, agriculture, forestry and highway sediment control. Minimum requirements for WS-I to WS-IV include a 30-foot undisturbed vegetated buffer. The WS-I and WS-II classifications are HQW by definition because requirements for these levels of water supply protection are at least as stringent as for HQWs.

Classifications and Standards in the Roanoke River Basin

The waters of the Roanoke River basin have a variety of surface water quality classifications applied to them. Water supply watersheds range from WS-II to WS-IV. There are currently no designated High Quality Waters in the basin and only two small segments of Outstanding Resource Waters which are discussed in the following section. Several miles of stream, including the Dan River mainstem, in the upper portion of the Dan River watershed are classified

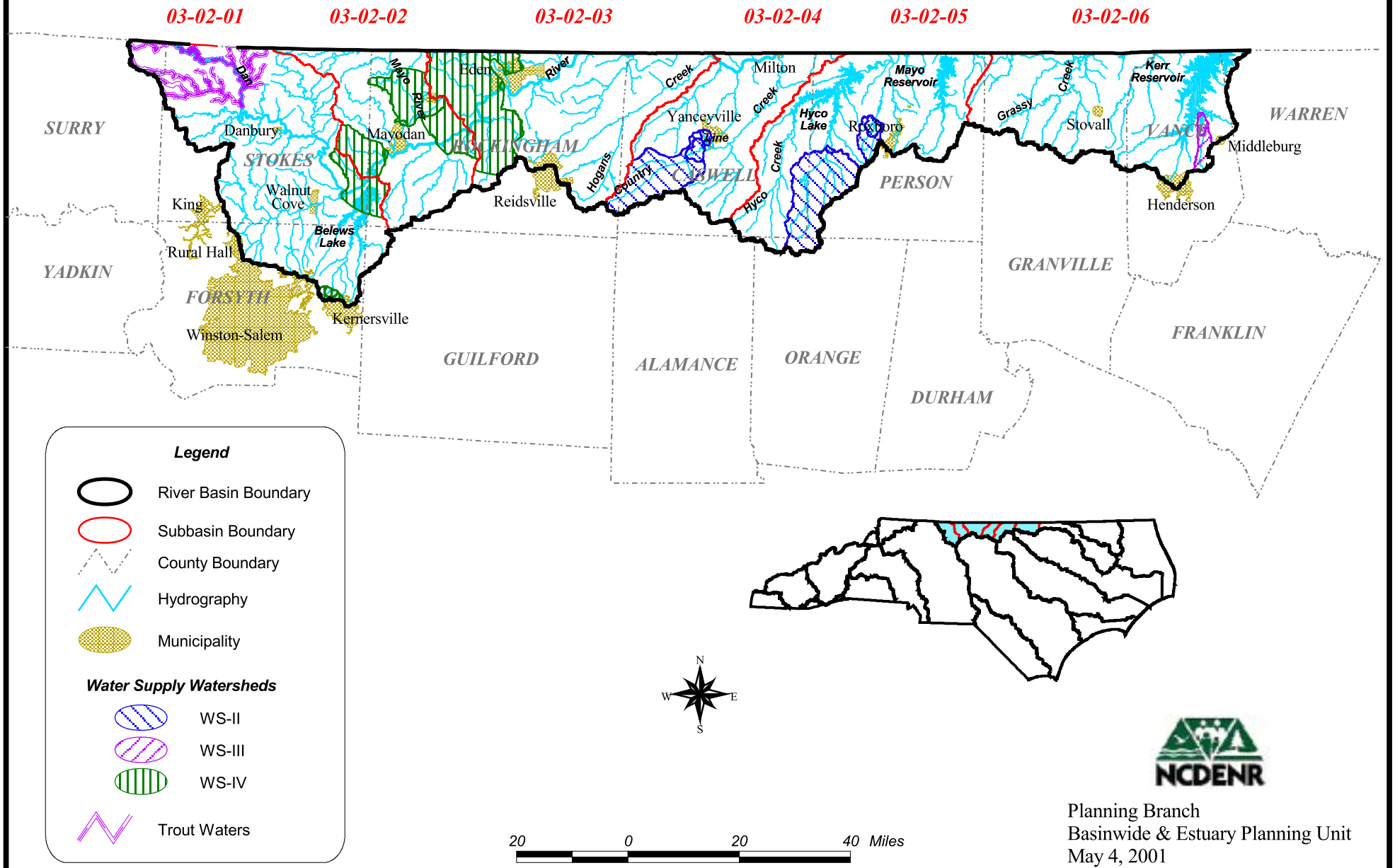
Trout Waters. Portions of the Roanoke River basin that contain these special classifications are shown on Figures A-15 and A-16.

Pending and Recent Reclassifications in the Roanoke River Basin

In August of 1998, a portion of two streams, Cascade and Indian Creeks, inside the Hanging Rock State Park were reclassified Outstanding Resource Waters. In addition to excellent water quality found in both streams, rare benthic macroinvertebrate species were found in both Cascade Creek and an unnamed tributary. Both streams were also found to be "important components of a state park" that have "special ecological significance" in the area.

Parts of some streams located in the lower portion of the Roanoke River basin may qualify for the Outstanding Resource Waters designation and/or a special set of management strategies based on their ecological and scientific significance, their presence as part of a National Wildlife Refuge, and their unique recreational value. Management strategies associated with these reclassifications would take into account natural variations in these complex swamp stream systems. Citizens, organizations or local governments can recommend waters for reclassification at any time, and DWQ will consider them for these protective classifications.

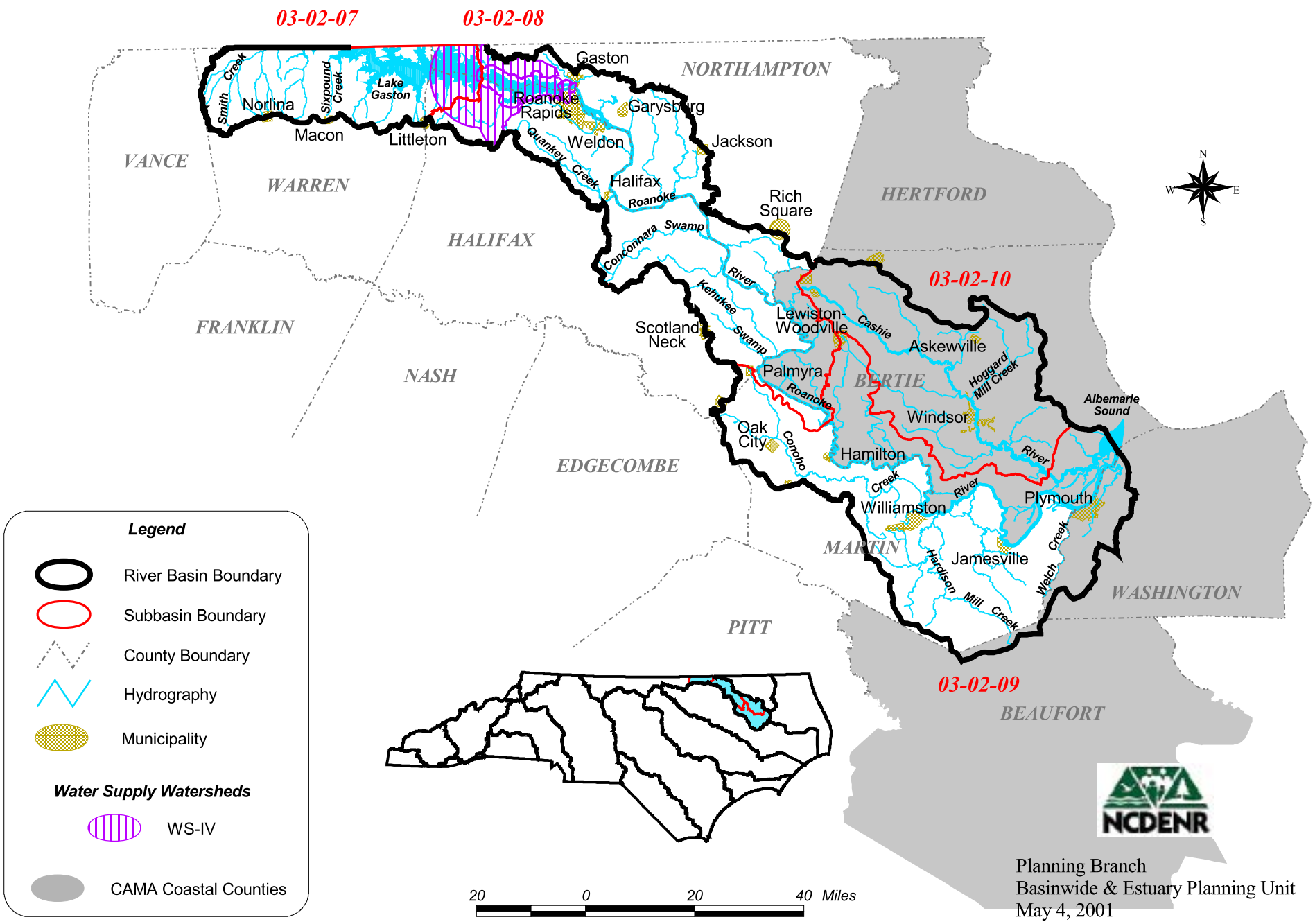
Figure A-15 Water Supply Watersheds and Trout Waters of the Western Portion of the Roanoke River Basin



NCDENR

Planning Branch
Basinwide & Estuary Planning Unit
May 4, 2001

Figure A-16 Water Supply Watersheds and CAMA Coastal Counties in the Eastern Portion of the Roanoke River Basin



3.3 DWQ Water Quality Monitoring Programs in the Roanoke River Basin

Staff in the Environmental Sciences Branch 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 the Roanoke 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 Roanoke 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 Roanoke River Basin include:

- benthic macroinvertebrates (Section 3.3.1)
- fish assessments (Section 3.3.2)
- aquatic toxicity monitoring (Section 3.3.3)
- lakes assessment (Section 3.3.4)
- ambient monitoring system (Section 3.3.5)

3.3.1 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, and a Biotic Index value, which gives an indication of overall community pollution tolerance. Different benthic macroinvertebrate criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina. Bioclassifications fall into five categories ranging from Poor to Excellent.

Extensive evaluation of swamp streams across eastern North Carolina suggests that current coastal plain criteria are not appropriate for assessing the condition of water quality in these special systems. Swamp streams are characterized by slower flow, lower dissolved oxygen, lower pH, and sometimes very complex braided channels and dark-colored water. DWQ is working to refine biological criteria that may be used in the future to assign bioclassifications to these streams. Refer to Chapter 4 of this section for more detailed information.

Overview of Benthic Macroinvertebrate Data

Appendix II lists all the benthic macroinvertebrate collections in the Roanoke River basin between 1983 and 1999, giving site location, collection date, taxa richness, biotic index values

and bioclassifications. Benthic macroinvertebrates have been collected at 79 sites in the Roanoke River basin since 1983. Table A-21 lists the most recent ratings since 1983, by subbasin, for all 79 benthos sites. Most of the streams listed as "Not Rated" are swamp streams in subbasins 03-02-08, 03-02-09 and 03-02-10. Benthos sampling may slightly overestimate the proportion of Fair and Poor sites, as DWQ special studies often have the greatest sampling intensity (number of sites/stream) in areas where it is believed that water quality problems exist.

Table A-21 Summary of Bioclassifications for All Freshwater Benthic Macroinvertebrate Sites (using the most recent rating for each site) in the Roanoke River Basin

Subbasin	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Total
03-02-01	3	7	7	2	1	0	20
03-02-02	0	2	3	0	0	0	5
03-02-03	1	4	0	2	0	0	7
03-02-04	0	1	1	0	0	0	2
03-02-05	0	0	0	2	0	0	2
03-02-06	0	0	2	3	0	2	7
03-02-07	0	0	1	1	0	0	2
03-02-08	0	3	0	3	0	5	11
03-02-09	0	0	2	0	0	10	12
03-02-10	0	0	0	0	0	8	8
Total (#)	**4**	**17**	**16**	**13**	**1**	**28**	**79**
Total (%)	**5%**	**22%**	**20%**	**16%**	**2%**	**35%**	100%

Sampling was hampered by extremes in streamflows in 1999. Many streams ceased flowing during the summer drought, while other sites could not be sampled because of high flow events. Therefore, only 35 sites were sampled during 1999 basinwide surveys or special studies. For the 1999 collections, Figure A-17 presents the following bioclassifications: Excellent – 0, Good – 6 (17%), Good-Fair – 5 (14%), Fair – 7 (20%), Poor – 0, Not Rated – 17 (49%).

Long-term trends (>5 years of data) in water quality were evaluated at six sites in the Roanoke River basin. None of the sites showed a decline in water quality. One site showed positive changes related to improvements in wastewater treatment. Subbasin chapters in Section B contain more specific information regarding these streams.

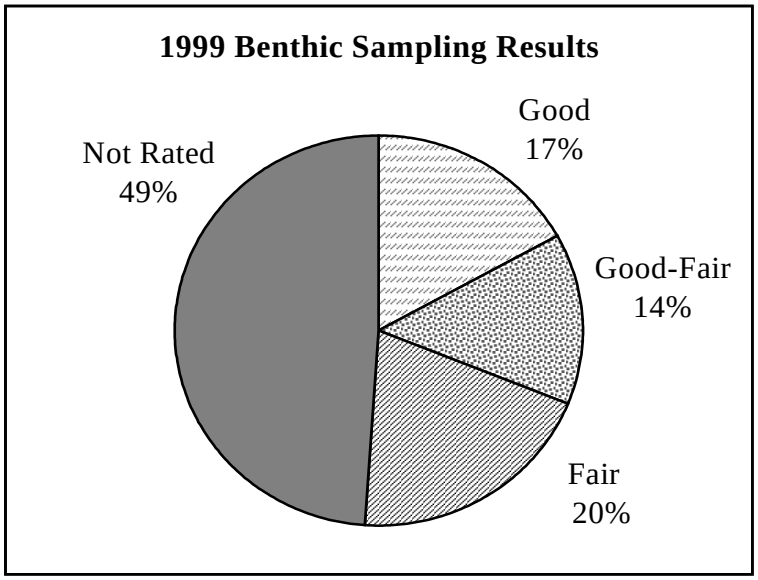


Figure A-17 Bioclassifications for 35 Roanoke River Basin Benthic Macroinvertebrate Sites Sampled by DWQ in 1999

3.3.2 Fish Assessments

Historical studies of fish communities in the Roanoke River basin were conducted primarily by the North Carolina Wildlife Resources Commission (NCWRC) in the 1960s and late 1970s. Approximately 102 species have been collected from the Roanoke River basin in North Carolina. Several streams were sampled by DWQ during the last basinwide planning cycle (1994), and two samples were collected in 1999. Scores are assigned to these samples using the North Carolina Index of Biotic Integrity (NCIBI). The NCIBI uses a cumulative assessment of twelve parameters or metrics. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. Appendix II contains more information regarding the NCIBI.

During the late 1990s, application of the NCIBI has been restricted to wadeable streams that can be sampled by a crew of 2-4 persons using backpack electrofishers and following the DWQ Standard Operating Procedures (NCDEHNR, 1997). Work began in 1998 to develop a fish community boat sampling method that could be used in non-wadeable coastal plain streams. Plans are to sample 10-15 reference sites with the boat method once it is finalized. As with other biological monitoring programs, many years of reference site data will be needed before solid criteria can be developed to evaluate biological integrity of large streams and rivers using the fish community assessment. Refer to Chapter 4 of this section for further information.

Overview of Fish Community Data

Appendix II lists all of the fish community collections in the Roanoke River basin between 1990 and 1999, giving site location, collection date and NCIBI rating. Fish community samples have been collected at 16 sites in the Roanoke River basin since 1990. Table A-22 lists the most recent ratings since 1990, by subbasin, for all fish community sites.

Table A-22 Summary of NCIBI Categories for All Freshwater Fish Community Sites (using the most recent rating for each site) in the Roanoke River Basin

Subbasin	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Total
03-02-01	0	0	0	0	0	0	0
03-02-02	0	1	0	0	0	0	1
03-02-03	1	0	0	0	0	0	1
03-02-04	0	2	1	0	0	0	3
03-02-05	0	0	1	0	0	0	1
03-02-06	1	1	1	0	0	0	3
03-02-07	0	0	2	0	0	0	2
03-02-08	0	1	1	0	0	2	4
03-02-09	0	0	0	0	0	0	0
03-02-10	0	0	0	0	0	1	1
Total (#)	**2**	**5**	**6**	**0**	**0**	**3**	**16**
Total (%)	**13%**	**31%**	**37%**	**0%**	**0%**	**19%**	100%

No basinwide fish community surveys were conducted during 1999 because of ongoing special studies and additional reference site sampling. Only 2 sites were sampled in 1999: Grassy Creek received a Good NCIBI score and Island Creek received an Excellent score.

Roanoke River Basin Fish Kills

DWQ has only systematically tracked reported fish kill events across the state since 1996. From 1994 to 1999, DWQ field investigators reported five fish kill events in the Roanoke River basin. Fish kills occurred on the Roanoke River from Roanoke Rapids to Jamesville and along the Cashie River near Windsor and Sans Souci. Mortality estimates ranged from 30 to more than 10,000 fish per event.

Two of these fish kills were extensive and occurred in the Roanoke River between July 25 and August 2, 1995 as a result of operations at the Roanoke Rapids dam. The first kill occurred directly below the dam after spillway gates were closed leaving fish stranded in isolated pools where water temperature increased rapidly. The second kill began after water release rates from the dam were rapidly curtailed causing waters which had inundated thousands of acres of wetlands adjacent the Roanoke River, and which had become anoxic, to empty into the river. This fish kill occurred over approximately 76 miles and killed an estimated 7,000 striped bass as well as approximately 16,000 other species. Dissolved oxygen in the kill area ranged from 0.4 to 2.0 mg/l (Kornegay and Jones, 1995).

The magnitude of these events led Dominion (formerly North Carolina Power) to implement, in cooperation with the NC Wildlife Resources Commission and the US Army Corps of Engineers, a plan to incrementally "step down" flood control flow reductions (refer to Part 2.9.4 of this

section for more information). Since the plan was put into effect, no additional fish kills have been reported related to reduction of water releases. Fish kills were also reported following Hurricane Fran and Hurricane Bonnie in 1996 and 1998, respectively.

Overview of Fish Tissue Sampling

Fish tissue surveys were conducted by DWQ at eight stations within the basin from 1994 to 1999. These surveys were conducted as part of special mercury contamination assessments in the eastern part of the state and during routine basinwide assessments.

The majority of fish tissue samples collected from the Roanoke River basin in 1994 and 1999 contained metal and organic contaminants at undetectable levels or at levels less than the EPA, Food and Drug Administration, and State of North Carolina consumption criteria. Figure A-18 shows the number of fish tissue samples that exceeded one or more of these consumption criteria. Only six sites are represented on the figure because none of the samples collected from the Dan River at Eden or from Lake Gaston exceeded any consumption criteria. More detailed information regarding these sampling events and streams can be found in the appropriate subbasin chapter in Section B.

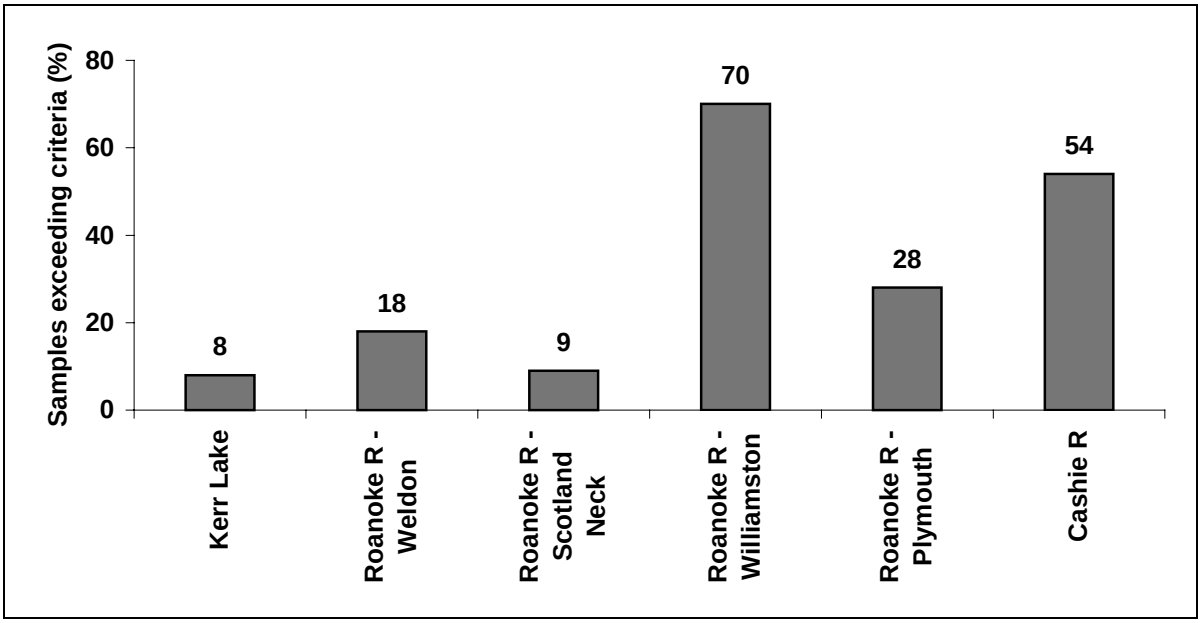


Figure A-18 Fish Tissue Samples Exceeding Consumption Criteria at Six Sites Sampled by DWQ in 1994 and 1999

Elevated mercury concentrations were most often detected in largemouth bass and bowfin. These two species are at the top of the food chain and are most often associated with mercury bioaccumulation in fish tissue in North Carolina. More than 50 percent of samples collected from the Roanoke River at Williamston and the Cashie River at Windsor contained mercury concentrations exceeding the state criteria. Presently, the only consumption advisory for mercury-contaminated fish in the Roanoke River basin is the statewide advisory for bowfin.

No samples from the above referenced eight stations contained concentrations greater than consumption criteria of any other metals of concern (arsenic, cadmium, chromium, copper, lead, nickel, selenium and zinc). Samples collected by Duke Power Company and Carolina Power & Light Company in Belews Lake and Hyco Reservoir, respectively, have shown high concentrations of selenium. However, contamination levels have declined in recent years. More information regarding causes and sources of the selenium, as well as recommended management strategies for these waters, can be found in Section B.

Weyerhaeuser Company monitors dioxin levels in fish tissue in the lower Roanoke River and Welch Creek. Fish consumption advisories for almost all species of fish due to dioxin contamination are in effect in these waters, as well as the western portion of Albemarle Sound, although levels of dioxin have also been declining in recent years. Refer to Chapter 9 of Section B for more information regarding these waters.

3.3.3 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 by their NPDES permit or by administrative letter. Other facilities may be tested by DWQ's Aquatic Toxicology laboratory.

The Aquatic Toxicology Unit maintains a compliance summary (Figure A-19) for all facilities required to perform tests and provides a monthly update 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.

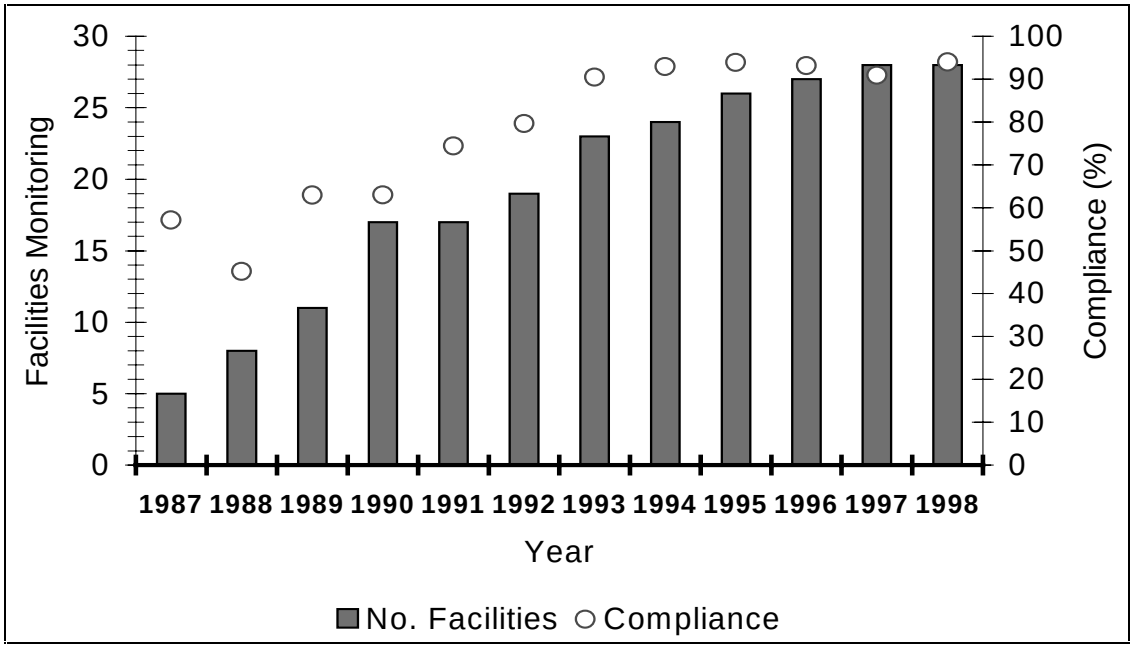


Figure A-19 Summary of Compliance with Aquatic Toxicity Tests in the Roanoke River Basin

Twenty-nine NPDES permits in the Roanoke River basin currently require whole effluent toxicity (WET) testing. Twenty-seven permits have a WET limit; the other two facilities have episodic discharges and their permits specify monitoring but with no limit.

The number of facilities required to monitor whole effluent toxicity has increased steadily since 1987, the first year that whole effluent toxicity limits were written into permits in North Carolina. The compliance rate has risen as well. Since 1993, the compliance rate has stabilized at approximately 90-95 percent. Facilities with toxicity problems during the most recent two-year review period are discussed in the subbasin chapters in Section B

3.3.4 Lakes Assessment Program

Eleven lakes in the Roanoke River basin were sampled as part of the Lakes Assessment Program in summer of 1999. These data are used to determine the trophic state of each lake, a relative measure of nutrient enrichment and biological productivity. Five lakes (Hanging Rock, Belews Lake, Hyco Lake, Mayo Reservoir and Lake Gaston) exhibited low biological productivity. The North Carolina portion of John H. Kerr Reservoir and Roanoke Rapids Lake demonstrated moderate biological productivity. The remaining four lakes (Kernersville Reservoir, Farmer Lake, Lake Roxboro and Roxboro Lake) were found to be very biologically productive. Lakes for which one or more uses are impaired are listed in Part 3.5.3 of this section (Table A-31) and are discussed in the appropriate subbasin chapter in Section B.

3.3.5 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine sample stations strategically located for the collection of physical and chemical water quality data. North Carolina has 21 stations in the Roanoke River basin listed in Table A-23 and shown on individual subbasin maps in Section B. These stations are sampled monthly for 27 parameters.

Overall, measurements of water quality parameters in the Roanoke River basin showed few temporal patterns. An exception is the site located on Nutbush Creek, where water quality improved greatly during the mid-1980s as improvements to the Town of Henderson's WWTP were put into place. At other sites, distinct spatial differences occurred depending upon whether or not the sites were located upstream or downstream of wastewater dischargers.

Fecal coliform bacteria are widely used as an indicator of the potential presence of pathogens typically associated with the intestinal tract of warm-blooded animals. The water quality standard for fecal coliform bacteria is based on a geometric mean of 200 colonies/100ml. Fecal coliform bacteria concentrations, represented by geometric means, showed few temporal patterns. The only ambient monitoring station with a geometric mean greater than 200 colonies/100 ml for this five-year assessment period was Marlowe Creek (N4400000). Most stations in the basin (67 percent) had geometric means of less than 100 colonies/100ml.

Table A-23 Ambient Monitoring System Stations within the Roanoke River Basin

Subbasin/ Station code	Station	County	Classification*
03-02-01			
N0150000	Dan River at NC Hwy 704, near Francisco	Stokes	C Tr
03-02-02			
N1400000	Mayo River at SR 1358, near Price	Rockingham	WS-IV
03-02-03			
N2300000	Dan River at SR 2150, near Wentworth	Rockingham	WS-IV
N2450000	Smith River at NC Hwy 14, at Eden	Rockingham	WS-IV
N3000000	Dan River at SR 1716, near Mayfield	Rockingham	C
03-02-04			
N3500000	Dan River at NC Hwy 62 at NC-VA state line	Caswell	C
03-02-05			
N4110000	Hyco Creek at US Hwy 158, near Leasburg	Caswell	C
N4250000	Hyco River below afterbay dam, near McGhees Mill	Person	C
N4400000	Marlowe Creek at SR 1322, near Woodsdale	Person	C
N4510000	Hyco River at US Hwy 501, near Denniston, VA	Halifax	Virginia
N4590000	Mayo Creek at SR 1501, near Bethel Hill	Person	C
03-02-06			
N5000000	Nutbush Creek at SR 1317, near Henderson	Vance	C
03-02-07			
N6400000	Smith Creek at US 1, near Paschall	Warren	C
03-02-08			
N7300000	Roanoke River at Roanoke Rapids	Halifax	C
N8200000	Roanoke River near Scotland Neck	Halifax	C
N8300000	Roanoke River at NC Hwy 11	Martin	C
03-02-09			
N8550000	Roanoke River at Williamston	Martin	C
N9250000	Roanoke River near Plymouth	Martin	C Sw
N9600000	Roanoke River at Sans Souci	Bertie	C Sw
N9700000	Albemarle Sound (Batchelor Bay) near Black Walnut	Bertie	B Sw
03-02-10			
N8950000	Cashie River at SR 1219, near Lewiston	Bertie	C Sw

* An index for DWQ freshwater classifications can be found in Part 3.2 of this section (Table A-20).

Elevated turbidity measurements were observed often in streams in the Dan River subbasins over the past five years. The turbidity standard for trout waters (10 NTU) was exceeded in 35 percent of 54 samples collected from the upper Dan River (N0150000) near Fransico. The turbidity standard (50 NTU) was exceeded at the Dan River near Wentworth station (N2300000) in 18 percent of 55 samples between 1995 and 1999. Concentrations in this segment of the Dan River ranged from 2.6 to 200 NTU, compared with 1.4 to 90 NTU near Francisco upstream. The turbidity water quality standard was only exceeded in 9 percent of samples at the downstream station near Mayfield (N3000000). More information regarding causes and sources of turbidity, as well as recommended management strategies for the Dan River, can be found in Section B.

Figure A-20 depicts nearly 20 years of dissolved oxygen data collected from DWQ Ambient Monitoring Stations in the Roanoke River basin. (Appendix V contains an explanation of box plots.) Dissolved oxygen (DO) concentrations were low at the Smith Creek station in the Dan River watershed. Approximately 25 percent of measurements were less than the 5.0 mg/l water quality standard between September 1994 and August 1999. The stream at this sampling location is slow moving, a factor which could contribute to these sample results. In the eastern portion of the basin, the Cashie River exhibited very low DO concentrations; however, the monitoring site is located in swamp waters where DO is naturally lower.

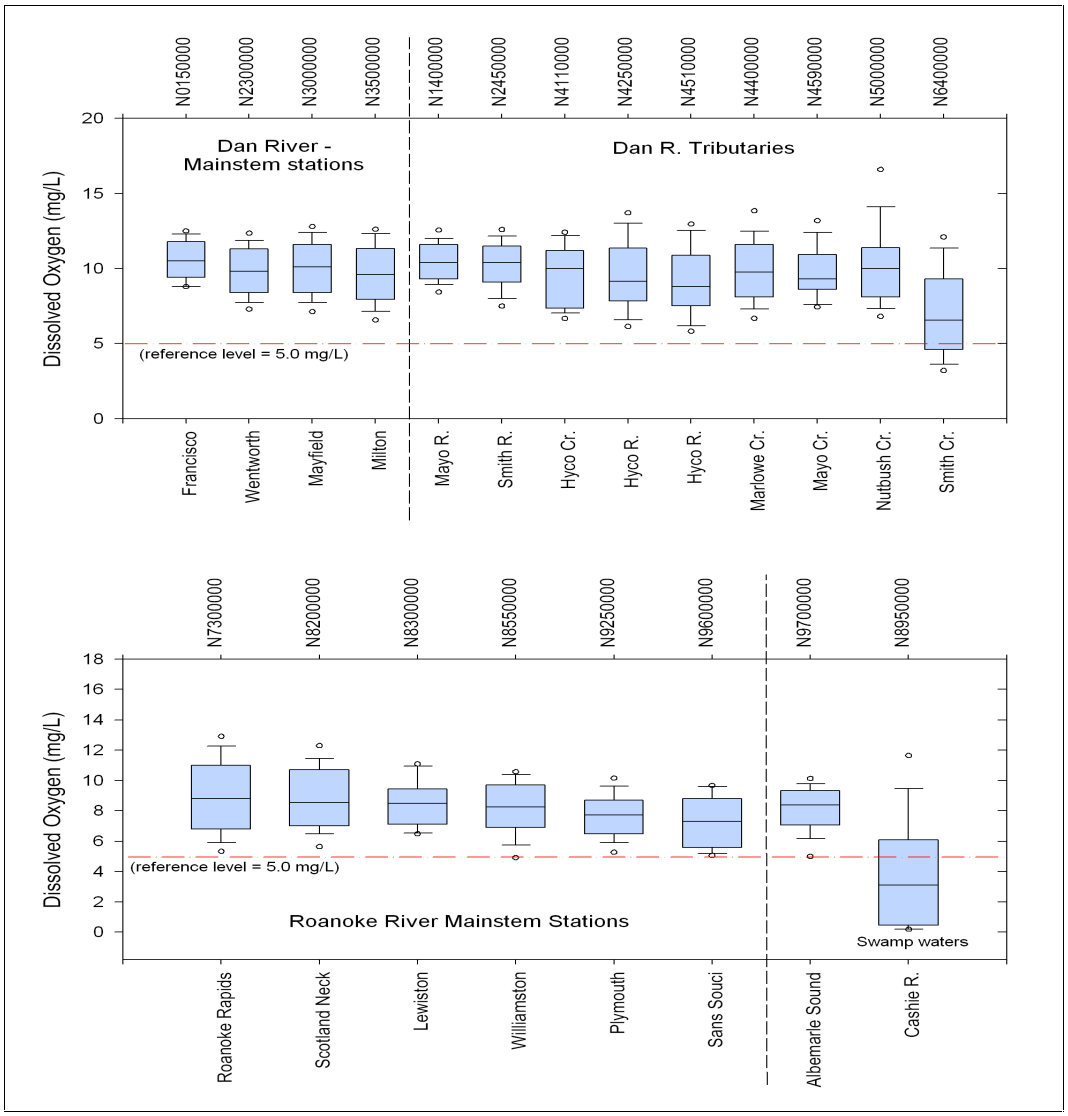


Figure A-20 Dissolved Oxygen Concentrations at Ambient Monitoring Stations in the Roanoke River Basin (1980-1999)

Dissolved oxygen fell below the water quality standard in less than seven percent of samples collected between September 1994 and August 1999 from any station on the Roanoke River mainstem. DWQ Ambient Monitoring System data showed no significant difference between

DO data collected above (N9250000) and below (N9600000) Plymouth over the same five-year period.

Copper and iron were the only two metals that often exceed their action levels. Iron is a common element in clay soils; therefore, elevated concentrations may reflect the geochemistry of the watershed. In general, elevated concentrations of copper were found at sites located downstream of wastewater discharges.

3.4 Other Water Quality Research

North Carolina actively solicits "existing and readily available" data and information for each basin as part of the basinwide planning process. Data meeting DWQ quality assurance objectives are used in making use support determinations. Data and information indicating possible water quality problems are investigated further. Both quantitative and qualitative information are accepted during the solicitation period. High levels of confidence must be present in order for outside quantitative information to carry the same weight as information collected from within DWQ. This is particularly the case when considering waters for the 303(d) list. Methodology for soliciting and evaluating outside data is presented in *North Carolina's Draft 2000 § 303(d) List* (DENR-DWQ, October 2000). The next data solicitation period for the Roanoke River is planned for fall 2003.

DWQ data solicitation includes the following:

- Information, letters and photographs regarding the uses of surface waters for boating, drinking water, swimming, aesthetics and fishing.
- Raw data submitted electronically and accompanied by documentation of quality assurance methods used to collect and analyze the samples. Maps showing sampling locations must also be included.
- Summary reports and memos, including distribution statistics and accompanied by documentation of quality assurance methods used to collect and analyze the data.
- Contact information must accompany all data and information submitted.

Continuous monitoring data (dissolved oxygen and temperature) were submitted by the US Fish and Wildlife Service from five US Geological Survey stations on the Roanoke River: Halifax (station #0208062765); Oak City (station #02081022); Grabtown (station #0208102855); Jamesville (station #02081094); and Westover (station #020811450). Data are collected from each of these stations at 15-minute intervals. Data summarized below are from January 1, 1998 (when the stations were put into operation) through August 31, 1999. August 31, 1999 is the end of the five-year window for data collected during this five-year planning cycle and reported in this plan.

The dissolved oxygen (DO) water quality standard for Class C waters is "not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l". Swamp waters (Class C Sw) "may have lower values if caused by natural conditions" (DENR, August 2000). Table A-24 presents the number of samples representing daily averages and the number and percent of samples less than the 5.0 mg/l DO standard for each monitoring station. Table A-25 presents the number of samples representing instantaneous measurements and the number and percent of samples less than the 4.0 mg/l DO standard for each monitoring station.

Table A-24 USGS Continuous Monitoring Station Daily Average Dissolved Oxygen (DO) Data Summary for the Roanoke River Basin (1/98-8/99)

USGS Station Name	Stream Class	Water Quality Standard	Number of Samples	Number of Samples DO <5.0 mg/l	% of total Samples DO <5.0 mg/l
Halifax	C	5.0 mg/l	512	0	--
Oak City	C	5.0 mg/l	389	0	--
Grabtown	C	5.0 mg/l	494	0	--
Jamesville	C	5.0 mg/l	524	30	5.7%
Westover	C Sw	5.0 mg/l*	501	107	21.4%

* Swamp waters may have lower values if caused by natural conditions.

Table A-25 USGS Continuous Monitoring Station Instantaneous Dissolved Oxygen (DO) Data Summary for the Roanoke River Basin (1/98-8/99)

USGS Station Name	Stream Class	Water Quality Standard	Number of Samples	Number of Samples DO <4.0 mg/l	% of total Samples DO <4.0 mg/l
Halifax	C	4.0 mg/l	48,790	0	--
Oak City	C	4.0 mg/l	36,852	0	--
Grabtown	C	4.0 mg/l	47,068	0	--
Jamesville	C	4.0 mg/l	49,966	561	1.1%
Westover	C Sw	4.0 mg/l*	47,575	5,077	10.7%

* Swamp waters may have lower values if caused by natural conditions.

Although, according to a strict interpretation, the data presented above show numerous violations of the water quality standards for dissolved oxygen at the Jamesville monitoring station, this station is located a short distance upstream of the boundary between the Class C and Class C Sw portions of the Roanoke River. It is possible that some "swamp stream" characteristics are being observed at this location.

Additional DWQ analyses show that an increase in temperature does not always accompany a decrease in DO at the Oak City, Grabtown and Jamesville stations. Therefore, there are factors other than temperature influencing DO concentrations at these stations. Refer to Chapter 4 of this section for a discussion of studies designed to provide further information about dissolved oxygen in the lower Roanoke River.

Water quality monitoring data for Nutbush Creek and the Nutbush Creek Arm of Kerr Reservoir were submitted by the City of Henderson in hardcopy form only. Unfortunately, due to staff time constraints, DWQ is unable to use raw data that is not submitted electronically.

3.5 Use Support Summary

3.5.1 Introduction to Use Support

Waters are classified according to their best intended uses. Determining how well a water supports its uses (*use support* status) is an important method of interpreting water quality data and assessing water quality. Surface waters are rated *fully supporting* (FS), *partially supporting* (PS) or *not supporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and recreation) are being met.

For example, waters classified for fishing and secondary contact recreation (Class C for freshwater) are rated as fully supporting if data used to determine use support did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as PS or NS, depending on the degree of degradation. Waters rated PS or NS are considered to be impaired. Waters lacking data, or having inconclusive data, are listed as not rated (NR).

Use support ratings for surface waters:

- *fully supporting (FS)*
- *partially supporting (PS)*
- *not supporting (NS)*
- *not rated (NR)*

Impaired waters categories:

- partially supporting
- not supporting

Historically, the non-impaired category was subdivided into fully supporting and fully supporting but threatened (ST). ST was used to identify waters that were fully supporting but had some notable water quality concerns and could represent constant, degrading or improving conditions. North Carolina's past use of ST was very different from that of the US Environmental Protection Agency (EPA), which uses it to identify waters that demonstrate declining water quality (EPA Guidelines for Preparation of the Comprehensive State Water Quality Assessments [305(b) Reports] and Electronic Updates, 1997). Given the difference between the EPA and North Carolina definitions of ST and the resulting confusion that arises from this difference, North Carolina no longer subdivides the non-impaired category. However, these waters and the specific water quality concerns remain identified in the subbasin chapters in Section B so that data, management and the need to address the identified concerns are not lost.

Beginning in 2000 with the Roanoke River basin, an approach to assess ecosystem health and human health risk is applied to use support categories. Six categories are used to assess this approach: aquatic life and secondary recreation, fish consumption, shellfish harvesting, primary recreation, water supply and "other" uses. Each of these categories relates to the primary classifications applied to NC rivers and streams. A single water could have more than one use support rating corresponding to one or more of the multiple use support categories, as shown in Table A-31. For many waters, a use support category will not be applicable (NA) to the best use classification of that water (e.g., drinking water supply is not the best use of a Class C water). This method of determining use support differs from that done prior to 2000; in that, there is no longer an *overall* use support rating for a water. For more detailed information regarding use support methodology, refer to Appendix III.

3.5.2 Comparison of Use Support Ratings to Streams on the Section 303(d) List

Section 303(d) of the Clean Water Act requires states to identify waters not meeting standards. EPA must then provide review and approval of the listed waters. A list of waters not meeting standards is submitted to EPA biennially. Waters placed on this list, termed the 303(d) list, require the establishment of total maximum daily loads (TMDLs) intended to guide the restoration of water quality. See Appendix IV for a description of 303(d) listing methodology.

Waters are placed on North Carolina's 303(d) list primarily due to a partially or not supporting use support rating. These use support ratings are based on biological and chemical data and, for some categories, human health advisories. When the state water quality standard is exceeded, then this constituent is listed as the problem parameter. TMDLs must be developed for problem parameters on the 303(d) list. Other strategies may be implemented to restore water quality; however, the waterbody must remain on the 303(d) list until improvement has been realized based on either biological bioclassifications or water quality standards.

The 303(d) list and accompanying data are updated as the basinwide plans are revised. In some cases, the new data will demonstrate water quality improvement and waters may receive a better use support rating. These waters may be removed from the 303(d) list since water quality improvement has been attained. In other cases, the new data will show a stable or decreasing trend in overall water quality resulting in the same, or lower, use support rating. Attention remains focused on these waters until water quality standards are being met.

3.5.3 Use Support Ratings for the Roanoke River Basin

Aquatic Life/Secondary Recreation

The aquatic life/secondary recreation use support category is applied to all waters in North Carolina. Therefore, this category is applied to the total number of stream miles (2213.0) in the North Carolina portion of the Roanoke River basin. Table A-26 presents use support ratings by subbasin for both monitored and evaluated streams in the aquatic life/secondary recreation category. A basinwide summary of current aquatic life/secondary recreation use support ratings is presented in Table A-27.

Approximately 29 percent of stream miles (638) were monitored for the protection of aquatic life and secondary recreation by DWQ during this basinwide planning cycle. All waters rated impaired in the aquatic life/secondary recreation use support category were monitored within the past five years. Impaired waters accounted for 2.6 percent of the total stream miles and 8.9 percent of monitored stream miles.

Table A-26 Aquatic Life/Secondary Recreation Use Support Ratings for Monitored and Evaluated Waters Listed by Subbasin in Miles (1995-1999)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-02-01	276.5	0	8.0	148.9	433.4
03-02-02	76.4	0	0	55.6	132.0
03-02-03	154.6	19.5	0	68.8	242.9
03-02-04	112.0	0	0	39.6	151.6
03-02-05	84.8	10.8	0	99.3	194.9
03-02-06	127.0	4.6	0	53.0	184.6
03-02-07	41.7	10.4	0	49.4	101.5
03-02-08	167.9	3.4	0	180.6	351.9
03-02-09	72.8	0	0	198.3	271.1
03-02-10	0	0	0	149.1	149.1
TOTAL	**1113.7**	**48.7**	**8.0**	**1042.6**	**2213.0**
Percent	50.3%	2.2%	0.4%	47.1%	100%

Table A-27 Aquatic Life/Secondary Recreation Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Aquatic Life/Secondary Recreation Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**1113.7**	**50.3%**		**357.0**	**56.0%**
Impaired	**56.7**	**2.6%**		**56.7**	**8.9%**
Partially Supporting	*48.7*	*2.2%*		*48.7*	*7.6%*
Not Supporting	*8.0*	*0.4%*		*8.0*	*1.3%*
Not Rated	**1042.6**	**47.1%**		**223.9**	**35.1%**
TOTAL	**2213.0**			**637.6**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Fish Consumption

Like the aquatic life/secondary recreation use support category, the fish consumption use support category is also applied to all waters in the state. Approximately 14 percent of stream miles (308.0 miles) in the Roanoke River basin were monitored for the fish consumption category during this basinwide cycle. Fish consumption use support ratings are based on fish consumption advisories issued by the NC Department of Health and Human Services (DHHS). Currently, there is a statewide advisory limiting consumption of bowfin due to elevated mercury concentrations. Because of this advisory, all waters in the state are considered partially supporting the fish consumption use. However, samples collected by DWQ in 1999 from some waters in the basin, including the Dan River, Kerr Reservoir and Lake Gaston (where bowfin are

not typically found), revealed concentrations of metals and PCBs below federal and state consumption criteria.

Table A-28 presents use support ratings by subbasin for monitored streams in the fish consumption use support category. A basinwide summary of current fish consumption use support ratings is presented in Table A-29.

Table A-28 Fish Consumption Use Support Ratings for Monitored Waters Listed by Subbasin in Miles (1995-1999)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-02-01[1,2]	0	55.8	0	0	55.8
03-02-02[1]	0	9.3	0	0	9.3
03-02-03[1]	0	14.8	0	0	14.8
03-02-04[1]	0	7.5	0	0	7.5
03-02-05[3]	0	0.2	0	0	0.2
03-02-06[4]	0	5.1	0	0	5.1
03-02-07[4]	0	5.4	0	0	5.4
03-02-08	0	123.7	0	0	123.7
03-02-09	0	25.3	13.3	0	38.6
03-02-10	0	47.6	0	0	47.6
TOTAL	**0**	**294.7**	**13.3**	**0**	**308.0**
Percent	0%	95.7%	4.3%	0%	100%

[1] Analysis of fish tissue samples, collected by DWQ in 1999 from the Dan River, did not reveal elevated concentrations of any metals, including mercury, in any species of fish collected.

[2] Belews Lake (4,030 acres) is also included in the monitored waters in this subbasin.

[3] Hyco Lake (3,750 acres) is also included in the monitored waters in this subbasin.

[4] Analysis of fish tissues samples, collected by DWQ in 1999 from Kerr Reservoir and Lake Gaston, did not reveal elevated concentrations of any metals or PCBs in any species of fish collected.

Table A-29 Fish Consumption Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Fish Consumption Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**0.0**			**0.0**	
Impaired	**2213.0**	**100%**		**308.0**	**100%**
Partially Supporting	*2199.7*	*99.4%*		*294.7*	*95.7%*
Not Supporting	*13.3*	*0.6%*		*13.3*	*4.3%*
Not Rated	**0.0**			**0.0**	
TOTAL	**2213.0**			**308.0**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Primary Recreation

There are 120.2 stream miles currently classified for primary recreation in the Roanoke River basin. Approximately 15 percent were monitored by DWQ over the past five years; all are fully supporting the primary recreation use. Monitored waters include Hyco Lake, Kerr Reservoir and Lake Gaston. A basinwide summary of current primary recreation use support ratings is presented in Table A-30.

Table A-30 Primary Recreation Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Primary Recreation Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**18.5**	**15.4%**		**18.5**	**100%**
Impaired	**0.0**			**0.0**	
Not Rated	**101.7**	**84.6%**		**0.0**	
TOTAL	**120.2**			**18.5**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Water Supply

There are 270.4 stream miles currently classified for water supply in the Roanoke River basin. All were monitored within the past five years; all are fully supporting the water supply use. Monitored waters include Belews Lake, Hyco Lake, Kerr Reservoir and Lake Gaston. A basinwide summary of current water supply use support ratings is presented in Table A-31.

Table A-31 Water Supply Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Water Supply Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**270.4**	**100%**		**270.4**	**100%**
Impaired	**0.0**			**0.0**	
Not Rated	**0.0**			**0.0**	
TOTAL	**270.4**			**270.4**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Impaired Waters

Table A-32 presents impaired waters (in all categories), listed by subbasin, in the Roanoke River basin that were monitored by DWQ within the last five years. Ratings for each applicable use support category are shown, even though only one use may be impaired. Impaired ratings are shown in bold followed by the number of miles (streams and rivers) or acres (lakes) where the

corresponding use is impaired. Descriptions of impaired segments, as well as problem parameters, are outlined in Appendix III. Management strategies for each water are discussed in detail in the appropriate subbasin chapter.

Color maps showing current use support ratings for the Roanoke River basin are presented in Figures A-21 and A-22. Only waters where fish tissue has been monitored during this basinwide cycle are shown as impaired for fish consumption on the maps. When use support ratings have been assigned to more than one category for a particular water, the rating that represents the most severe impairment is shown on the map (e.g., Hyco Lake is fully supporting aquatic life/secondary recreation, but is partially supporting fish consumption. The lake is shown on Figure A-21 as partially supporting.)

Table A-32 Monitored Impaired Waters within the Roanoke River Basin (as of 2000)[1]

				Use Support Categories/Rating– Impaired Miles (or Acres)				
Impaired Water	**Subbasin**	**Chapter in Section B**	**Classification[2]**	**Aquatic Life/ Secondary Recreation**	**Fish Consumption**	**Primary Recreation**	**Water Supply**	**Potential Sources**
Town Fork Creek	03-02-01	1	C	NS – 8.0 mi	*	*N/A*	*N/A*	NP, P
Dan River	03-02-03 03-02-04	2 & 3	C	PS – 14.2 mi	[3]	*N/A*	*N/A*	NP, P
Smith River	03-02-03	3	C WS-IV	PS – 5.4 mi	*	*N/A*	FS	P
Hyco Lake	03-02-05	5	B WS-V	FS	PS – 3,750 ac	FS	FS	P
Marlowe Creek	03-02-05	5	C	PS – 10.9 mi	*	*N/A*	*N/A*	NP, P
Nutbush Creek	03-02-06	6	C	PS – 4.6 mi	*	*N/A*	*N/A*	NP, P
Smith Creek	03-02-07	7	C	PS – 10.4 mi	*	*N/A*	*N/A*	NP
Quankey Creek	03-02-08	8	C	PS – 3.4 mi	*	*N/A*	*N/A*	NP, P
Roanoke Rapids Lake	03-02-08	8	B WS-IV CA	PS – 4,893 ac	*	FS	FS	NP
Roanoke River	03-02-08 03-02-09	8 & 9	C C Sw	FS	PS – 137.8 mi	*N/A*	*N/A*	NP, P
Albemarle Sound	03-02-09	9	B Sw	FS	PS – 2,586 ac	FS	*N/A*	NP. P
Welch Creek	03-02-09	9	C Sw	NR	NS – 13.3 mi	*N/A*	*N/A*	P
Cashie River	03-02-10	10	C Sw B Sw	NR	PS – 54.6 mi	FS	*N/A*	NP

* These waters are impaired because of a statewide fish consumption advisory for bowfin. However, they were not monitored for the fish consumption category during this basinwide cycle. Refer to Section A, Part 4.8.4 for further information.

FS	Fully Supporting	NR	Not Rated	P	Point Sources
PS	Partially Supporting	N/A	Not Applicable	NP	Nonpoint Sources
NS	Not Supporting				

Notes

[1] These waters are currently, or will be placed, on the 303(d) list, and a TMDL and/or management strategy will be developed to address causes and sources of impairment. Refer to Appendix IV for further information regarding 303(d) listing methodology.

[2] An index for DWQ freshwater classifications can be found in Part 3.2 of this section (Table A-20).

[3] Analysis of fish tissues samples, collected by DWQ in 1999 from the Dan River, did not reveal elevated concentrations of any metals in any species of fish collected.

Figure A-21 Use Support Ratings for the Western Portion of the Roanoke River Basin

INSERT COLOR MAP…..Figure A-21

Figure A-22 Use Support Ratings for the Eastern Portion of the Roanoke River Basin

INSERT COLOR MAP…..Figure A-22

Chapter 4 -
Water Quality Issues Related to Multiple Watersheds in the Roanoke River Basin

4.1 Overview

This chapter discusses water quality issues that relate to multiple watersheds within the basin. Habitat degradation, including sedimentation, which results from a variety of activities in the watershed, is the most prevalent water quality problem in the Roanoke River basin. Other issues related to water quality include fish tissue contamination, population growth and urbanization. There are also a wide variety of concerns related to water quantity and flow management.

4.2 Habitat Degradation

Instream habitat degradation is identified in the use support summary (Appendix III) where there is a notable reduction in habitat diversity or a negative change in aquatic habitat. This term includes sedimentation, bank erosion, channelization, lack of riparian vegetation, loss of pools or riffles, lack of woody material, and streambed scour. 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 (construction, mining, timber harvest and 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 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.

Determining the cause and quantifying amounts 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 perhaps even more resources to restore the stream. DWQ is working to develop a reliable habitat assessment methodology.

Although DWQ and other agencies 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 sources become less of a source of water quality impairment, nonpoint sources that pollute water and cause habitat degradation will need to be addressed to further improve water quality in North Carolina's streams and rivers.

4.2.1 Sedimentation

Introduction

Soil erosion, transport and redeposition are among the most essential natural processes occurring in watersheds. However, land-disturbing activities such as the construction of roads and

buildings, crop production, livestock grazing, mining and timber harvesting can accelerate erosion rates by causing more soil than usual to be detached and moved by water. If best management practices (BMPs) are not used effectively, accelerated erosion can strip the land of its topsoil, decreasing soil productivity, and causing sedimentation in streams and rivers (DENR-DLR, 1998).

Sedimentation is the process by which eroded soil is deposited into waters. Sediment that accumulates on the bottom of streams and rivers smothers fish habitat vital to reproduction and impacts aquatic insects that fish feed upon. Sediment filling rivers and streams decreases their storage volume and increases the frequency of floods (DENR-DLR, 1998).

Major Causes of Sedimentation in the Roanoke River Basin

- Land clearing activities (construction and preparing land for planting crops)
- Streambank erosion
- Channelization

Suspended sediment can decrease primary productivity (photosynthesis) by shading sunlight from aquatic plants, 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, and therefore, reduced growth by some species, respiratory impairment, reduced tolerance to diseases and toxicants, and increased physiological stress (Roell, June 1999). Suspended sediment also increases the cost of treating municipal drinking water.

During 1999 basinwide monitoring, DWQ aquatic biologists reported streambank erosion and sedimentation throughout the Dan River portions of the basin that were moderate to severe. Some streams are currently considered biologically impaired due to habitat degradation related in part to these impacts. Even in streams that were not listed as impaired, lower bioclassification ratings were assigned because of sedimentation; bottom substrate was embedded by silt and/or pools were partially filled with sediment. Unstable and/or undercut (eroding) streambanks were also noted in explanation of lower ratings for the Roanoke River (DENR-DWQ, May 2000). Additionally, one section of the Dan River is impaired by excess turbidity, due in large part to suspended sediment.

Land Clearing Activities

Erosion and sedimentation can be controlled during most land-disturbing activities by using appropriate BMPs. In fact, substantial amounts of erosion can be prevented by planning to minimize the (1) amount and (2) time the land is exposed. Land clearing activities that contribute to sedimentation in the Roanoke River basin include: construction of homes and subdivisions as well as commercial and public buildings; plowing soil to plant crops; site preparation and harvest on timberlands; and road projects.

DWQ's role in sediment control is to work cooperatively with those agencies that administer sediment control programs in order to maximize the effectiveness of the programs and protect water quality. Where programs are not effective, as evidenced by a violation of instream water quality standards, and where DWQ can identify a source, then appropriate enforcement action can be taken. Generally, this would entail requiring the landowner or responsible party to install acceptable BMPs.

As a result of new stormwater rules enacted by EPA in 1999, construction or land development activities that disturb one acre or more are required to obtain a NPDES stormwater permit (refer to Part 2.7.2 of this section for more information). An erosion and sediment control plan must also be developed for these sites under the state's Sedimentation Pollution Control Act (SPCA) administered by the NC Division of Land Resources. Site disturbances of less than one acre are required to use BMPs, but a plan is not required.

Forestry activities in North Carolina are subject to regulation under the SPCA. However, a forestry operation in the Roanoke River basin may be exempt from the permitting requirements if compliance with performance standards outlined in *Forest Practice Guidelines Related to Water Quality* (15NCAC 1I .201-.209) and General Statutes regarding stream obstruction (77-13 and 77-14) are maintained. Forestry activities in the adjacent Tar-Pamlico and Neuse River basins must also adhere to the riparian buffer protection rules (15A NCAC 2B .0233 and 15A NCAC 2B .0259), established by DWQ to improve water quality in those particular basins. Extensive information regarding these performance standards and rules as they apply to forestry operations can be found on the NC Division of Forest Resources website at http://www.dfr.state.nc.us/managing/water_qual.htm.

Some Best Management Practices

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

For agricultural activities which are not subject to the SPCA, sediment controls are carried out on a voluntary basis through programs administered by several different agencies (see Appendix VI for further information).

New Rules Regarding Sediment Control

The Division of Land Resources (DLR) has the primary responsibility for assuring that erosion is minimized and sedimentation is reduced. In February 1999, the NC Sedimentation Control Commission adopted significant changes for strengthening the Erosion and Sedimentation Control Program. The following rule changes were filed as temporary rules, subject to approval by the Rules Review Commission and the NC General Assembly:

- Allows state and local erosion and sediment control programs to require a pre-construction conference when one is deemed necessary.
- Reduces the number of days allowed for establishment of ground cover from 30 working days to 15 working days and from 120 calendar days to 90 calendar days. (Stabilization must now be complete in 15 working days or 90 calendar days, whichever period is shorter.)
- Provides that no person may initiate a land-disturbing activity until notifying the agency that issued the plan approval of the date the activity will begin.
- Allows assessment penalties for significant violations upon initial issuance of a Notice of Violation (NOV).

Additionally, during its 1999 session, the NC General Assembly passed House Bill 1098 to strengthen the Sediment Pollution Control Act of 1973 (SPCA). The bill made the following changes to the Act:

- Increases the maximum civil penalty for violating the SPCA from $500 to $5000 per day.
- Provides that a person may be assessed a civil penalty from the date a violation is detected if the deadline stated in the Notice of Violation is not met.
- Provides that approval of an erosion control plan is conditioned on compliance with federal and state water quality laws, regulations and rules.
- Provides that any erosion control plan that involves using ditches for the purpose of de-watering or lowering the water table must be forwarded to the Director of DWQ.
- Amends the General Statutes governing licensing of general contractors to provide that the State Licensing Board for General Contractors shall test applicants' knowledge of requirements of the SPCA and rules adopted pursuant to the Act.
- Removes a cap on the percentage of administrative costs that may be recovered through plan review fees.

For information on North Carolina's Erosion and Sedimentation Control Program or to report erosion and sedimentation problems, visit the new website at http://www.dlr.enr.state.nc.us/ or you may call the NC Division of Land Resources, Land Quality Section at (919) 733-4574.

4.2.2 Loss of Riparian Vegetation

During 1999 basinwide sampling, DWQ biologists reported degradation of aquatic communities at numerous sites throughout the Roanoke River basin in association with narrow or nonexistent zones of native riparian vegetation. Riparian vegetation loss was common in rural and residential areas, as well as in urban watersheds (DENR-DWQ, May 2000).

Removing trees, shrubs and other vegetation to plant grass or place rock (also known as rip-rap) along the bank of a river or stream degrades water quality. Removing riparian vegetation eliminates habitat for aquatic macroinvertebrates that are food for a variety of fish. Rocks lining a bank 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 banks with grass or rock severely impact the habitat that aquatic insects and fish need to survive (WNCT, 1999).

Livestock grazing with unlimited access to the stream channel and banks can cause severe streambank erosion resulting in 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 down-cutting 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).

Probably the best-known and most widely used category of BMPs is the retention of naturally vegetated buffer strips along streams. Streamside buffers serve many functions including nutrient filtering, bank stabilization, reduction of soil and land loss, moderating water temperature (which helps maintain higher levels of dissolved oxygen, and hence, a more suitable fish environment), and providing wildlife habitat and corridors for movement (EPA, 1999).

4.2.3 Channelization

Channelization refers to the physical alteration of naturally occurring stream and riverbeds. Typical modifications are described in the text box. Although increased flooding, bank erosion and channel instability often occur in downstream areas after channelization has occurred; flood control, reduce erosion, increase usable land area, increase navigability and more efficient drainage are frequently cited as the objectives of channelization projects (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.

Direct or immediate biological effects of channelization include injury and mortality of benthic macroinvertebrates, fish, shellfish/mussels and other wildlife populations, as well as habitat loss. Indirect biological effects include changes in benthic macroinvertebrate, fish and wildlife community structures, favoring species that are more tolerant of or better adapted to the altered habitat (McGarvey, 1996).

Restoration or recovery of channelized streams may occur through natural processes or artificially induced ones. 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 down cutting. 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 throughout the Roanoke River basin and continues to occur in some watersheds, especially in small headwater streams.

4.2.4 Recommendations for Reducing Habitat Degradation

DWQ will continue to work cooperatively with DLR and other agencies that administer sediment control and instream mining programs 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 Roanoke River basin. 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 for cost sharing with local governments that set up new erosion and sedimentation control programs or conduct their own training workshops. The Sediment Control Commission will provide 40% of the cost of starting a new local erosion and sedimentation control program for up to 18 months. Two municipalities or a municipality and county can develop a program together and split the match. It is recommended that local governments draft and implement local erosion and sedimentation control programs.

Funding is also available through numerous federal and state programs for farmers 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 Section C, Part 1.4.3). 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 visit the website at http://www.epa.gov/OWOW/watershed/wacademy/fund.html. Local contacts for various state and local agencies are listed in Appendix VI.

4.3 Urban Runoff

Runoff from built-up (developed) areas carries a wide variety of contaminants to streams including sediment, oil and grease from roads and parking lots, street litter, and pollutants from the atmosphere. Generally, there are also a larger number of point source discharges in these areas. Cumulative impacts from habitat and floodplain alterations, point and nonpoint source pollution can cause severe impairment to streams.

Projected population growth over the next ten years (1998-2018) for the Roanoke River basin shows a 2-10 percent increase for Rockingham and Caswell counties, 10-20 percent increase for Vance, Person, Guilford and Forsyth counties, and a 20-30 percent increase for Stokes and Granville counties. As populations expand, so do developed areas. Some local governments in the Roanoke River basin have prioritized water quality planning; however, proactive planning efforts at the local level are needed across the entire western portion of the basin in order to assure that development is done in a manner that minimizes impacts to water quality. A lack of good environmental planning was identified by participants at the public workshops as a threat to water quality in the Roanoke River basin.

4.3.1 Urbanization

Urbanization often has greater hydrologic effects than any other land use, as native watershed vegetation is replaced with impervious surfaces in the form of paved roads, buildings, parking lots, and residential homes and yards. Urbanization results in increased surface runoff and correspondingly earlier and higher peak flows after storms. Flooding frequency is also increased. These effects are compounded when small streams are channelized (straightened) or piped and

storm sewer systems are installed to increase transport of drainage waters 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).

In and around municipalities in the Roanoke River basin, 1999 DWQ biological assessments revealed that streams are being impacted by urban stormwater runoff. Most of the impacts are in terms of habitat degradation (see Part 4.2 of this section), but runoff from developed and developing areas can also carry toxic pollutants to a stream (DENR-DWQ, May 2000).

The presence of intact riparian buffers and/or wetlands in urban areas can lessen these impacts and restoration of these watershed features should be considered where feasible; however, the amount of impervious cover should be limited as much as possible. Wide streets, huge cul-de-sacs, long driveways and sidewalks lining both sides of the street are all features of urban development that create excess impervious cover and consume natural areas.

4.3.2 Stormwater Regulations

DWQ administers a number of programs aimed at controlling stormwater runoff in the Roanoke River basin. These include: 1) programs for the control of development activities within designated water supply (WS) watersheds and in the "coastal" counties as defined by the Coastal Area Management Act (CAMA); 2) NPDES stormwater permit requirements for industrial activities and municipalities; and 3) NPDES stormwater permit requirements for construction activities on five acres of land or more. For more detailed information on current and proposed stormwater rules, refer to Part 2.7.2 of this section.

4.3.3 Recommendations for Reducing Urban Runoff

Proactive planning efforts at the local level are needed to assure that development is done in a manner that minimizes impacts to water quality. These planning efforts must find a balance among water quality protection, natural resource management and economic growth. Growth management requires planning for the needs of future population increases 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.

Planning Recommendations for New Development

- Minimize number and width of residential streets.
- Minimize size of parking areas (angled parking and narrower slots).
- Place sidewalks on only one side of residential streets.
- 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 floodplain development.
- Protect and restore wetland/bog areas.

Public education is needed in the Roanoke River basin in order for citizens to understand the value of urban planning and stormwater management. Action should be taken by county governments and municipalities to plan for new development in urban and rural areas. 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.

4.4 Turbidity in the Dan River Watershed

As was discussed in Part 4.2.1 of this section, excess sediment in streams is detrimental to fish and other aquatic life. The impact of suspended sediment, a large component of turbidity (see Glossary in Appendix VII), depends on both the concentration and duration. For example, suspended sediments may be present at high concentrations for short periods of time or at low concentrations for extended periods of time. The greatest impacts to fish populations are observed when suspended sediment is present in high concentrations for extended periods.

The turbidity water quality standard for Class C waters is 50 Nephelometric Turbidity Units (NTU). Trout waters have a more stringent water quality standard of 10 NTU. The water quality standards also indicate that "if turbidity exceeds these levels due to natural background conditions, the existing turbidity level cannot be increased". Elevated turbidity measurements were observed often in streams in the Dan River subbasins over the past five years. Refer to Part 3.3.5 for a discussion of ambient monitoring data in the Dan River watershed.

4.4.1 Instream Mining Operations

Construction sand and gravel were produced by an estimated 4,000 companies from 6,100 operations in 50 states in 2000. Overall production increased 5.4 percent in that year. It is estimated that production will increase again by 2.6 percent in 2001. Uses include concrete aggregates, road base, covering and stabilization, construction fill, concrete products (such as bricks, blocks and pipes), plaster, snow and ice control, railroad ballast, roofing granules and filtration. The most important commercial sources of sand and gravel nationwide have been river floodplains, river channels and glacial deposits (USGS, January 2001). Mining of sand and gravel occurs in two major forms: instream mining and land mining, which include floodplain excavations that often involve a connecting outlet to a stream (Meador, 1998)

The composition of the streambed and banks is an important facet of stream character, influencing channel form and hydraulics, erosion rates, sediment supply and other parameters. Channel bed and bank materials determine the extent of sediment transport and provide the means of dissipating energy in a stream or river. For a stream to be stable it must be able to consistently transport its sediment load, both in size and type, associated with local deposition and scour. Channel instability occurs when the scouring process leads to degradation (deepening or lowering of channel elevation) or excess sediment results in aggradation (filling or raising of channel elevation) (Rosgen, 1996).

In addition to physical stream changes, sedimentation and increased turbidity also can accrue from mining activities, wash-water discharge, and storm runoff from active or abandoned mining sites. Other effects may include higher stream temperatures and reduced dissolved oxygen, lowering of the water table, and decreased wetted periods in riparian wetlands. Expansion of a mine site or mining at a new site is often preceded by riparian forest clearing, which can affect instream habitat and contribute to bank instability (Meador, 1998).

The Division of Land Resources' (DLR) Mining Program "provide(s) for the mining of mineral resources while ensuring the usefulness, productivity and scenic value of all lands and waters" in North Carolina. DLR issues permits for two types of instream mining which are described in the text box: sand dipping (DP) and sand dredging (DR). Figure A-23 presents permitted instream mining sites in the North Carolina portion of the Dan River watershed. There are four permitted sand dredging operations and two permitted sand dipping operations in a 35-mile stretch of the Dan River between Walnut Cove and Eden.

Two Types of Instream Mining Permits

Sand Dipping – Removes sand from the river bottom through the use of a dragline (a crane with a bucket) that sits on the riverbank. There is potential for large amounts of vegetation to be removed from the riverbank with this type of mining operation.

Sand Dredging – Hydraulically removes sand from the river bottom through the use of a floating dredge and a suction pump.

Processing typically includes screening and grading sand in wash water (usually stream water), and discharging the wash water into settling pits before releasing it back into the stream (Meador, 1998)

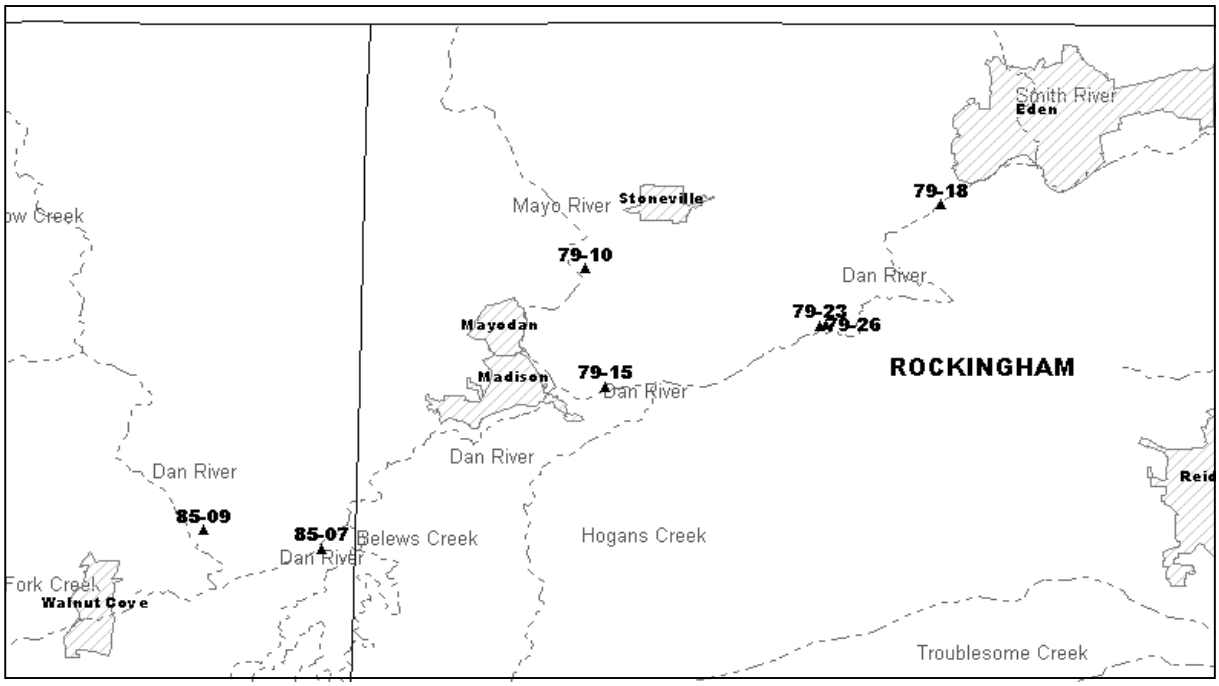


Figure A-23 Permitted Instream Mine Sites in the Dan River Watershed (DLR, June 2001)

The NC Wildlife Resources Commission (WRC) has identified 10 aquatic species that are endangered, threatened or of special concern (refer to Table A-12 in Part 2.6.3) in the North Carolina portion of the Dan River watershed: seven species of fish, two mussels and one salamander. Because of these sensitive species, DLR may restrict instream mining operations during the fishes' spawning season in the Dan River. Additionally, river access for sand dipping operations is restricted to specific, size-limited points along the river. Operations that had removed large amounts of riparian vegetation were required to restore streambanks and reestablish an appropriate vegetated buffer. The buffer must be maintained throughout the life of the permit.

Typically, instream mining permits for sand dipping operations are issued for 5 years and sand dredging operations are permitted for 10 years. However, because WRC, DLR and DWQ are continuing to collect more data and learn more about the effects of operations on aquatic life and water quality in the Dan River, shorter term permits may be required. One new permit for instream mining operations in the Dan River has been denied.

4.4.2 Recommendations

DWQ will work with DLR to evaluate and reduce turbidity from permitted instream mining operations in the Dan River. As permits are renewed, monitoring upstream and downstream of mining operations and instream BMPs (such as those used by the NC Department of Transportation during bridge construction) could be required. In addition, DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

4.5 Dissolved Oxygen in the Lower Roanoke River Basin

Maintaining an adequate amount of dissolved oxygen (DO) is critical to the survival of aquatic life and to the general health of surface waters. A number of factors influence DO concentrations including water temperature, depth and turbulence. Additionally, in the Roanoke River basin, a large floodplain drainage system and flow management from upstream impoundments also influence DO. The dissolved oxygen water quality standard for Class C waters is "not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l". Swamp waters (Class C Sw) "may have lower values if caused by natural conditions" (DENR, August 2000).

Oxygen-consuming wastes such as decomposing organic matter and some chemicals can reduce dissolved oxygen levels in surface water through biological activity and chemical reactions. NPDES permits for wastewater discharges set limits on certain parameters in order to control the effects that oxygen depletion can have in receiving waters. This section discusses discharges of oxygen-consuming wastes in the Roanoke River basin and studies that have been, or are currently being, conducted to better understand dissolved oxygen in the Roanoke River mainstem.

For more information about oxygen-consuming wastes and what DWQ does to limit water quality impacts from these wastes, refer to *A Citizen's Guide to Water Quality Management in North Carolina*. This document is available online at http://h2o.enr.state.nc.us/basinwide/ or by calling (919) 733-5083.

4.5.1 Discharges to Zero Flow Streams

Because of the nature of the coastal plain region of the state (refer to Part 2.3 of Section A), streams in the lower portion of the Roanoke River basin have a low potential for sustaining base flow. This low flow frequency, measured by a 7Q10 (annual minimum 7-day consecutive low flow, which on average, will be exceeded 9 out of 10 years) flow calculation, is zero for all but the largest watersheds. This very low flow over the hottest several months of the year limits streams' ability to maintain high dissolved oxygen levels (temperature increases depleting

dissolved oxygen while velocity decreases so there is little reaeration). The capacity for streams to assimilate oxygen-consuming wastes is also limited under these conditions. DWQ developed regulations for evaluating discharges to such waters.

In 1980, a study was performed on zero flow streams (7Q10 = 0 cfs and 30Q2 = 0 cfs) to determine the effect of wastewater discharges. The study concluded that:

- Steady-state models do not apply to zero flow streams, particularly those receiving waste from small discharges.
- The pool/riffle configuration of these small streams results in violations of the DO standard even when wastewater is well treated.
- Small streams receiving wastes from schools, mobile home parks, subdivisions, etc. flow through populated areas where children have easy access to streams.
- Noxious conditions were found in the low flow streams that were part of the study.

As a result of the study, regulations [15A NCAC 2B .0206 (d)] were developed that prohibit new or expanded discharges of oxygen-consuming wastes to zero flow streams. Existing facilities discharging to zero flow streams were evaluated for alternatives to discharge. Many facilities found alternatives to a surface water discharge, and some built new treatment plants to meet advanced tertiary limits for BOD_5 and NH_3-N.

This policy typically covers small discharges such as schools, mobile home parks, subdivisions and rest homes, which discharge to zero flow streams in headwater areas. Such discharges generally do not cause significant water quality problems in the mainstem of the Roanoke River or larger tributaries, but they can cause localized problems in the zero flow receiving streams.

The results of the 1980 study were extrapolated to facilities discharging to low flow streams (those with a 7Q10 = 0, but with a 30Q2 > 0) since similar adverse impacts are expected in these waters. Regulations [15A NCAC 2B .0206 (d)] were developed to set effluent limitations for new and expanding discharges to 5 mg/l BOD_5, 2 mg/l NH_3-N and 6 mg/l dissolved oxygen (DO) unless it is determined that these limitations will not protect water quality standards.

4.5.2 Modeling Dissolved Oxygen in the Roanoke River

In 1995, DWQ developed a field-calibrated, steady-state model for dissolved oxygen in approximately 74 miles of the Roanoke River**,** which extends from the NC 48 bridge at Roanoke Rapids to the Wildlife Resources Commission boat ramp at Hamilton. At existing permitted loads during low flow conditions, the predicted minimum dissolved oxygen level is approximately 6.0 mg/l. Currently, DWQ does not have the proper modeling tool in place to determine the potential impacts of new or expanding discharges of oxygen-consuming wastes on the lower Roanoke River and Albemarle Sound (see Recommendations).

4.5.3 Other Dissolved Oxygen Studies

Five US Geological Survey (USGS) continuous monitoring stations measure dissolved oxygen and temperature along the Roanoke River at 15-minute intervals. Data collection began in 1998 and continues into 2001. These stations were being funded by the US Fish and Wildlife Service;

however, Dominion is funding their operation for several months in 2001. Refer to Part 3.4 for further information and a partial data summary.

In 1996 and 1997, personnel from the Roanoke River National Wildlife Refuge monitored the Roanoke River and its tributaries from Indian Creek to Coniott Creek for dissolved oxygen (DO) and pH. DO concentrations less than 2.0 mg/l were documented in Coniott Creek from April to November 1996. In 1997, DO concentrations of less than 2.0 mg/l were recorded only in July. Black Gut showed DO concentrations less than 2.0 mg/l from August to October 1996. At other locations there were sporadic low DO events, but none were longer than two weeks duration (DENR-DWQ, May 2000). DWQ has no means for determining whether these particular data represent natural conditions or impacts from man-induced changes in the watershed; and therefore, this information is simply reported. These data were not used as a basis for use support determinations.

Studies to determine impacts of Roanoke Rapids and Gaston Hydropower Project operations on DO concentrations in the Roanoke River mainstem and tributaries are being conducted by Dominion, in cooperation with DWQ and other federal and state natural resource agencies, as part of the Federal Energy Regulatory Commission's (FERC) hydropower dam relicensing process (refer to Part 4.6.2 below for further information). Section 401 of the federal Clean Water Act states that no federal agency can issue any license or permit to conduct any activity that may result in a discharge to navigable waters, unless the state in which the discharge may occur certifies that the discharge will not result in a violation of any state water quality or related standards. The water quality studies currently being conducted will provide DWQ with the data needed to make this determination.

4.5.4 Recommendations

DWQ will continue to evaluate proposed discharges of oxygen-consuming wastes on a case-by-case basis. For discharges above the WRC boat ramp at Hamilton, the model will be re-evaluated, including the proposed discharge, to determine the impact of oxygen-consuming waste on the Roanoke River. If a discharge is proposed below the boat ramp at Hamilton, or if the model predicts a potential impact from a proposed discharge above the boat ramp at Hamilton, the Division will require the applicant to meet Best Available Technology (BAT) limits or to provide/fund a multi-dimensional estuary model.

DWQ will ensure through the 401 Water Quality Certification process that Roanoke Rapids and Gaston Hydropower Project operations will not result in violations of water quality standards.

4.6 Major Studies Related to Water Quality

Several large studies are being conducted in the Roanoke River basin that could impact water quality. Current work includes: EPA/Weyerhaeuser Company Dioxin Contamination Studies, FERC Relicensing of Hydropower Projects and the US Army Corps of Engineers Section 216 study. This section discusses the nature of these studies.

4.6.1 EPA/Weyerhaeuser Dioxin Contamination Studies

The EPA and Weyerhaeuser are conducting a Remedial Investigation and Feasibility Study for the Weyerhaeuser Company-Plymouth Facility (Washington County). The work addresses dioxin contamination of Welch Creek (refer to Section B, Part 9.2.1 for more information), as well as potential contaminant sources on the property (i.e., the former chlorine plant and on-site landfill). Related studies are being conducted by the EPA (alone) on the extent of dioxin contamination in the lower Roanoke River and western Albemarle Sound. Biological effects of that contamination will also be evaluated.

4.6.2 FERC Relicensing of Hydropower Projects

The license issued by the Federal Energy Regulatory Commission (FERC) to Dominion (formerly North Carolina Power Company) for the operation of the Roanoke Rapids and Gaston Hydroelectric Project expired on January 31, 2001. The relicensing process began in early 1995 and will include an assessment of how current and future project operations may affect environmental resources in the Roanoke River basin. Several studies related to instream flow are at various stages of completion. Additionally, studies to determine impacts of project operations on DO concentrations in the Roanoke River mainstem and tributaries are being conducted by Dominion, in cooperation with DWQ and other federal and state natural resource agencies. Three technical work groups, including a water quality subcommittee, are analyzing the results of these studies. The next *Roanoke River Basinwide Water Quality Plan* will summarize relevant data collected during this process.

The Pinnacles Hydro-Electric Project is also undergoing relicensing at this time. It is owned by the City of Danville, but is located on the headwaters of the Dan River near Meadow of Dan, Virginia. The project consists of two impoundments: Talbott and Townes Reservoirs. Talbott is used as storage and supplies water to Townes downstream. From Townes Reservoir, water bypasses a stretch of the Dan River channel to the powerhouse where water is returned to the river. Changes in the flow regimes or general operation of this project have the potential to impact water quality in the North Carolina portion of the Dan River.

4.6.3 USCOE Section 216 Study

The US Army Corps of Engineers (COE) is conducting a Section 216 Study to investigate the operations of Kerr Dam and Reservoir and the impact of those operations, both from an environmental and a hydrologic perspective. The Section 216 Study is a multiyear process and will involve four stages: 1) Reconnaissance Phase; 2) Feasibility Study; 3) Planning, Engineering and Design; and 4) Construction.

Currently, the Section 216 Study for Kerr is in the Reconnaissance Phase. During the Reconnaissance Phase, the Corps determines concerns of basin stakeholders regarding dam and reservoir operations and prepares a report summarizing these areas of concern. The Feasibility Study is typically a three-year study of the basin and the impacts caused by dam and reservoir operations, during which data are collected and analyzed. During Planning, Engineering and Design, plans are made for things such as wetland restoration, buffers, changes in turbines, etc. The Construction Phase is the final implementation phase of the project.

4.6.4 Recommendations

DWQ will continue to follow these studies and provide assistance and input as is appropriate. Any results that become available over the next five-year basinwide planning cycle will be discussed in the revised *Roanoke River Basinwide Water Quality Plan* (2006).

4.7 Protecting Headwaters

Many streams in a given river basin are only small trickles of water that emerge from the ground. 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. However, impairment of headwater streams can (and does) impact the larger stream or river.

Headwater areas are found from the mountains to the coast along all river systems and drain all of the land in a river basin. 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 and excluding cattle from streams. Local rural and urban planning initiatives should also consider impacts to headwater streams when land is being developed.

On a larger scale, many streams in the NC portion of the Dan River watershed are part of the headwaters of the Roanoke River basin. They are important as sources of water for downstream water supplies and as food production sources for downstream aquatic life. For a more detailed description of watershed hydrology, please refer to EPA's Watershed Academy website at http://www.epa.gov/OWOW/watershed/wacademy/acad2000/watershedmgt/principle1.html.

4.8 Biological Community Assessment Issues

DWQ strives to properly evaluate the health of biological communities throughout the state. Swamp stream systems, non-wadeable waters and coldwater fisheries have presented unique challenges. This section discusses some of these challenges. This section also discusses the accumulation of contaminants in fish tissues and how waters with consumption advisories are assessed by DWQ.

4.8.1 Draft Criteria for Assessing Benthic Macroinvertebrates in Swamp Streams

Extensive evaluation, conducted by DWQ, of swamp streams across eastern North Carolina suggests that different criteria must be used to assess the condition of water quality in these systems. Swamp streams are characterized by slower flow, lower dissolved oxygen and lower pH. Sometimes they also have very complex braided channels and dark-colored water. Since 1995, benthos swamp sampling methods have been used at over 100 sites in the coastal plain of North Carolina, including more than 20 reference sites. In 1999, 16 sites on swamp streams in the Roanoke River basin were sampled by DWQ. Preliminary investigations indicate that there

are at least four unique swamp ecoregions in the NC coastal plain. The lowest "natural" diversity has been found in low-gradient streams (especially in the outer coastal plain east of the Suffolk Scarp) and in areas with poorly drained soils.

DWQ has developed draft biological criteria that may be used in the future to assign bioclassifications to these streams (as is currently done for other streams and rivers across the state). However, validation of the swamp criteria will require collecting data for several years from swamp stream reference sites. The criteria will remain in draft form until DWQ is better able to evaluate such things as: year-to-year variation at reference swamp sites, effects of flow interruption, variation among reference swamp sites, and the effect of small changes in pH on the benthos community. Other factors, such as whether the habitat evaluation can be improved and the role fisheries data should play in the evaluation, must also be resolved. While it may be difficult to assign use support ratings to these swamp streams, these data can be used to evaluate changes in a particular stream between dates or to evaluate effects of different land uses on water quality within a relatively uniform ecoregion.

4.8.2 Draft Criteria for Assessing Fish Communities in Non-Wadeable Streams

In the past, most fish communities were sampled by DWQ and scores were assigned using the North Carolina Index of Biotic Integrity (NCIBI). The NCIBI uses a cumulative assessment of twelve parameters or metrics. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. [Appendix II contains more information regarding the NCIBI.]

However, during the late 1990s, application of the NCIBI was restricted to wadeable streams that can be sampled by a crew of 2-4 persons using backpack electrofishers and following the DWQ Standard Operating Procedures (NCDEHNR, 1997). Work began in 1998 to develop a fish community boat sampling method that could be used in non-wadeable coastal plain streams. Plans are to sample 10-15 reference sites with the boat method once it is finalized. As with the benthos in swamp streams, several years of reference site data will be needed before criteria can be developed with confidence to evaluate the biological integrity of large streams and rivers, like the Roanoke River, using the fish community.

4.8.3 Fish Consumption Advisories

The NC Department of Health and Human Services (DHHS) Occupational and Environmental Epidemiology Branch has developed guidelines to advise people as to safe levels of fish consumption. DWQ considers uses of waters with a consumption advisory for one or more species of fish to be impaired. Currently, there are several different fish consumption advisories in the North Carolina portion of the Roanoke River basin. In the western portion of the Roanoke River basin, Hyco Lake has a limited consumption advisory due to selenium contamination, and a portion of the Dan River in Virginia has an advisory because of elevated levels of polychlorinated biphenols (an organic compound abbreviated PCB). The lower Roanoke River, Welch Creek and a portion of the Albemarle Sound, in the eastern portion of the basin, have limited consumption advisories due to high levels of dioxin in fish tissue. The reasons for these advisories and actions taken by DWQ and others to reduce or eliminate the source of selenium and dioxin are discussed in detail in the appropriate subbasin chapter in Section B.

Additionally, in 1997, DHHS issued a statewide fish consumption advisory due to elevated levels of mercury in bowfin (also known as blackfish). As a result of this advisory, DWQ considers all waters in the Roanoke River basin to be partially supporting the fish consumption use. (Refer to Appendix III for more information regarding use support ratings and assessment methodology.)

DWQ has sampled fish tissue from a variety of species at eight locations in the Roanoke River basin. Mercury levels in bowfin from both the Roanoke and Cashie Rivers exceed the North Carolina action level for mercury in fish.

The presence and accumulation of mercury in North Carolina's aquatic environment is 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 into biological organisms. Mercury circulates in the environment as a result of natural and human (anthropogenic) activities. A dominant pathway of mercury in the environment is through the atmosphere. Mercury that has been emitted from industrial and municipal stacks into the ambient air can circulate across 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 levels in fish.

For more information regarding fish consumption advisories, visit the NC Department of Health and Human Services website at http://www.schs.state.nc.us/epi/fish/current.html or call (919) 733-3816.

4.8.4 Recommendations for Biological Community Assessment

DWQ will continue to monitor concentrations of various contaminants in fish tissue across the state (in cooperation with several NPDES permitted dischargers) and will work to identify and reduce wastewater contributions of mercury to surface waters. The Division of Air Quality (DAQ) evaluates mercury levels in rainwater on a regular basis through the EPA Mercury Deposition Network. EPA continues to focus on nationwide mercury reductions from stack emissions and through pollution prevention efforts. Given the global scale of mercury cycling, it may be difficult for state and federal agencies to recognize significant reductions of mercury in fish over the short-term. Governmental and scientific agencies and organizations will continue efforts to reduce mercury cycling on a national and global scale.

DWQ will also continue to work to prepare and improve biological monitoring criteria.

4.9 Effects of Hurricanes on Water Quality

The Roanoke River basin in North Carolina is periodically subjected to hurricanes and tropical storms. Aquatic ecosystems and water quality can, and do, recover from the wind damage and extensive flooding that result from these storms. However, human activities in hurricane-prone areas can greatly increase the extent and severity of water quality and ecosystem impacts, as well as the system's recovery time.

In September 1999, Hurricane Floyd made landfall in North Carolina only a few days after Hurricane/Tropical Storm Dennis, made two passes across the eastern part of the state. Wind

damage was not as severe as what has occurred during these types of storms in the past; however, flooding in eastern North Carolina was higher and more extensive than any ever recorded. Many towns and homes were completely inundated, and in some areas because of extended rainfall after Floyd, flooding continued for weeks. Bridges and buildings were washed downstream, animal waste lagoons breached, and wastewater treatment plants were inundated. Floyd resulted in more fatalities than any hurricane to strike the United States since 1972. More than 50 people in North Carolina were killed and thousands were left homeless (Bales, 2000).

4.9.1 Contaminants

Floods can transport large amounts of materials from the land into surface waters, inundate areas that are contaminated with various substances, flood wastewater treatment facilities that may be located in or near the floodplain, and result in the failure of animal waste lagoons. The large volume of water transported during the Hurricane Floyd flooding demonstrated that even low concentrations of pollutants can result in the transport of an extremely large mass of these materials through watersheds and into the estuaries of eastern North Carolina. Pollutants that can be carried into waters during large floods include excess nutrients (nitrogen, phosphorus and organic carbon), bacteria and other pathogens, pesticides and fuels, and sediment. As a result of contamination by these pollutants, dissolved oxygen can be depleted, causing stress (or death) to fish and other aquatic life. Salt concentrations in the estuaries can also be affected by the large volume of freshwater flowing into the system within a short period of time.

Although the Roanoke River basin comprises almost 33 percent of the total Albemarle-Pamlico Sound drainage area, freshwater inflow from this basin accounted for only about 10 percent of the total inflow to the sound following the 1999 hurricanes because of (1) the presence of a large flood-control reservoir at the lower end of the basin and (2) the paths of the hurricanes avoided much of the basin. On the other hand, the Neuse and Tar-Pamlico basins, which together compose about 31 percent of the Pamlico Sound drainage area, contributed 44 percent of the inflow to the sound in September and more than 50 percent of the inflow in October. This is particularly important because both of these rivers are known to carry relatively high loads of nutrients and other contaminants. Even though flooding was not as severe in the Roanoke River basin compared to the Neuse and Tar-Pamlico River basins, the previously recorded maximum water level on the Cashie River was exceeded by seven feet during Hurricane Floyd, and the flood recurrence interval was greater than 500 years (Bales, 2000).

4.9.2 De-snagging

Emergency de-snagging (removal of piles of woody debris from stream and river channels) began after the storm as part of Natural Resources Conservation Services' (NRCS) Emergency Watershed Protection (EWP) program. NRCS intends for this activity to be used only to prevent imminent flooding around bridges and economic loss of property. Therefore, much of the NRCS-supervised de-snagging operations affected only the areas in streams and rivers immediately upstream and downstream of road crossings. NRCS also intends to remove only debris that was deposited during the storm, leaving in place snags that predated the event such as those associated with beavers. However, there were difficulties assessing snag origins and ages because most of the de-snagging projects did not start until almost a year after the storm.

In addition to the EWP program, funding from the Federal Emergency Management Agency (FEMA) was also made available to some local governments for additional de-snagging activities. There was no requirement associated with this funding that the operations be monitored to prevent excessive or improper removal of woody debris. Several stream segments and wetland areas in non-emergency situations were completely cleared of debris and snags and, in some cases, relocated and channelized using this funding.

Woody debris is the predominant habitat for benthic macroinvertebrates in larger, slower-moving coastal stream and wetland systems. Therefore, removal of these snags removes most of the habitat available for aquatic life. If care is not taken in properly removing woody debris, the streambanks and streambed can be altered as well as causing moderate to severe habitat degradation. Although no de-snagging activities have been reported or observed in the Roanoke River basin following Hurricane Floyd, it is important for citizens to be aware of water quality concerns associated with this activity.

4.9.3 Bank Failure

There are many places along the Roanoke River where large portions of the riverbank fell as a result of high flows during and following Hurricane Floyd. When these banks began to fail, tons of sediment were washed into the river along with trees and other debris. The portion of river near Hamilton seems to be the area with the most damage; however, smaller sections of severe erosion are scattered along the entire length of river from Weldon to Jamesville. Preventing further erosion and land loss near Hamilton will require a large expenditure of time and resources.

4.9.4 Recommendations

Benthic macroinvertebrate data collected prior to the hurricanes in coastal river basins were from summer or winter collections, with little fall sampling available for comparisons. It is not yet possible to conduct a detailed analysis of post-hurricane samples at many stream sites, because some normal seasonal differences would be present in fall samples. However, some sampling of reference swamp streams was conducted by DWQ in November 1999. These collections did not indicate any significant damage from Hurricane Floyd (DENR-DWQ, December 1999). The next *Roanoke River Basinwide Water Quality Plan* will summarize data collected in the basin over the next five-year (2000-2004) cycle.

DWQ is aware of the need to remove obstructions to water flow, including snags, in the vicinity of bridges or other structures in emergency situations because of safety concerns and to reduce economic loss in the event of natural disasters. However, the NRCS should reevaluate allowing de-snagging after the immediate emergency situation has passed. The method in which snags are removed, the amount of debris that is removed, and the sites selected could all be approached, during a non-emergency situation, in such a manner as to reduce impacts to the stream channel and aquatic communities. Local governments that receive additional funding for this type of activity should also take water quality into consideration.

4.10 Priority Issues for the Next Five Years

Clean water is crucial to the health, economic and ecological well-being of the state. Tourism, water supplies, recreation and a high quality of life for residents are dependent on the water resources within any given river basin. Water quality problems are varied and complex. Inevitably, water quality impairment is due to human activities within the watershed. Solving these problems and protecting the surface water quality of the basin in the face of continued growth and development will be a major challenge. Looking to the future, water quality in this basin will depend on the manner in which growth and development occur.

The long-range mission of basinwide management is to provide a means of addressing the complex problem of planning for increased development and economic growth while protecting and/or restoring the quality and intended uses of the Roanoke River basin's surface waters. In striving towards its mission, DWQ's highest priority near-term goals are to:

- identify and restore impaired waters in the basin;
- identify and protect high value resource waters and biological communities of special importance; and
- protect unimpaired waters while allowing for reasonable economic growth.

4.10.1 Strategies for Restoring and Protecting Impaired Waters

Impaired waters are those waters identified in Section A, Chapter 3 as partially supporting (PS) or not supporting (NS) their designated uses based on DWQ assessments of monitoring data. These waters are summarized by subbasin in Table A-31 and indicated on Figures A-21 and A-22. The impaired waters are also discussed individually in the subbasin chapters in Section B.

These waters are impaired, at least in part, due to nonpoint sources (NPS) of pollution. The tasks of identifying nonpoint sources of pollution and developing management strategies for these impaired waters are very resource intensive. Accomplishing these tasks is overwhelming, given the current limited resources of DWQ, other agencies (e.g., Division of Land Resources, Division of Soil and Water Conservation, Cooperative Extension Service, etc.) and local governments. Therefore, only limited progress towards restoring NPS impaired waters can be expected during this five-year cycle unless substantial resources are put toward solving NPS problems.

DWQ plans to further evaluate the impaired waters in the Roanoke River basin in conjunction with other NPS agencies and develop management strategies for a portion of these impaired waters for the next Roanoke River Basinwide Water Quality Plan, in accordance with the requirements of Section 303(d) (see below).

4.10.2 Addressing Waters on the State's Section 303(d) List

For the next several years, addressing water quality impairment in waters that are on the state's 303(d) list will be a priority. The waters in the Roanoke River basin that are on this list are presented in the individual subbasin descriptions in Section B. For information on listing requirements and approaches, refer to Appendix IV.

Section 303(d) of the federal Clean Water Act requires states to develop a 303(d) list of waters not meeting water quality standards or which have impaired uses. States are also required to develop Total Maximum Daily Loads (TMDLs) or management strategies for 303(d) listed waters to address impairment. In the last few years, the TMDL program has received a great deal of attention as the result of a number of lawsuits filed across the country against EPA. These lawsuits argue that TMDLs have not adequately been developed for specific impaired waters. As a result of these lawsuits, EPA issued a guidance memorandum in August 1997 that called for states to develop schedules for developing TMDLs for all waters on the 303(d) list. The schedules for TMDL development, according to this EPA memo, are to span 8-13 years.

There are approximately 2,387 impaired stream miles on the 2000 303(d) list in NC. The rigorous and demanding task of developing TMDLs for each of these waters during an 8 to 13-year time frame will require the focus of much of the water quality program's resources. Therefore, it will be a priority for North Carolina's water quality programs over the next several years to develop TMDLs for 303(d) listed waters.

Section B

Water Quality Data
and
Information by Subbasin

Chapter 1 -
Roanoke River Subbasin 03-02-01
Includes a portion of the Dan River, Town Fork and Snow Creeks

1.1 Water Quality Overview

Subbasin 03-02-01 at a Glance

Land and Water Area

Total area:	453 mi^2
Land area:	445 mi^2
Water area:	8 mi^2

Population

1990 Est. Pop.:	45,777 people
Pop. Density:	103 persons / mi^2

Land Cover (%)

Forest / Wetland:	72.8
Water:	1.9
Urban:	0.6
Cultivated Crop:	2.9
Pasture / Managed Herbaceous:	21.8

Although the headwaters of the Dan River are in Virginia, this North Carolina subbasin contains a large portion of the upper reaches that flow through moderately steep terrain including the towns of Danbury and Walnut Cove. Waters include Snow Creek, North and South Double Creeks, Town Fork Creek and Belews Lake. A map of this subbasin including water quality sampling locations is presented in Figure B-1.

Bioclassifications for these sample locations are presented in Table B-1. Use support ratings for each applicable category in this subbasin are summarized in Tables B-2 and B-3. Refer to Appendix III for a complete listing of monitored waters and more information about use support ratings.

As a result of moderately steep slopes throughout the area, streams in this subbasin, as well as major sections of the Dan River, are deeply entrenched, suggesting the effects of long-term erosion. Soil erosion rates as high as 21 tons/acre/yr have been documented for cultivated cropland in the upper Dan River watershed, compared to 7.3 tons/acre/yr in the nearby upper Tar River basin (USDA, 1992).

Most of the land in this portion of the basin is forested (73 percent), but a significant portion is also in use as cultivated cropland and pasture (25 percent). The estimated subbasin population, based on the 1990 census, is 45,777. Stokes County is projected to receive the largest population increase of the sixteen counties in the Roanoke River basin (NC portion). From 1998 to 2018, estimated population growth for Stokes County is 28 percent and Forsyth County is 16 percent.

There are 23 NPDES permitted dischargers in the subbasin, most of which are small wastewater treatment plants serving schools or subdivisions. Four of these small wastewater treatment plants had problems with elevated BOD and ammonia in their discharges. The largest discharge is from the Town of Walnut Cove's WWTP to Town Fork Creek. Duke Power Company's Belews Creek Steam Station discharges cooling water to Belews Lake and ash pond basin effluent to the Dan River. Five dischargers, including the steam station, are required to monitor their effluent's toxicity: Kobe Copper Products, two Stokes County high schools, and Rayco Utilities. There were no indications of toxicity problems in 1999, and substantial improvements in effluent toxicity were observed relative to earlier data.

Figure B-1 Upper Dan River Subbasin 03-02-01

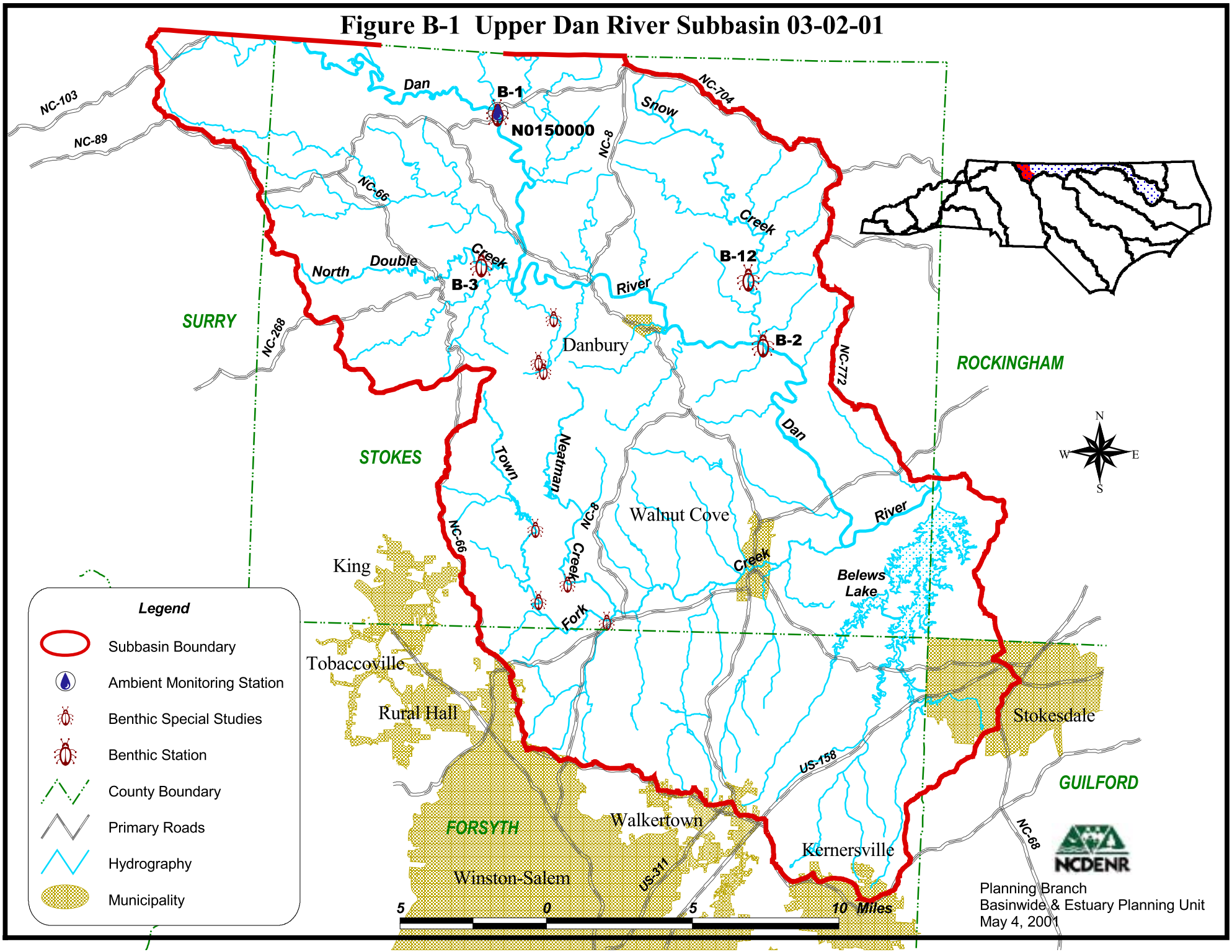


Table B-1 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999-2000) for Roanoke River Subbasin 03-02-01

Site	Stream	County	Road	Bioclassification
Benthic Macroinvertebrates				
B-1*	Dan River	Stokes	NC 704	Good
B-2	Dan River	Stokes	SR 1695	Good
B-3	North Double Creek	Stokes	SR 1504	Good-Fair
B-12	Snow Creek (1999)	Stokes	SR 1673	Fair
B-12	Snow Creek (2000)	Stokes	SR 1673	Good
Ambient Monitoring				
N0150000	Dan River	Stokes	NC 704	N/A

* Historical data are available; refer to Appendix II.

Benthic macroinvertebrates in this subbasin were sampled under extreme low flow conditions in 1999. For larger streams affected by nonpoint source pollution, a sharp decline in flow may result in a higher bioclassification; smaller streams, however, might be adversely affected by extremely low flow.

No sample was collected at Town Fork Creek in 1999 due to inaccessibility, but a special study was conducted in the watershed in 1995. Two sites in the middle portion of Town Fork Creek (see Figure B-1) received Good-Fair bioclassifications, but the upstream portion received a Poor bioclassification. The aquatic life/secondary recreation uses in the upper part of Town Fork Creek are impaired. This portion is discussed further in Part 1.3.1 of this chapter. Neatman Creek was also sampled as part of the study and the benthic community received a Good bioclassification.

Good benthic macroinvertebrate bioclassifications have been recorded since 1983 from the two Dan River sampling locations, but more variable results have been observed at tributary sites. Historically, the only Excellent bioclassifications were from small headwater tributaries in Hanging Rock State Park which are classified High Quality Waters.

Snow Creek received the lowest bioclassification (Fair) of the four sites sampled in 1999. Snow and North Double Creeks both drain agricultural areas, and their bioclassifications have fluctuated between Fair and Good-Fair. Because of this fluctuation, Snow Creek was sampled again by DWQ in August 2000. The benthic community received a Good bioclassification at the time of this collection. Part 1.5.1 contains more details about impacts observed at Snow Creek.

Water chemistry samples are collected monthly from the Dan River a few miles above Danbury. This site is located well into North Carolina, but above any major tributaries in order to monitor the condition of the river as it flows in from Virginia. These data have indicated good water quality, with the exception of turbidity and total suspended solids. The Dan River at this location is protected for trout propagation and survival of stocked trout (Tr) making the water quality

standard for turbidity, among other parameters, more restrictive. This turbidity standard was exceeded in 35 percent of samples collected from 1995 to 1999, at times reaching levels seven and eight times the standard. For more information regarding general water quality issues in the Dan River watershed, including sedimentation, refer to Section A, Chapter 4.

Three lakes in this subbasin were monitored in 1999: Hanging Rock Lake, Kernersville Reservoir and Belews Lake. Hanging Rock and Belews Lakes are oligotrophic lakes with no indications of water quality problems. Kernersville Lake's status changed from mesotrophic in 1994 to eutrophic in 1999, reflecting high nitrogen and phosphorus concentrations. In 1999, chlorophyll *a* concentrations were greater than the state standard; however, no algal blooms have been reported.

For more detailed information on sampling and assessment of streams and lakes in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-2 Use Support Ratings Summary (1999) for Monitored Lakes (acres) in Roanoke River Subbasin 03-02-01

Use Support Category	FS	PS	NS	Total[1]
Aquatic Life/ Secondary Recreation	4,087	0	0	4,087
Fish Consumption[3]	0	4,030	0	4,030
Primary Recreation	4,042	0	0	4,042
Water Supply	4,075	0	0	4,075

Table B-3 Use Support Ratings Summary (1999) for Monitored and Evaluated[2] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-01

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation	288.1	0	8.0	137.3	433.4
Fish Consumption[3]	0	55.8	0	0	55.8
Primary Recreation	0	0	0	11.3	11.3
Water Supply	45.2	0	0	0	45.2

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information. Fish tissue monitoring in the Dan River is discussed in Chapter 3 of this section.

1.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River Basinwide Plan identified one impaired water in this subbasin: Belews Lake. This lake is no longer impaired and is discussed in further detail below.

1.2.1 **Belews Lake** (4,030 acres)

1996 Recommendation(s)

Belews Lake was constructed by Duke Power Company in 1973 to provide a source of cooling water for the Belews Creek Steam Station. Water was used to wash out ash residue, routed to a settling pond, and then discharged into the lake. In 1978, it was determined that this practice resulted in the accumulation of high concentrations of selenium in fish tissue. The 1996 plan reported a fish consumption advisory for selenium contamination in common carp, redear sunfish and crappie, which resulted in a rating of partially supporting for the lake. In 1984, the Belews Creek Steam Station upgraded their ash disposal system and rerouted the discharge into the Dan River. The current NPDES permit contains a protective selenium limitation. Therefore, the only recommendation given in the 1996 plan was to monitor selenium concentrations in water quality and fish tissue in the lake and the Dan River.

Status of Progress

Belews Lake was most recently sampled by DWQ during the summer of 1999. Surface water selenium concentrations were less than the laboratory detection limit. Concentrations in benthic macroinvertebrates have declined, but are still at levels higher than those observed in benthic macroinvertebrates found in uncontaminated waters. Selenium concentrations in fish tissue have declined to levels considered safe for human consumption by the Department of Health and Human Services. The consumption advisory was lifted in August 2000. Chapter 3 of this section discusses recent fish tissue monitoring in the Dan River below Belews Lake (near Eden).

1.3 Status and Recommendations for Newly Impaired Waters

Town Fork Creek, from its source to Timmons Creek, is an additional stream segment rated impaired (not supporting) based on recent DWQ monitoring (1995-1999). This section outlines the potential causes and sources of impairment and provides recommendations for improving water quality.

1.3.1 **Town Fork Creek** (8.0 miles from source to Timmons Creek)

Current Status

During a special study conducted by DWQ in 1995, the upper section of Town Fork Creek received a Poor benthic macroinvertebrate bioclassification. As a result, the referenced portion of the stream is rated not supporting aquatic life due to severe habitat degradation and possible organic enrichment. The stream is impounded above the sample location, and the drainage area supports a mixture of agricultural and residential land uses. There is one small permitted

discharge on an unnamed tributary higher up in the watershed, but records do not indicate any problems at the facility.

2001 Recommendation(s)
More field investigation is needed in order to determine the actual sources of pollution in this watershed. DWQ will further investigate the one permitted facility to ensure compliance. However, identification and reduction of nonpoint sources of pollution that contribute to habitat degradation will likely result in significant improvement for the aquatic community at this location. Refer to Section A, Chapter 4 for more information about habitat degradation.

1.4 Section 303(d) Listed Waters

Belews Lake (discussed above) is the only water listed on the state's year 2000 303(d) list. A portion of Town Fork Creek, discussed above, will likely be added to the list in 2002. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

1.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program agency contacts are listed in Appendix VI.

1.5.1 Snow Creek

Snow Creek has been sampled by DWQ on three occasions, each time producing a different bioclassification. These changes appear to be related to both varying flow conditions and land use activities in the watershed. In August 1994, the benthic community received a Good-Fair bioclassification. The site was sampled under normal flow conditions, although flow records from nearby Hyco Creek suggest that at least two high flow events had occurred prior to DWQ's sample date. It is likely that some scouring of the streambed occurred during those high flow events impacting the benthic macroinvertebrate community.

In August 1999, flow was extremely low and the benthic community received a Fair bioclassification. Floating algal mats were observed along the edges of the stream suggesting nutrient enrichment. Samples were collected just after construction of a new bridge which may have created a localized impact on part of the stream. DWQ sampled Snow Creek again in August 2000 and the benthic community received a Good bioclassification. This year represented optimal flow conditions that were reflected in the species diversity and abundance.

Although aquatic life in this stream is not considered impaired, there are nonpoint source pollution impacts present in the watershed. Sedimentation, infrequent riffle areas and a

significant lack of riparian vegetation have been observed. Identification and reduction of nonpoint sources of pollution that contribute to habitat degradation are needed in order to insure a healthy aquatic community in the future. For general recommendations on habitat degradation and best management practices, please refer to Section A, Chapter 4.

1.5.2 Dan River

As was mentioned previously, the Dan River from the Virginia state line to the confluence with Big Creek is protected for trout propagation and survival of stocked trout. Trout (as well as other aquatic life) are sensitive to turbidity in streams and rivers. The turbidity standard at a DWQ ambient monitoring station above Danbury was exceeded in 35 percent of samples collected from 1995 to 1999, at times reaching levels seven and eight times the standard. Aquatic life in the Dan River is currently not considered to be impaired because the benthic community was assigned a Good bioclassification in 1999. However, high levels of turbidity over a sustained period of time have the potential to negatively impact aquatic communities.

It has come to the attention of DWQ that all-terrain vehicle use occurs in portions of the Dan River. Disturbing channel substrate with any type of heavy equipment or vehicles destroys instream habitat. In flowing water, this type of disturbance also creates turbidity and adds to suspended sediment concentrations. Public education about impacts of all-terrain vehicles on the river and riparian areas is needed in this subbasin.

1.5.3 Projected Population Growth

Stokes County is projected to receive the largest population increase of the sixteen counties in the Roanoke River basin (NC portion). From 1998 to 2018, estimated population growth for Stokes County is 28 percent and Forsyth County is 16 percent. Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin. Growth management can be defined as the application of strategies and practices that help achieve sustainable development in harmony with the conservation of environmental qualities and features of an area. On a local level, growth management often involves planning and development review requirements that are designed to maintain or improve water quality.

1.5.4 NPDES Discharges

As was mentioned in this chapter's overview, four facilities experienced problems complying with NPDES permit limits over the most recent two-year review period. The Town of Walkertown and the Winston-Salem/Forsyth County Utility Commission are planning to construct sewer lines in order to connect both Walkertown Middle and Elementary Schools into the Winston-Salem WWTP. It is estimated that this connection will be completed in 2003, eliminating these two discharges.

Two small "package plant" wastewater treatment facilities also had occasional, fairly short-term violations of ammonia limits: Greystone Subdivision and Cain's Way Mobile Home Park. The Greystone Subdivision WWTP is in need of major improvements to allow it to meet the restrictive ammonia limits consistently. Flow-splitting between the two clarifiers at the plant often causes excessive flows to be routed through only one unit.

Chapter 2 -
Roanoke River Subbasin 03-02-02
Includes a portion of the Dan and Mayo Rivers

2.1 Water Quality Overview

Subbasin 03-02-02 at a Glance

Land and Water Area

Total area:	231 mi^2
Land area:	229 mi^2
Water area:	2 mi^2

Population Statistics

1990 Est. Pop.:	19,588 people
Pop. Density:	86 persons / mi^2

Land Cover (%)

Forest / Wetland:	76.1
Surface Water:	0.8
Urban:	1.3
Cultivated Crop:	3.6
Pasture / Managed Herbaceous:	18.2

This subbasin contains a ten-mile segment of the Dan River and the Mayo River in Stokes and Rockingham counties. Mayodan, Madison and Stoneville are the largest towns. Other streams include Big and Little Beaver Island Creeks, Hogans Creek and Jacobs Creek. A map of this subbasin including water quality sampling locations is presented in Figure B-2.

Bioclassifications for the 1999 sample locations are presented in Table B-4. Use support ratings for each applicable category in this subbasin are summarized in Table B-5. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

Most of the land in this portion of the basin is forested (76 percent), but a significant portion is also in use as cultivated cropland and pasture (22 percent). The estimated subbasin population, based on the 1990 census, is 19,588. Population is expected to increase by 28 percent in Stokes County and three percent in Rockingham County over a twenty-year period (1998 to 2018).

There are nine NPDES permitted dischargers in this subbasin, most of which are small wastewater treatment plants serving residential areas. One of these small wastewater treatment plants had problems with elevated BOD and ammonia in its discharge. The largest discharge is from the Town of Mayodan's WWTP to the Mayo River. Two facilities in this subbasin are required to monitor their effluent's toxicity: Mayodan WWTP and Stoneville WWTP. There were no indications of toxicity problems during the most recent review period.

Benthic macroinvertebrates in this subbasin were sampled under extreme low flow conditions in 1999. For larger streams affected by nonpoint source pollution, a sharp decline in flow may result in a higher bioclassification; smaller streams, however, might be adversely affected by extremely low flow.

Figure B-2 Upper Dan River Subbasin 03-02-02

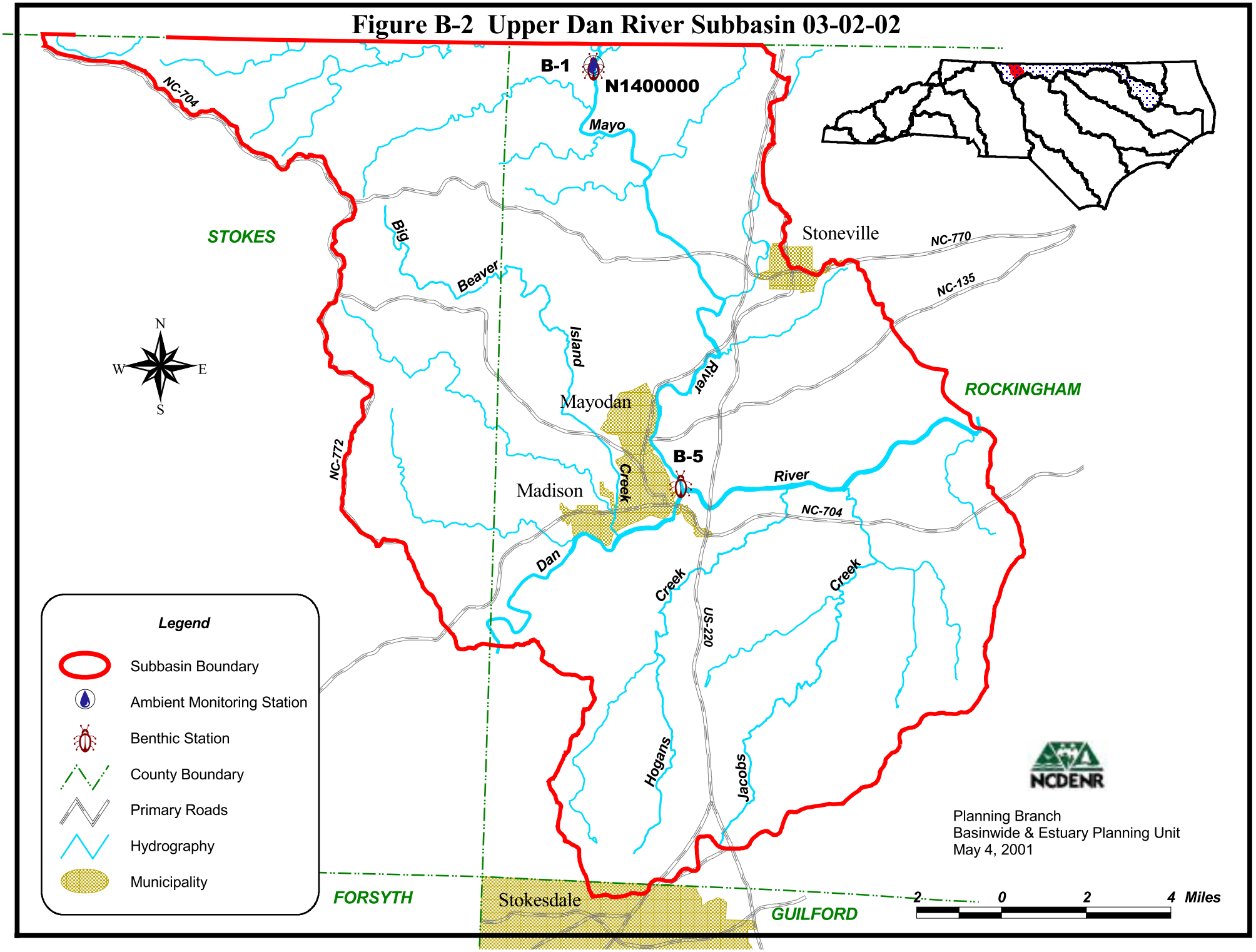


Table B-4 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-02

Site	Stream	County	Road	Bioclassification
Benthic Macroinvertebrates				
B-1*	Mayo River	Rockingham	SR 1358	Good
B-5*	Mayo River	Rockingham	SR 2177	Good-Fair
Ambient Monitoring				
N1400000	Mayo River	Rockingham	SR 1358	N/A

* Historical data are available; refer to Appendix II.

Benthic macroinvertebrates were collected from two locations on the Mayo River in 1999. The most upstream location (near the NC/VA state line) has consistently received Good bioclassifications over five collections since 1986. The most downstream location (near the confluence with the Dan River), however, received a Good-Fair bioclassification in 1999, indicating a decline in water quality as the river flows through North Carolina. Water quality in the Mayo River is discussed further in Part 2.5 of this chapter.

Water chemistry samples are collected monthly from the Mayo River near the North Carolina/Virginia state line. These data have indicated good water quality with few violations of water quality standards. Although the geometric mean of fecal coliform bacteria samples was below the 200 colonies/100ml reference level, this station had elevated levels of fecal coliform compared to other monitoring locations in the Roanoke River basin. Turbidity was also slightly elevated.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-5 Use Support Ratings Summary (1999) for Monitored and Evaluated[1] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-02

Use Support Category	FS	PS	NS	NR	Total[2]
Aquatic Life/ Secondary Recreation	85.5	0	0	45.8	131.3
Fish Consumption[3]	0	9.3	0	0	9.3
Primary Recreation	0	0	0	11.3	11.3
Water Supply	0	0	0	0	0

[1] For the fish consumption use support category, only monitored stream miles are presented.

[2] Total stream miles assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information. Fish tissue monitoring in the Dan River is discussed in Chapter 3 of this section.

2.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each waterbody. The 1996 Roanoke River Basinwide Plan did not identify any impaired stream segments in this subbasin.

2.3 Status and Recommendations for Newly Impaired Waters

The Dan River, from the confluence with Jacobs Creek to a point just downstream of Matrimony Creek in subbasin 03-02-03, is rated partially supporting based on recent DWQ monitoring (1995-1999). This section outlines the potential causes and sources of impairment and provides recommendations for improving water quality.

2.3.1 **Dan River** (14.2 miles from Jacobs Creek to Matrimony Creek)

Current Status

The turbidity standard (50 NTU) was exceeded at the Dan River near Wentworth (N2300000) ambient monitoring station in 18 percent of 55 samples collected from 1995 to 1999. Results of data collected from this station are discussed more thoroughly in Section A, Chapter 3. All particles in the water that may scatter or absorb light, including suspended sediment, aquatic organisms and organic particles such as pieces of leaves, contribute to turbidity. Therefore, all types of nonpoint source pollution have the potential to increase turbidity concentrations. Construction in the Madison/Mayodan area, agricultural activities, suspended sediment loading from upstream in both the Dan and the Mayo Rivers, as well as permitted instream mining operations are all potential sources.

2001 Recommendations

DWQ will work with the Division of Land Resources to evaluate and reduce turbidity from permitted instream mining operations in the Dan River. As permits are renewed, monitoring upstream and downstream of mining operations and instream BMPs (such as those used by the NC Department of Transportation during bridge construction) could be required. Refer to Section A, Chapter 4 for further discussion and recommendations about instream mining operations and other potential sources of nonpoint source pollution in the watershed. In addition, DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

2.4 Section 303(d) Listed Waters

Currently in this subbasin, no waterbodies are listed on the state's year 2000 303(d) list. A portion of the Dan River, discussed above, will likely be added to the list in 2002. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

2.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program agency contacts are listed in Appendix VI.

2.5.1 Mayo River

As was noted in the overview of monitoring data, a decline in biological integrity was observed in the Mayo River between the upper sampling station near the NC/VA state line and the lower sampling station near the confluence with the Dan River at Mayodan. The lower site declined to Good-Fair under low flow conditions in 1999. Two of the most common pollutants in runoff associated with livestock grazing in riparian areas (with direct access to streams) are bacteria and sediment. Failing septic systems and problems with wastewater treatment plants can also cause high levels of fecal coliform bacteria.

There are several discharges between the two Mayo River monitoring stations; however, records did not indicate significant compliance or toxicity problems with these discharges over the past five years. There is one permitted instream mining operation in this section of the Mayo River. Urban/construction and agricultural runoff are likely contributing to this decline in water quality as well. DWQ will continue to monitor water quality in the Mayo River. Section A, Chapter 4 contains general recommendations for development, construction, stormwater and agricultural best management practices, as well as instream mining activities.

2.5.2 Projected Population Growth

Stokes County is projected to receive the largest population increase of the sixteen counties in the NC portion of the Roanoke River basin. From 1998 to 2018, the estimated population growth for Stokes County is 28 percent and Rockingham County is three percent. Growth management within the next five years will be imperative, especially in and around urbanizing areas, in order to maintain good water quality in this subbasin. Growth management can be defined as the application of strategies and practices that help achieve sustainable development in harmony with the conservation of environmental qualities and features of an area. On a local level, growth management often involves planning and development review requirements that are designed to maintain or improve water quality. Refer to Section A, Chapter 4 for more information about urbanization and development and recommendations to minimize impacts to water quality.

2.5.3 NPDES Discharges

As was mentioned in this chapter's overview, one facility experienced problems complying with NPDES permit limits over the most recent two-year review period: Bethany Elementary School. Rockingham County upgraded the WWTP at Bethany Elementary in 1998 to a recirculating sand filter system with ultraviolet disinfection. This facility is currently in full compliance (Russell, June 7, 2001).

Chapter 3 -
Roanoke River Subbasin 03-02-03
Includes a portion of the Dan and Smith Rivers

3.1 Water Quality Overview

Subbasin 03-02-03 at a Glance

Land and Water Area

Total area:	340 mi^2
Land area:	335 mi^2
Water area:	5 mi^2

Population Statistics

1990 Est. Pop.:	11,695 people
Pop. Density:	35 persons / mi^2

Land Cover (%)

Forest / Wetland:	74.0
Surface Water:	1.2
Urban:	2.1
Cultivated Crop:	3.3
Pasture / Managed Herbaceous:	19.4

Approximately 25-river miles of the Dan River (before it flows back into Virginia) are contained in this subbasin. Also included is the lower portion of the Smith River after it flows into North Carolina. Most of the Smith River watershed is in Virginia, and river flow in North Carolina is regulated by dams upstream. Other streams in this subbasin include Buffalo, Rock House, Matrimony, Wolf Island and Hogans Creeks. The Town of Wentworth and the cities of Eden and Reidsville are the only municipalities. A map of this subbasin including water quality sampling locations is presented in Figure B-3.

Bioclassifications for the 1999 sample locations are presented in Table B-6. Use support ratings for each applicable category in this subbasin are summarized in Table B-7. Refer to Appendix III for a complete listing of monitored waters and more information about use support ratings.

The population, based on 1990 census data, is 11,695 people with a low population density of only 35 persons per square mile. Only two percent of the subbasin is urban/built-up area. The land is characteristic of the piedmont. The rolling hills are dominated by forest (74 percent) and agricultural activities (23 percent).

There are 17 NPDES permitted dischargers in this subbasin. The largest facilities discharge to the Dan River, including Fieldcrest/Cannon, Miller Brewing Company and two WWTPs in Eden, one of which is permitted to discharge up to 13.5 MGD. Three small wastewater treatment plants had problems with elevated BOD and ammonia in their discharges. The Smith River has been affected in the past by upstream discharges in Virginia, notably the Town of Martinsville's WWTP. Four facilities are required to monitor their effluent's toxicity: Duke Power's Dan River Station, Miller Brewing Company, and both Eden WWTP discharges. All discharges passed toxicity tests in 1999.

Extremes in flow conditions made it difficult to collect samples at most sites in this subbasin in 1999. Most tributary sites had no flow during drought conditions in mid-August, and high flows near the end of August caused the cancellation of sampling at other sites. Therefore, current benthic macroinvertebrate data are available only from the Smith River.

Figure B-3 Upper Dan River Subbasin 03-02-03

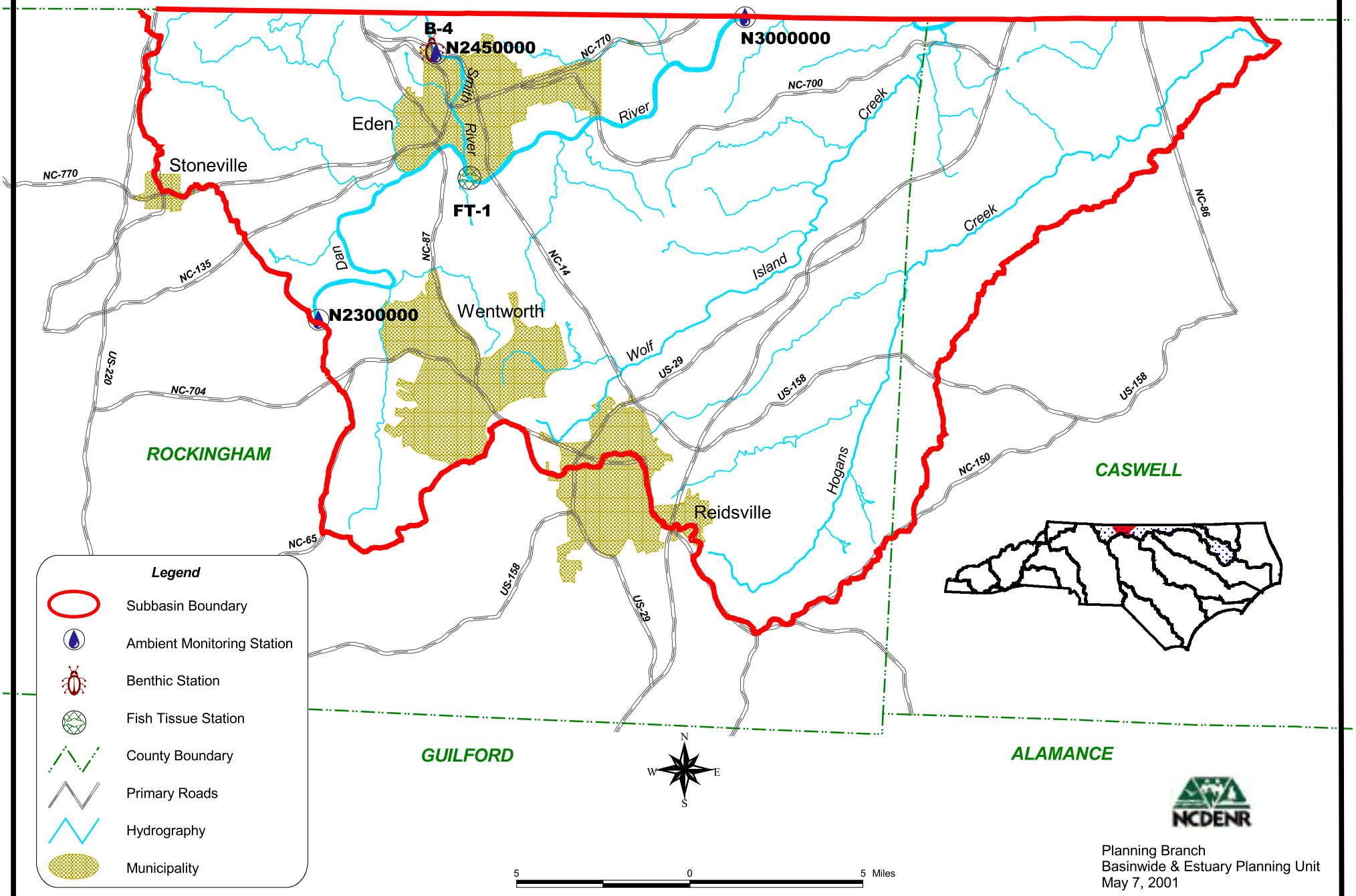


Table B-6 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-03

Site	Stream	County	Road	Bioclassification
Benthic Macroinvertebrates				
B-4*	Smith River	Rockingham	NC 14	Fair
Fish Tissue				
FT-1	Dan River	Rockingham	Near Eden	N/A
Ambient Monitoring				
N2300000	Dan River	Rockingham	SR 2150	N/A
N2450000	Smith River	Rockingham	NC 14 at Eden	N/A
N3000000	Dan River	Rockingham	SR 1716	N/A

* Historical data are available; refer to Appendix II.

Benthic macroinvertebrates samples have been collected at this site on the Smith River five times since 1984. Bioclassifications have been mostly Fair (Appendix III). Aquatic life in this stream is considered impaired, and the stream is discussed further in Part 3.3 of this chapter.

Benthic macroinvertebrate samples were also collected from three sites on a small, unnamed tributary to Hogans Creek in November 1996 and June 1998 as part of a special study. This small stream is located in Pittsylvannia County (Virginia) and northern Caswell County (North Carolina). These samples were intended to document conditions prior to stream restoration. The existing stream was channelized (straightened) in the 1950s and was severely entrenched. A new stream channel was constructed in 1999 with normal bends and riffle/pool sequences, and the sites will be sampled again to determine improvements in the biological community.

Water chemistry samples are collected monthly from two sites on the Dan River (near Wentworth and near Mayfield) and from the Smith River at Eden. The Dan River stations monitor the influences of the Smith River and discharges near the Town of Eden. There were few violations of water quality standards at either site, with the exception of turbidity. The turbidity standard (50 NTU) was exceeded at the Dan River near Wentworth (N2300000) station in 18 percent of 55 samples between 1995 and 1999. Concentrations in this segment of the Dan River ranged from 2.6 to 200 NTU, compared with a range of 1.4 to 90 NTU near Francisco upstream. The turbidity water quality standard was only exceeded in nine percent of samples at the downstream station near Mayfield (N3000000).

The Smith River ambient monitoring station is located near the Virginia/North Carolina state line. Historically, the Town of Martinsville, Virginia's WWTP was responsible for elevated concentrations of chloride and total dissolved solids in the Smith River, but problems have not been observed for either parameter within the last five years.

Nineteen fish tissue samples (largemouth bass, sunfish and suckers) were collected during August 1999 and analyzed for metal contaminants. All concentrations were below state and federal criteria for consumption. Duke Power Company also monitors selenium in fish tissue in the Dan River near Eden to assess impacts from the Belews Creek Steam Station discharge (refer to Section B, Chapter 1). The most recent data, collected in 1998, showed selenium concentrations ranging from 0.10 to 1.03 µg/g (DPC, 1999). These concentrations were much less than the state's advisory criterion of 5µg/g for selenium.

The Virginia Department of Environmental Quality (VADEQ) has done extensive fish tissue monitoring in the Dan River for organic compounds called Polychlorinated biphenyls (PCBs). High levels of PCBs have been detected in several fish species collected in the South Boston, Virginia area (refer to Chapter 4 of this section for details). Low levels have also been detected in fish tissue collected from the Dan River below Danville, Virginia (downstream of the NC/VA state line near Eden). However, a series of dams minimizes upstream migration of these fish into the portion of the Dan River in North Carolina located within this subbasin. Concentrations of PCBs in fish tissue are well below the PCB consumption criteria in fish collected from the Dan River upstream of the NC/VA state line above Eden (VADEQ, March 2001).

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-7 Use Support Ratings Summary (1999) for Monitored and Evaluated[1] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-03

Use Support Category	FS	PS	NS	NR	Total[2]
Aquatic Life/ Secondary Recreation	169.5	5.2	0	68.2	242.9
Fish Consumption[3]	0	14.8	0	0	14.8
Primary Recreation	0	0	0	5.7	5.7
Water Supply	69.7	0	0	0	69.7

[1] For the fish consumption use support category, only monitored stream miles are presented.

[2] Total stream miles assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information. Fish tissue monitoring in the Dan River is discussed above.

3.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River Basinwide Plan did not identify any impaired stream segments in this subbasin.

3.3 Status and Recommendations for Newly Impaired Waters

The North Carolina portion of the Smith River is rated impaired based on recent DWQ monitoring (1995-1999). This section outlines the potential causes and sources of impairment and provides recommendations for improving water quality.

3.3.1 **Smith River** (5.4 miles from North Carolina/Virginia state line to the Dan River)

Current Status

As a result of sampling in 1994 and 1999, the benthic community in the Smith River near Eden was assigned a Fair bioclassification. This lowest segment of the river is only partially supporting the aquatic life/secondary recreation designated use. Habitat degradation was documented on both sampling dates, including sedimentation and streambed scour likely resulting from large fluctuations in flow.

Flow in the river is regulated by two dams (Philpott Reservoir and Martinsville Reservoir) upstream in Virginia, and USGS records indicate extreme daily fluctuations (DENR-DWQ, May 2000). Philpott Reservoir, located 43 miles upstream of Eden, NC, has an instream minimum flow requirement designed to protect aquatic life; and the Martinsville Reservoir, located approximately 20 miles upstream of Eden, does not. Fifteen miles of the Smith River in Virginia below the Town of Martinsville are considered partially supporting the aquatic life designated use by the State of Virginia for habitat degradation (VADEQ, 1998).

Historically, the Smith River has also been characterized by high conductivity and discolored water, indicating problems from a point source upstream. The source of these problems was the Town of Martinsville, Virginia's WWTP. The plant receives wastewater from several textile mills and, until the mid-1990s, was not able to adequately treat it. Thanks in part to citizens of Rockingham County, NC and DWQ staff reporting problems to authorities in Virginia, the quality of the discharge from Martinsville's WWTP has improved drastically since 1997. There were few permit violations in 1998 and 1999. Recently, one of the larger mills discontinued operation in the Smith River watershed, and the WWTP discharge is expected to continue to improve (Willis, July 20, 2000).

2001 Recommendation(s)

DWQ will work with the NC Division of Water Resources, the State of Virginia's Department of Environmental Quality and the Town of Martinsville, Virginia to address flow fluctuation issues. However, nonpoint source pollution in the North Carolina portion of the watershed may also contribute to further degradation of habitat and water quality downstream. It is imperative that, in addition to citizens' and municipalities' actions in the State of Virginia, citizens and municipalities in the State of North Carolina implement best management practices as well. Of particular concern are urban areas and construction stormwater activities in and around the City of Eden. Please refer to Section A, Chapter 4 for further information.

3.3.2 **Dan River** (14.2 miles from Jacobs Creek to Matrimony Creek)

Current Status
As was discussed in the previous section, the water quality standard for turbidity was exceeded at the Dan River near Wentworth ambient monitoring station in 18 percent of 55 samples collected from 1995 to 1999. Therefore, this section of the Dan River is partially supporting the aquatic life/secondary recreation use support category. All particles in the water that may scatter or absorb light, including suspended sediment, aquatic organisms and organic particles such as pieces of leaves, contribute to turbidity. Therefore, all types of nonpoint source pollution have the potential to increase turbidity. Construction in the Madison/Mayodan area, agricultural activities, loading from upstream in both the Dan and the Mayo Rivers, as well as permitted instream mining operations are all potential sources.

2001 Recommendations
DWQ will work with the NC Division of Land Resources to evaluate and reduce turbidity from permitted instream mining operations in the Dan River. As permits are renewed, monitoring upstream and downstream of mining operations and instream BMPs (such as those used by the NC Department of Transportation during bridge construction) could be required. Refer to Section A, Chapter 4 for further discussion and recommendations about instream mining operations and other potential sources of nonpoint source pollution in the watershed. In addition, DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.

3.4 Section 303(d) Listed Waters

Currently in this subbasin, no waters are listed on the state's year 2000 303(d) list. The Smith River and a portion of the Dan River, from Jacobs Creek to Matrimony Creek, will likely be added to the list in 2002. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

3.5 Other Issues and Recommendations

There are no additional issues for specific surface waters in this subbasin; however, recent DWQ monitoring revealed habitat degradation impacts to aquatic life resulting from nonpoint source pollution. Although no action is required, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. Section A, Chapter 4 contains general information and recommendations about habitat degradation and other water quality problems that affect more than one watershed in the basin. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program descriptions and agency contacts are listed in Appendix VI.

3.5.1 Phase II Stormwater Requirements

Amendments were made to the Clean Water Act in 1990 (Phase I) and most recently in 1999 (Phase II) pertaining to permit requirements for stormwater discharges associated with storm sewer systems. Part of Phase II requires some municipal storm sewer systems serving

populations under 100,000, which are located in larger urbanized areas and/or that have a high population density to obtain an NPDES stormwater permit. The municipal permitting requirements are designed to lead into the formation of comprehensive stormwater management programs for municipal areas. The cities of Eden and Reidsville will be considered for inclusion under the Phase II rules because of a population greater than 10,000 and/or a population density greater than 1,000 persons per square mile. DWQ is currently developing criteria that will be used to determine whether these and other municipalities will be required to obtain a NPDES permit. Refer to Section A, Part 2.7.2 for further information.

3.5.2 NPDES Discharges

As was mentioned in this chapter's overview, three facilities experienced problems complying with NPDES permit limits over the most recent two-year review period: Happy Home and Sadler Elementary School WWTPs and the Betsy Jeff Penn 4-H Education WWTP. Betsy Jeff Penn 4-H Education's WWTP was upgraded to include ultraviolet disinfection. This WWTP serves a 4-H camp, and the discharge is difficult to manage because of the large increase in volume that occurs during the summer months.

Rockingham County built a new school to replace both Sadler and Happy Home Elementary Schools. The new facility began sending waste to the Eden WWTP in October 2000, and the two smaller discharges were eliminated.

Chapter 4 -
Roanoke River Subbasin 03-02-04
Includes a portion of the Dan River and Country Line Creek

4.1 Water Quality Overview

Subbasin 03-02-04 at a Glance

Land and Water Area

Total area:	239 mi^2
Land area:	236 mi^2
Water area:	3 mi^2

Population Statistics

1990 Est. Pop.:	27, 208 people
Pop. Density:	115 persons / mi^2

Land Cover (%)

Forest / Wetland:	75.9
Surface Water:	1.0
Urban:	0.5
Cultivated Cropland:	2.3
Pasture / Managed Herbaceous:	20.4

This subbasin contains a short reach of the Dan River (approximately 8 river miles) and three larger tributaries: Country Line, Moon and Rattlesnake Creeks. The Dan River flows into North Carolina, after passing through Danville, Virginia, and then back out of North Carolina for a final time before merging with the Roanoke River to form the headwaters of the John H. Kerr Reservoir. Yanceyville and Milton are the only towns within the subbasin. A map including water quality sampling locations is presented as Figure B-4.

Bioclassifications for sample locations are presented in Table B-8. Use support ratings for each applicable category in this subbasin are summarized in Tables B-9 and B-10. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

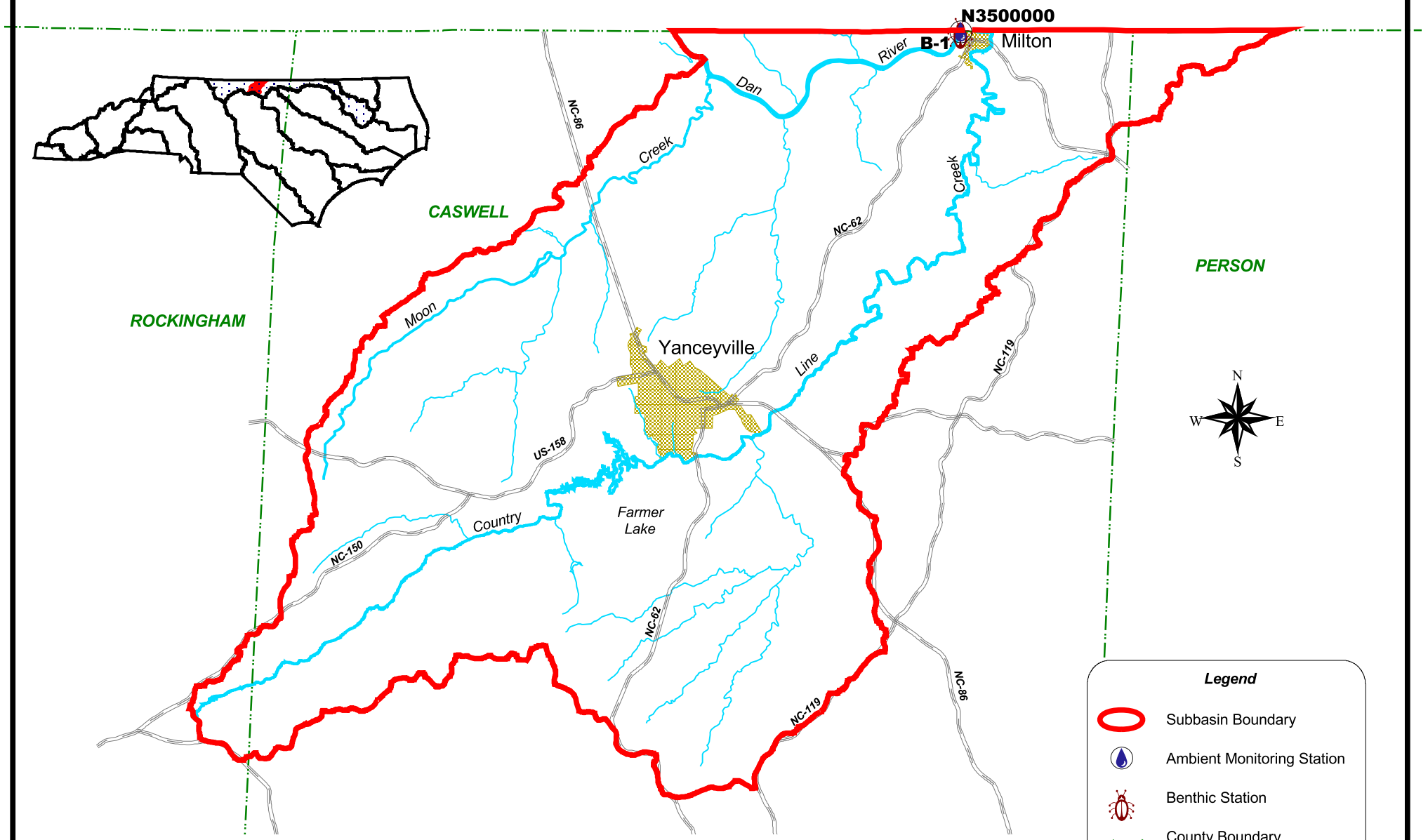
Land within this subbasin is mostly low rolling hills, characteristic of the piedmont. Land use is dominated by forest and agricultural activities, although residential development is increasing. The estimated subbasin population, based on the 1990 census, is 27,208. The population of Caswell County is expected to increase six percent from 1998 to 2018. Yanceyville's population has more than doubled over the past ten years and is expected to continue growing.

This subbasin contains three permitted dischargers. The largest facility is Yanceyville's WWTP, which discharges to Country Line Creek. This is also the only facility required to monitor its effluent's toxicity. No significant compliance or toxicity problems were noted during the most recent review period.

Farmer Lake is the only lake routinely monitored in this subbasin. It is a 368-acre water supply reservoir built in 1983 by the Town of Yanceyville and located in the Country Line Creek watershed. All designated uses are currently fully supported in the lake.

During the dry summer of 1999, many streams in this subbasin had little or no visible flow. Country Line Creek was one such stream where no benthic sample could be collected. However, the low flow conditions did make it possible to collect benthic samples for the first time from the Dan River near Milton.

Figure B-4 Dan River Subbasin 03-02-04



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Planning Branch
Basinwide & Estuary Planning Unit
May 7, 2001

Table B-8 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-04

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
B-1	Dan River	Caswell	NC 57	Good
Ambient Monitoring				
N3500000	Dan River	Caswell	NC/VA state line	N/A

Benthic macroinvertebrate collections in 1999 from the Dan River at Milton produced a Good bioclassification, with few differences between the community observed here and the upstream site near Mayfield (subbasin 03-02-03). Water chemistry is recorded monthly from the Dan River at Milton as well. Good water quality conditions have been recorded at this site with very few violations of water quality standards.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-9 Use Support Ratings Summary (1999) for Monitored Lakes (acres) in Roanoke River Subbasin 03-02-04

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation	368	0	0	0	368
Fish Consumption[3]	0	368	0	0	0
Primary Recreation	0	0	0	0	0
Water Supply	368	0	0	0	368

[1] Total stream miles assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information. Fish tissue monitoring in the Dan River in Chapter 3 of this section.

Table B-10 Use Support Ratings Summary (1999) for Monitored and Evaluated[2] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-04

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation	112.0	0	0	39.6	151.6
Fish Consumption[3]	0	7.5	0	0	7.5
Primary Recreation	0	0	0	17.2	17.2
Water Supply	24.5	0	0	0	24.5

[1] Total stream miles assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information. Fish tissue monitoring in the Dan River in Chapter 3 of this section.

4.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River Basinwide Plan did not identify any impaired stream segments in this subbasin. However, the plan did mention habitat degradation in the Country Line Creek watershed. Please refer to Part 4.5.1 of this chapter for more detailed information.

4.3 Status and Recommendations for Newly Impaired Waters

No stream segments are rated impaired based on recent DWQ monitoring (1995-1999); however, as mentioned previously, some impacts to water quality were observed. Refer to Part 4.5 of this chapter for further discussion of potential water quality problems.

4.4 Section 303(d) Listed Waters

No waters in this subbasin are listed on the state's year 2000 303(d) list. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

4.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding. Additionally, education on local water quality

issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program agency contacts are listed in Appendix VI.

4.5.1 Country Line Creek

The benthic macroinvertebrate community of Country Line Creek was sampled at Milton near the NC/VA state line in 1994. The stream received a bioclassification of Good-Fair, indicating some impacts to water quality were present, but the biological community was not considered impaired. As was mentioned previously in this chapter, the flow was too low in the stream for it to be sampled in 1999; and therefore, the stream is currently not rated. The 1996 basin plan mentioned higher turbidity and nutrient levels in the upstream arm of Farmer Lake near Yanceyville. Additionally, moderate sedimentation and elevated levels of turbidity have been observed by DWQ staff in the stream both above and below Farmer Lake.

Many new homes and subdivisions are being built throughout the upper portion of the watershed, northeast of Greensboro. However, there is still a substantial amount of pastureland in the watershed as well. BMPs should be carefully installed and maintained in this area during construction because of the moderate slopes and high erosion potential of soils in this area. Agricultural BMPs for controlling sediment should also be installed to protect aquatic life in the Country Line Creek watershed. Section A, Chapter 4 discusses habitat degradation, including sedimentation, and provides general recommendations.

Some requirements have been put into place recently by Caswell County, as part of a Water Supply Watershed Ordinance, that will reduce sediment and nutrient inputs and protect the upper portion of Country Line Creek, Hostler Branch and Farmer Lake from further water quality degradation. These measures include: 1) an increase in minimum residential lot sizes within the watershed's Critical Area from one acre to three acres per lot; and 2) a requirement, as a condition to development along Country Line Creek and Hostler Branch, of an 80-foot vegetated buffer.

4.5.2 Dan River

The Virginia Department of Environmental Quality (DEQ) recently issued a health advisory for fish consumption for a 42-mile stretch of the Dan River from Kerr Reservoir at Staunton River State Park to southwestern Halifax County where the river crosses into North Carolina, north of Virginia Route 62. Polychlorinated biphenyls (PCBs) have been detected in seven fish species collected in the South Boston, Virginia area. Flathead and channel catfish were the only species determined to have levels of PCBs in the tissue above 60 parts per billion, the DEQ level of concern. The advisory cautions people to eat no more than two eight-ounce meals a month of flathead and channel catfish taken from the advisory area. Pregnant women and children are advised not to eat any of these fish (VADEQ, March 2001).

DWQ has not analyzed the PCB content of fish tissue in the Dan River in North Carolina. Although data do not indicate a problem in the North Carolina portion of river upstream of Danville, Virginia (refer to Chapter 3 of this section for details), it is likely that the portion of the Dan River contained within this subbasin does contain fish with elevated PCB concentrations.

DWQ is expanding laboratory facilities in order to conduct additional fish tissue analyses in the future.

4.5.3 Projected Population Growth

The population of Caswell County is expected to increase six percent over the next fifteen years. Yanceyville's population has more than doubled over the past ten years and is expected to continue growing. Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin. Growth management can be defined as the application of strategies and practices that help achieve sustainable development in harmony with the conservation of environmental qualities and features of an area. On a local level, growth management often involves planning and development review requirements that are designed to maintain or improve water quality. Refer to Section A, Chapter 4 for more information about urbanization and development and recommendations to minimize impacts to water quality.

Chapter 5 -
Roanoke River Subbasin 03-02-05
Includes Hyco Lake, Marlowe Creek and Mayo Reservoir

5.1 Water Quality Overview

Subbasin 03-02-05 at a Glance

Land and Water Area

Total area:	337 mi^2
Land area:	322 mi^2
Water area:	15 mi^2

Population Statistics

1990 Est. Pop.:	9,903 people
Pop. Density:	31 person / mi^2

Land Cover (%)

Forest / Wetland:	71.9
Surface Water:	4.5
Urban:	1.3
Cultivated Crop:	2.4
Pasture / Managed Herbaceous:	19.8

The Hyco River watershed in North Carolina, including Hyco and South Hyco Creeks and Hyco Lake, as well as Mayo Creek and the Mayo Reservoir watershed are contained in this subbasin. Other waters include Storys and Marlowe Creeks, Lake Roxboro and Roxboro Lake. Roxboro is the only municipality. All major streams flow generally northward into Virginia. A map of this subbasin including water quality sampling locations is presented in Figure B-5.

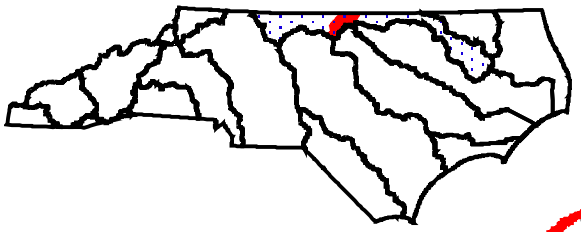
Bioclassifications for sample locations are presented in Table B-11. Use support ratings for each applicable category in this subbasin are summarized in Tables B-12 and B-13. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

Land within this subbasin is mostly low rolling hills, characteristic of the piedmont. Land use is dominated by forest (71 percent) and agricultural activities (22 percent), although residential development is increasing. The estimated subbasin population, based on the 1990 census, is 9,903. The population of Person County is projected to increase 14 percent and Caswell County six percent over a twenty-year period (1998-2018).

There are 7 permitted dischargers. The Town of Roxboro WWTP is the largest. During dry months, this discharge is more than 99 percent of total flow in Marlowe Creek. Carolina Power and Light Company's (CP&L) Roxboro and Mayo generating plants discharge tens of millions of gallons per day of cooling water to Hyco Lake and Mayo Reservoir. These two discharges, as well as the Roxboro WWTP and Cogentrix, are required to monitor their effluent's toxicity. Historically, the Roxboro WWTP had toxicity problems, but most of the problems with the discharge have been resolved. Cogentrix, however, also discharging in the Marlowe Creek watershed, failed the majority of toxicity tests over the past five years.

Four lakes in this subbasin are monitored by DWQ: Hyco Lake, Lake Roxboro, Roxboro Lake and Mayo Reservoir. All four lakes are fully supporting the aquatic life and secondary recreation designated use. Hyco Lake is also fully supporting its primary recreation use, but is only partially supporting the fish consumption use. This lake is discussed further in Part 5.2.2.

Figure B-5 Hyco Reservoir Subbasin 03-02-05



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Basinwide & Estuary Planning Unit
May 7, 2001

Table B-11 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-05

Site	Stream	County	Location	Bioclassifcation
Benthic Macroinvertebrates				
B-2*	Marlowe Creek	Person	SR 1322	Fair
Ambient Monitoring				
N4110000	Hyco Creek	Caswell	US 158	N/A
N4250000	Hyco River	Person	Mcghees Mill	N/A
N4510000	Hyco River	Halifax, VA	US 501	N/A
N4400000	Marlowe Creek	Person	SR 1322	N/A
N4590000	Mayo Creek	Person	SR 1501	N/A

* Historical data are available; refer to Appendix II.

Observations during the very dry summer of 1999 indicated that many streams in this subbasin stopped flowing. Seasonally intermittent low flow may limit the diversity of the fish and benthic macroinvertebrate communities.

The bioclassification for Marlowe Creek improved from Poor in 1994 to Fair in 1999. This change coincided with a significant reduction in Roxboro WWTP's effluent toxicity. However, the aquatic life/secondary recreation designated use is still impaired in this stream. Marlowe Creek is discussed in detail in the following sections.

Historically, Hyco Creek received a Good-Fair bioclassification under low flow and normal flow conditions, but declined to a Fair bioclassification under high flow conditions. This pattern suggests nonpoint source impacts to this stream. No sample was collected in 1999 because no flowing water was observed in the creek during the sampling period. Hyco Creek is discussed further in Part 5.5 of this chapter.

Water chemistry samples are collected monthly from five sites in this subbasin: Hyco Creek; Hyco River near McGhees Mill; Hyco River near Denniston, Virginia; Marlowe Creek; and Mayo Creek. The Marlowe Creek site is downstream of the Roxboro WWTP. Results at this location showed elevated nitrate, phosphorus and copper concentrations. Data from all other locations do not indicate any water quality problems. For further information about ambient monitoring station data, refer to Section A, Chapter 3.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-12 Use Support Ratings Summary (1999) for Monitored Lakes (acres) in Roanoke River Subbasin 03-02-05

Use Support Category	FS	PS	NS	Total[1]
Aquatic Life/ Secondary Recreation	6,957	0	0	6,957
Fish Consumption	0	3,750	0	3,750
Primary Recreation	6,745	0	0	6,745
Water Supply	6,957	0	0	6,957

Table B-13 Use Support Ratings Summary (1999) for Monitored and Evaluated[2] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-05

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation	84.8	10.8	0	99.3	194.9
Fish Consumption[3]	0	0.2	0	0	0.2
Primary Recreation	0	0	0	11.3	11.3
Water Supply	47.3	0	0	0	47.3

[1] Total stream miles assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information.

5.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each waterbody. The 1996 Roanoke River basin plan identified one impaired stream in this subbasin: Marlowe Creek from its source in Roxboro to the confluence with Storys Creek. This stream is discussed below.

5.2.1 **Marlowe Creek** (10.8 miles from source to Storys Creek)

1996 Recommendation(s)

Historically, the discharge from the Roxboro WWTP was not in compliance with permit limits and repeatedly failed toxicity tests. During dry months, the discharge is more than 99 percent of the flow in Marlowe Creek, so there is essentially no dilution from upstream. The first basin plan listed the stream as partially supporting because of elevated copper concentrations and recommended that improvements be made to the Roxboro WWTP. It was also recommended that other sources of nonpoint source pollution in the watershed be identified and addressed.

Status of Progress

Benthic macroinvertebrates in Marlowe Creek again received a Fair bioclassification in 1999, so the stream remains impaired. Compliance and toxicity problems with Roxboro's WWTP discharge have been resolved. However, Cogentrix, a power generating facility that discharges to Mitchell Creek (a tributary to Marlowe Creek) upstream of DWQ's sampling location, experienced toxicity problems over the two-year review period. The facility paid almost $6,000 in fines and conducted a Toxicity Reduction Evaluation (TRE). The TRE helped determine that the composition of a chemical used in the steam generation process had been changed by the vendor without notice. Compliance with toxicity tests was expected by the end of 2000.

There are collection system overflows in the Town of Roxboro that likely impact aquatic communities downstream, however, not to the extent that the discharge problems did. In addition, the headwaters of Marlowe Creek were historically channelized around the Town of Roxboro. Most of the stormwater runoff from this urban area flows into Marlowe Creek. There is significant sedimentation over the entire length of the stream which likely resulted from streambank erosion, scouring, runoff from urban areas and construction sites, and agricultural activities (in the lower portion of the watershed).

2001 Recommendation(s)

DWQ will continue to work with the Town of Roxboro's WWTP and Cogentrix to correct remaining problems at these facilities and Roxboro's collection system. However, it is possible that aquatic life will remain impaired because of significant habitat degradation in the stream. The Town of Roxboro should begin to install urban stormwater controls and best management practices to prevent further degradation by runoff from urban areas and construction sites. DWQ will continue to monitor the stream and work with local NPS agencies to restore water quality.

5.2.2 **Hyco Lake** (3,750 acres)

1996 Recommendation(s)

The 1996 basin plan identified Hyco Lake as partially supporting the fish consumption use support category due to an advisory related to elevated levels of selenium. High selenium concentrations in this lake, like Belews Lake, are associated with runoff from coal ash ponds (refer to Chapter 1, Part 1.2.1 of this section for more detailed information). Carolina Power & Light Company switched to a dry ash disposal system in 1990, significantly reducing selenium concentrations in their discharge (to meet lower permit limits). DWQ required long-term monitoring of the lake in order to evaluate the effect of new permit limits. The consumption advisory was partially lifted in 1995, and the recommendation was to continue to monitor the decline of selenium in fish tissue until the advisory is lifted completely.

Status of Progress

Hyco Lake was most recently sampled by DWQ during the summer of 1999. All selenium concentrations were less than the laboratory detection level (<5.0 µg/l) with the exception of one location in June. Monitoring by Carolina Power & Light Company (CP&L) in 1997 and 1998 also noted that selenium concentrations in surface waters were less than laboratory detection levels. A shift in the fish community from undesirable, selenium-tolerant species such as satinfin shiner and green sunfish to a bluegill-dominated community was first observed in 1994. CP&L fish community data demonstrated that largemouth bass and bluegill catch rates met expectations

for a piedmont reservoir in 1997 and 1998. The data also indicated that successful reproduction of these sport species was occurring in the lake.

The consumption of fish from the lake remains under an advisory due to elevated selenium levels from the coal ash pond discharge. Mean selenium concentrations in green sunfish and white catfish have been less than EPA consumption criteria of 5µg/g since the fall of 1996. In 2000, these two fish were removed from the consumption advisory. However, a limited advisory remains in effect for common carp, and the fish consumption designated use for Hyco Lake remains impaired.

2001 Recommendation(s)
DWQ, in cooperation with Carolina Power & Light Company, will continue to monitor Hyco Lake and the permitted discharge to insure a continued decline in selenium concentrations. DWQ will work closely with the Department of Health and Human Services to lift the advisory when there is no longer a risk to human health from consumption of fish from Hyco Lake. For more information regarding fish consumption advisories, contact the Division of Public Health at (919) 733-3816 or visit the website at http://www.schs.state.nc.us/epi/fish/current.html.

5.3 Status and Recommendations for Newly Impaired Waters

No stream segments were rated as impaired based on recent DWQ monitoring (1995-1999); however, as mentioned previously, some impacts to water quality were observed. Refer to Part 5.5 of this chapter, as well as Section A, Chapter 4 for further discussion of potential water quality problems in this portion of the basin.

5.4 Section 303(d) Listed Waters

Two waters in this subbasin are currently listed on Part I of the state's year 2000 303(d) list: Marlowe Creek and Hyco Lake. Copper is currently listed as a cause of impairment for Marlowe Creek, while Hyco Lake's impairment is due to levels of selenium in fish tissue that exceed consumption criteria. TMDLs are required for both of these waters; however, in both cases the majority, if not all, of the listed pollutants (copper and selenium) come from point sources. These two lakes are discussed in detail above. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

5.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program agency contacts are listed in Appendix VI.

5.5.1 Hyco Creek

The benthic macroinvertebrate community of Hyco Creek was sampled in 1994. The stream received a Fair bioclassification indicating impacts to water quality were present. As was mentioned previously in this chapter, the flow was too low in the stream for it to be sampled in 1999; and therefore, the stream is currently not rated.

Analyses of ambient monitoring data show elevated turbidity, iron and fecal coliform concentrations over the past five years. The turbidity reference level was exceeded in 10 percent of samples collected from Hyco Creek, and lake assessment data showed high turbidity and nutrient levels in the Hyco Creek arm of Hyco Lake. Shoreline development, as well as residential development along US Highway 158, has increased in recent years. Iron concentrations exceeded reference levels in 63 percent of samples. However, samples from Hyco Creek passed instream chronic toxicity tests conducted by DWQ in 2000.

Although the geometric mean of fecal coliform samples did not exceed the 200 colonies/100ml water quality standard, concentrations were as high as 15,000 colonies/100ml in some samples. This stream feeds the westernmost arm of Hyco Lake, which is classified by DWQ for primary recreation. Fecal coliform concentrations in the main body of the lake did not exceed the standard in 1999.

BMPs should be carefully installed and maintained in this area during construction because of the high erosion potential of local soils. Agricultural and forestry BMPs for controlling sediment should also be installed to protect aquatic life in the Hyco Creek watershed. Measures should be put in place now to reduce sediment and nutrient inputs and to protect this stream (and the lake) from further water quality degradation. Section A, Chapter 4 discusses habitat degradation, including sedimentation, and provides general recommendations.

5.5.2 Projected Population Growth

The population of Person County is projected to increase 14 percent and Caswell County six percent over a twenty-year period (1998-2018). Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin. Growth management can be defined as the application of strategies and practices that help achieve sustainable development in harmony with the conservation of environmental qualities and features of an area. On a local level, growth management often involves planning and development review requirements that are designed to maintain or improve water quality. Refer to Section A, Chapter 4 for more information about minimizing impacts to water quality from development.

Chapter 6 -
Roanoke River Subbasin 03-02-06
Includes a portion of Kerr Reservoir and Nutbush Creek

6.1 Water Quality Overview

Subbasin 03-02-06 at a Glance

Land and Water Area

Total area:	329 mi^2
Land area:	295 mi^2
Water area:	34 mi^2

Population Statistics

1990 Est. Pop.:	21,604 people
Pop. Density:	73 persons / mi^2

Land Cover (%)

Forest / Wetland:	75.0
Surface Water:	6.4
Urban:	1.1
Cultivated Crop:	8.6
Pasture / Managed Herbaceous:	9.0

John H. Kerr Reservoir (Kerr Lake) straddles the North Carolina/Virginia state line at the border of Granville and Vance counties. This subbasin contains many small to medium-sized tributaries of John H. Kerr Reservoir that generally flow northward to Virginia. These tributaries include Aarons Creek, Grassy Creek, Island Creek and Nutbush Creek. A large portion of Henderson and the Town of Stovall are the major municipal areas. A map of this subbasin including water quality sampling locations is presented in Figure B-6.

Bioclassifications for these sample sites are presented in Table B-14. Use support ratings for each applicable category in this subbasin are summarized in Tables B-15 and B-16. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

This land is characterized by low rolling hills and low gradient streams. Seventy-five percent of the land is forested. Row crops and pasture are the most prevalent agricultural land uses (18 percent). Several registered animal operations are also located in this subbasin. Over six percent of the area is surface water reflecting in part the nearly 21,700 acres of the Nutbush Creek Arm of Kerr Reservoir. The estimated subbasin population, based on the 1990 census, is 21,604. The population of Granville County is expected to increase 25 percent and Vance County 11 percent between 1998 and 2018.

There are only four NPDES permitted dischargers in this subbasin. The Henderson WWTP is the largest discharge. During dry months, this discharge is more than 97 percent of the total flow in Nutbush Creek. This facility is required to monitor its effluent's toxicity. Toxicity problems with this discharge have been identified and are discussed further in the following sections. The wastewater discharge in the Gills Creek/Island Creek watershed from a Granville County school near Stovall exceeded permit limits for ammonia in 1999. However, the school hooked into a new spray irrigation system in Stovall and the discharge has since been eliminated.

The Nutbush Creek Arm of Kerr Reservoir is monitored by DWQ. This portion of the lake is currently fully supporting aquatic life/secondary recreation and primary recreation.

Figure B-6 Kerr Reservoir and Tributaries Subbasin 03-02-06

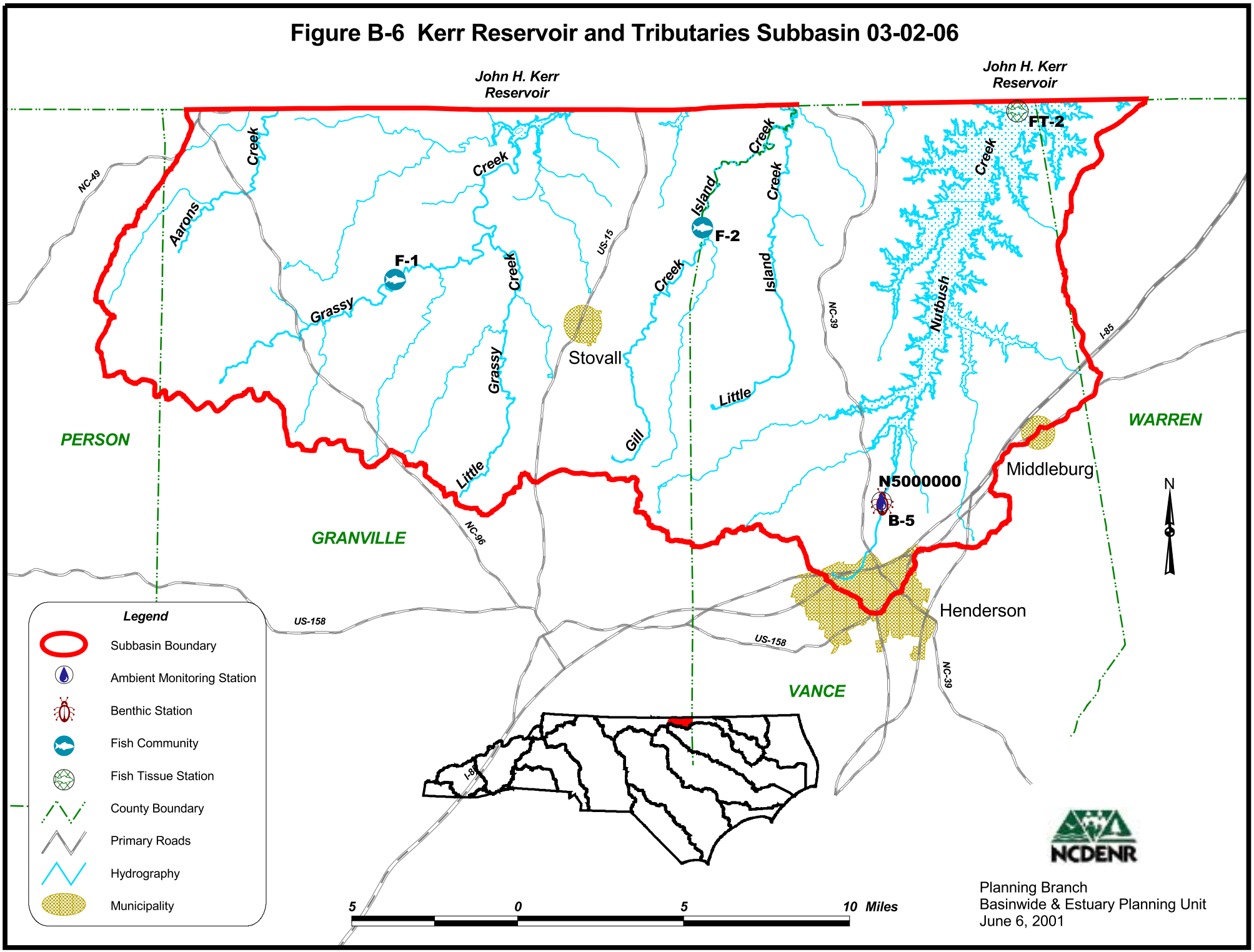


Table B-14 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-06

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
B-5*	Nutbush Creek	Vance	SR 1317	Fair
Fish Community				
F-1	Grassy Creek	Granville	SR 1300	Good
F-2	Island Creek	Granville	SR 1445	Excellent
Fish Tissue				
FT-2	Kerr Reservoir	Vance	Near NC/VA line	N/A
Ambient Monitoring				
N5000000	Nutbush Creek	Vance	SR 1317	N/A

* Historical data are available; refer to Appendix II.

Observations during the very dry summer of 1999 indicated that many streams in this subbasin stopped flowing during the severe drought conditions. This seasonal intermittent flow may limit the diversity of fish and macroinvertebrate communities. The only stream sampled in this subbasin in 1999 for benthic macroinvertebrates was Nutbush Creek. Nutbush Creek improved over a ten-year period from Poor in 1983 to Fair in 1994, but the biological community again received a Fair bioclassification based on the most recent DWQ sampling. This stream is impaired and is discussed in more detail in the following sections.

Grassy and Island Creeks were sampled as potential fish community regional reference sites in 1999. The fish communities of both streams were also sampled in 1994. Grassy Creek maintained a Good bioclassification and Island Creek improved to Excellent. The fish community of Island Creek was very diverse; 24 species were observed (DENR-DWQ, April 3, 2001). Refer to Appendix II for fish community data.

Water chemistry samples are collected monthly from Nutbush Creek near Henderson, downstream of the WWTP. During this monitoring cycle, most conventional water quality parameters did not show any violations of water quality standards. Long-term monitoring at this site has shown an increase in dissolved oxygen and declines in fecal coliform bacteria, turbidity, nitrogen and phosphorus concentrations. These positive water quality changes are likely the result of improvements at the Henderson WWTP that began in 1988.

Thirty-six fish tissue samples were collected from Kerr Reservoir during January and May 1999 and analyzed for PCBs (19 striped bass) and metal contaminants (17 largemouth bass, sunfish and catfish). The PCB analyses were performed at the request of the North Carolina Wildlife Resources Commission (WRC). WRC was concerned about PCB concentrations in striped bass in the North Carolina portion of the reservoir after detectable concentrations were measured in

the Virginia portion of the reservoir. Only two of nineteen striped bass samples contained PCBs at concentrations greater than the EPA screening value of 0.01 µg/g (Appendix II).

Only one of seventeen largemouth bass, catfish and sunfish samples had mercury concentrations exceeding the EPA screening value of 0.6 µg/g. All other metals concentrations were less than the federal and state screening criteria. DWQ works closely with the NC Department of Health and Human Services to make citizens aware of any risk to human health from consumption of fish. Currently, there is no fish consumption advisory specifically for Kerr Reservoir in North Carolina.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-15 Use Support Ratings Summary (1999) for Monitored Lakes (acres) in Roanoke River Subbasin 03-02-06

Use Support Category	FS	PS	NS	Total[1]
Aquatic Life/ Secondary Recreation	21,700	0	0	21,700
Fish Consumption[3]	0	21,700	0	21,700
Primary Recreation	21,700	0	0	21,700
Water Supply	0	0	0	0

Table B-16 Use Support Ratings Summary (1999) for Monitored and Evaluated[2] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-06

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation	127.0	4.6	0	53.0	184.6
Fish Consumption	0	0	0	0	0
Primary Recreation	4.1	0	0	28.2	32.3
Water Supply	4.7	0	0	0	4.7

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information.

6.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River basin plan identified two impaired streams in this subbasin: Nutbush and Anderson Swamp Creeks. This stream is discussed below.

6.2.1 **Nutbush Creek** (4.6 miles from source to Crooked Run)

1996 Recommendation(s)
Benthic macroinvertebrates were sampled intensively in the Nutbush Creek watershed in 1994 and rated Fair at all locations, including one site above the Henderson WWTP. The Henderson WWTP had significant problems with toxicity in their discharge, resulting from industries in Henderson that were sending inadequately pretreated waste to the facility. The recommendations in the 1996 basin plan were to monitor improvements to Henderson WWTP and investigate extent of other nonpoint source pollution problems.

Status of Progress
Aquatic life in Nutbush Creek again received a Fair bioclassification in 1999 and is only partially supporting the aquatic life/secondary recreation use support category. The Henderson WWTP discharge continues to have toxicity problems, although the town has made substantial progress in identifying which industries may be the sources of these problems. Some collection system problems have also been identified, and the town is actively working to correct them.

In addition, the headwaters of Nutbush Creek and several tributaries originate in the Town of Henderson. Most of the stormwater runoff from this urban area flows into the Nutbush Creek arm of Kerr Reservoir. There is significant sedimentation over the entire length of the creek, which likely resulted from streambank erosion, scouring, runoff from urban areas and construction sites, and agricultural activities (in the lower portion of the watershed).

2001 Recommendation(s)
DWQ will continue to work with the Town of Henderson's WWTP to correct remaining problems from their discharge and collection system. However, it is likely that aquatic life will remain impaired because of habitat degradation in the stream. Urban stormwater issues need to be addressed by the Town of Henderson. Best management practices to prevent further degradation by runoff from urban areas and construction sites should be installed. DWQ will continue to monitor the stream and work with local agencies to restore water quality.

6.2.2 **Anderson Swamp Creek** (4.0 miles from source to 0.6 miles upstream of SR 1374)

1996 Recommendation(s)
Anderson Swamp Creek was rated as impaired during the last basin cycle by using benthic macroinvertebrate data that resulted in a Fair bioclassification. An unnamed tributary below the Vulcan Materials-Greystone Quarry was also rated impaired based on a Poor benthic

macroinvertebrate bioclassification. The recommendation was to identify and address sedimentation in the watershed.

Status of Progress
In 1999, DWQ biologists determined that both of these streams are too small to rate using current benthic macroinvertebrate criteria, and the streams were not resampled during this basinwide cycle. The benthic macroinvertebrate bioclassification in this particular stream will remain not rated unless assessment criteria for small streams (<1.0 meter wide) are developed. This stream is not currently considered impaired. Refer to Section A, Chapter 4 for a more detailed discussion of habitat degradation.

6.3 Status and Recommendations for Newly Impaired Waters

No stream segments were rated as impaired based on recent DWQ monitoring (1995-1999); however, as mentioned previously, some impacts to water quality were observed. Refer to Part 6.5 of this chapter, as well as Section A, Chapter 4 for further discussion of potential water quality problems.

6.4 Section 303(d) Listed Waters

Currently in this subbasin, Nutbush Creek is listed on the state's year 2000 303(d) list. The stream is a biologically impaired water, and pollution sources are both point and nonpoint. Nutbush Creek is discussed in detail above. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

6.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program agency contacts are listed in Appendix VI.

6.5.1 Projected Population Growth

The population of Granville County is projected to increase 25 percent and Vance County 11 percent over a twenty-year period (1998-2018). Growth management within the next five years will be imperative in order to maintain good water quality in this subbasin. Growth management can be defined as the application of strategies and practices that help achieve sustainable development in harmony with the conservation of environmental qualities and features of an area. On a local level, growth management often involves planning and development review requirements that are designed to maintain or improve water quality. Refer to Section A, Chapter 4 for more information about minimizing impacts to water quality from development.

Local Programs

Vance and Granville counties both have planning departments with full-time planning staff. Vance County, in particular, has taken pro-active steps toward minimizing water quality impacts during development. Additionally, the City of Henderson adopted a local sediment-erosion control ordinance in order to minimize water quality impacts from construction activities. These local governments are commended for their planning initiatives. These programs should be supported, expanded and improved in the future.

6.5.2 Phase II Stormwater Requirements

Amendments were made to the Clean Water Act in 1990 (Phase I) and most recently in 1999 (Phase II) pertaining to permit requirements for stormwater discharges associated with storm sewer systems. Part of Phase II requires some municipal storm sewer systems serving populations under 100,000, which are located in larger urbanized areas and/or that have a high population density to obtain an NPDES stormwater permit. The municipal permitting requirements are designed to lead into the formation of comprehensive stormwater management programs for municipal areas. The Town of Henderson will be considered for inclusion under the Phase II rules because of a population greater than 10,000 and/or a population density greater than 1000 persons per square mile. DWQ is currently developing criteria that will be used to determine whether this and other municipalities will be required to obtain a NPDES permit. Refer to Section A, Part 2.7.2 for further information.

Chapter 7 -
Roanoke River Subbasin 03-02-07
Includes Lake Gaston and Smith, Hawtree and Sixpound Creeks

7.1 Water Quality Overview

Subbasin 03-02-07 at a Glance

Land and Water Area

Total area:	195 mi^2
Land area:	174 mi^2
Water area:	21 mi^2

Population Statistics

1990 Est. Pop.:	8,338 people
Pop. Density:	48 persons / mi^2

Land Cover (%)

Forest / Wetland:	75.1
Surface Water:	10.9
Urban:	0.1
Cultivated Crop:	7.4
Pasture / Managed Herbaceous:	6.4

Lake Gaston and its tributary streams make up this subbasin. Streams flow generally northward into Virginia or Lake Gaston in North Carolina. The towns of Norlina, Macon and Littleton straddle the Roanoke/Tar-Pamlico basin divide and are the only municipal areas. A map of this subbasin including water quality sampling locations is presented in Figure B-7.

Bioclassifications for sites that were sampled during this basinwide planning period are presented in Table B-17. Use support ratings for each applicable category in this subbasin are summarized in Tables B-18 and B-19. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

Seventy-five percent of the land in this subbasin is forested. Land use is a combination of agricultural activities, primarily in the western portion of the subbasin, and residential development around the lake in the eastern portion. Several registered animal operations are located in this subbasin. Nearly 11 percent of the area is surface water reflecting 13,400 acres of Lake Gaston. There are no NPDES permitted dischargers.

More so than Kerr Reservoir upstream, Lake Gaston straddles the North Carolina/Virginia state line. The lake was constructed in 1963 by Virginia Electric and Power Company (currently Dominion) for the purpose of generating hydroelectric power. However, the lake is also used extensively for recreation. Many residential developments, campgrounds, golf courses, marinas and swimming beaches are located along the shoreline. Lake Gaston was sampled by DWQ in 1999. Currently, the lake is fully supporting aquatic life and secondary recreation and primary recreation. However, the lake assessment did reveal some impacts to water quality which are discussed in detail in Part 7.5 of this chapter.

Observations during the very dry summer of 1999 indicated that many streams in this subbasin stopped flowing. Seasonally intermittent low flow may limit the diversity of the fish and benthic macroinvertebrate communities.

Figure B-7 Lake Gaston and Tributaries Subbasin 03-02-07

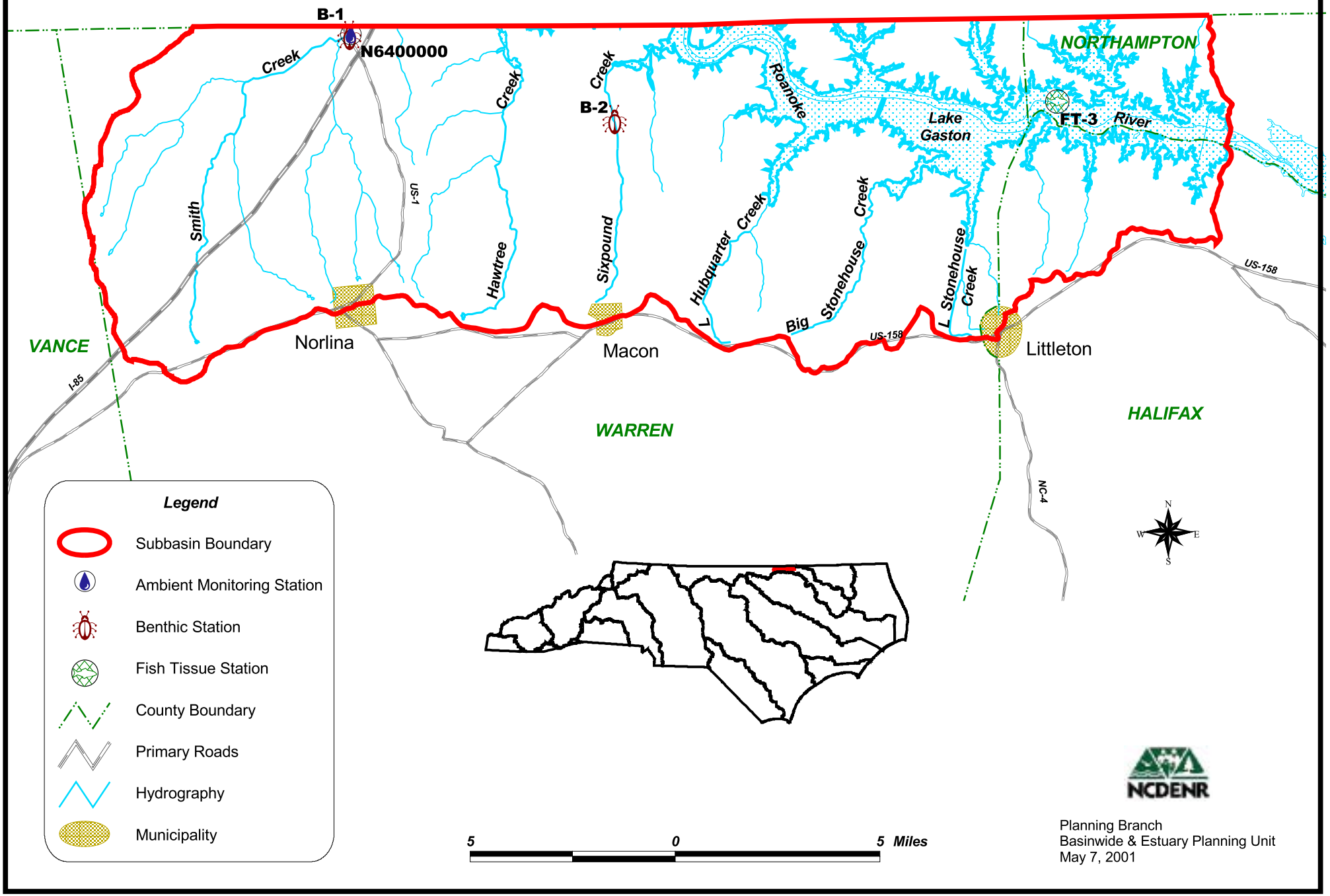


Table B-17 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-07

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
B-1*	Smith Creek	Warren	US 1	Fair
B-2*	Sixpound Creek	Warren	SR 1306	Good-Fair
Fish Tissue				
FT-3	Lake Gaston	Northampton	SR 1214	N/A
Ambient Monitoring				
N6400000	Smith Creek	Warren	US 1	N/A

* Historical data are available; refer to Appendix III.

Benthic macroinvertebrate surveys conducted on Smith Creek produced a Fair bioclassification while Sixpound Creek received a Good-Fair. Both sites indicated slight water quality improvements during the low flow and drought-like conditions in the summer of 1999 compared to samples collected after high flows in 1994. This improvement during low flow indicates that nonpoint source pollution problems may be affecting water quality. During high flow, sediment is carried into stream channels, "scouring" the streambed and removing macroinvertebrate habitat. Despite the slight flow-related improvement between the 1994 and 1999 samples, aquatic life in Smith Creek is impaired. This stream is discussed in more detail in following sections. No other streams in this subbasin were sampled.

Water chemistry samples are collected monthly from Smith Creek near the North Carolina/Virginia state line. Dissolved oxygen concentrations were lower here than at any other tributary site in the Roanoke River basin. Approximately 25 percent of samples were less than the standard of 5.0 mg/l. A steady increase in conductivity values has been observed at this site over the past ten years as well. Refer to Part 7.2.2 for more detailed information and recommendations for Smith Creek.

During July 1999, 20 fish tissue samples (bluegill, largemouth bass, channel catfish and yellow perch) were collected from Lake Gaston in Northampton County. All metals concentrations were below federal and state criteria for consumption (Appendix II).

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-18 Use Support Ratings Summary (1999) for Monitored Lakes (acres) in Roanoke River Subbasin 03-02-07

Use Support Category	FS	PS	NS	Total[1]
Aquatic Life/ Secondary Recreation	13,400	0	0	13,400
Fish Consumption[3]	0	13,400	0	13,400
Primary Recreation	13,400	0	0	13,400
Water Supply	13,400	0	0	13,400

Table B-19 Use Support Ratings Summary (1999) for Monitored and Evaluated[2] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-07

Use Support Category	FS	PS	NS	NR	Total[1]
Aquatic Life/ Secondary Recreation	41.7	10.4	0	49.4	101.5
Fish Consumption[3]	0	5.4	0	0	5.4
Primary Recreation	5.4	0	0	0.6	6.0
Water Supply	11.6	0	0	0	11.6

[1] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[2] For the fish consumption use support category, only monitored stream miles are presented.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information.

7.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River basin plan identified two impaired waters in this subbasin: Lake Gaston and Smith Creek. These waters are discussed below.

7.2.1 **Lake Gaston** (13,400 acres)

1996 Recommendation(s)

In 1996, Lake Gaston was partially supporting designated uses due to an infestation of aquatic plants. The lake was described as having "prolific growths of aquatic macrophytes", especially *Hydrilla*, that hindered secondary recreation activities such as boating and water-skiing on large portions of the lake. Nutrient levels were moderate, and the recommendation was to assess the need for a nonpoint source pollution nutrient management plan.

Status of Progress
Between 1995 and 1999, the surface area of Lake Gaston affected by aquatic macrophytes decreased. The Lake Gaston Weed Council, in cooperation with the NC Division of Water Resources, managed to keep the aquatic weeds under control through application of aquatic herbicides and the introduction of grass carp. Since almost all of the affected waters were available for recreation during this basinwide cycle, the lake is currently considered to be fully supporting all designated uses, including secondary recreation. However, moderate levels of nutrients and low dissolved oxygen concentrations were observed during DWQ's 1999 lake monitoring, and water quality in the lake is further discussed in Part 7.5.1 of this chapter.

7.2.2 **Smith Creek** (10.4 miles from source to NC/VA state line)

1996 Recommendation(s)
Smith Creek was rated as impaired during the last basin cycle by using benthic macroinvertebrate data that resulted in a Fair bioclassification. The recommendations were to continue to monitor water quality in the creek and to identify and address sources of sedimentation in the watershed, as resources allowed.

Status of Progress
The benthic macroinvertebrate community in Smith Creek again received a Fair bioclassification in 1999 primarily because of habitat degradation. The streambed was almost entirely sand, and the water was turbid at the sampling site in 1999. Median dissolved oxygen concentrations were lower in Smith Creek than at any other tributary site in the basin. Approximately 25 percent of observations were less than the water quality standard of 5.0 mg/l.

Additionally, iron concentrations in Smith Creek are very high. Almost 86 percent of more than 50 samples within the past five years exceeded the water quality standard. Over the last fifteen years, a steady increase in conductivity has also been observed. Water samples from Smith Creek did pass a 7-day chronic toxicity test conducted by DWQ in 2000. However, of the eight toxicity tests conducted in the Roanoke River basin, water from Smith Creek exhibited the largest deviation from control samples. Smith Creek remains impaired (partially supporting the aquatic life/secondary recreation use support category).

2001 Recommendation(s)
There are no NPDES permitted dischargers in the Smith Creek watershed; therefore most, if not all, impacts to this stream are from nonpoint sources of pollution. DWQ will continue to work cooperatively with agencies that administer sediment control programs in order to maximize effectiveness of these programs and to take appropriate enforcement action to protect or restore water quality. However, more voluntary implementation of BMPs on agricultural lands is needed in order to substantially improve water quality in this watershed. Funding is available through numerous federal and state agencies for farmers to restore and/or protect water quality on their land. Local contacts for some of these agencies are listed in Appendix VI. Refer also to Section A, Chapter 4 for more information.

7.3 Status and Recommendations for Newly Impaired Waters

No stream segments were rated as impaired based on recent DWQ monitoring (1995-1999); however, as mentioned previously, some impacts to water quality were observed. Refer to Part 7.5 of this chapter, as well as Section A, Chapter 4 for further discussion of potential water quality problems in this portion of the basin.

7.4 Section 303(d) Listed Waters

Currently in this subbasin, Smith Creek is listed on the state's year 2000 303(d) list. The stream is biologically impaired, and pollution sources are primarily agricultural. Smith Creek is discussed in detail above. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

7.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program agency contacts are listed in Appendix VI.

7.5.1 Lake Gaston

Dissolved oxygen concentrations in the lake are influenced by deep water releases from Kerr Reservoir upstream. In summer, the surface dissolved oxygen is often less than the water quality standard of 5.0 mg/l. The most upstream station in Lake Gaston (in Virginia) has consistently lower dissolved oxygen than the other three sampling sites. In 1999, the first of seven new turbines was modified at Kerr Dam, upstream of Lake Gaston. These modifications are designed to increase downstream dissolved oxygen; however, effects of this increase were not yet observed by DWQ monitoring staff in summer of 1999. Completion of the turbine aeration project is expected in spring of 2000 (DENR-DWQ, May 2000).

Levels of nitrogen and phosphorus in Lake Gaston are still considered moderate. Concentrations are highest in the North Carolina portion of the lake. Increases in nitrogen and/or phosphorus inputs could lead to algae blooms and violations of the chlorophyll *a* standard in the future. Measures should be put in place now to reduce nutrient loads to the reservoir in runoff from residential lawns, impervious surfaces, golf courses and agricultural lands.

Although DWQ's assessment of the secondary recreation category for Lake Gaston led to a fully supporting rating for the 1995-1999 review period, DWQ remains concerned about excessive growth of aquatic plants in the lake and will continue to support the work of the Lake Gaston

Weed Council and DWR in order to ensure that designated uses of the lake remain unimpaired. DWQ will assess the lake again in 2004.

Dominion's Shoreline Management Plan

Dominion (formerly NC Power), in consultation with participants of the relicensing Shoreline Management Technical Work Group, has developed and implemented a Shoreline Management Plan (SMP). The SMP includes measures designed to reduce nutrient loads through the protection of riparian buffers around Lake Gaston and Roanoke Rapids Lake. Components of the SMP include: reducing clearing of shoreline vegetation, encouraging replanting of native species in areas where vegetation has been cleared, protecting emergent macrophytes, prohibiting the use of commercial fertilizers, and identifying and protecting environmentally sensitive areas.

7.5.2 Sixpound Creek

The benthic macroinvertebrate community of Sixpound Creek received a Fair bioclassification in 1994 when flow in the stream was high and Good-Fair in 1999 during low flow. These results indicate impacts to water quality are present and are primarily a result of nonpoint source pollution. However, impacts were not as detrimental to the aquatic community as those in Smith Creek, which is impaired and discussed in previous sections.

Land use in the watershed is primarily agricultural and residential with large amounts of open (not forested) land. DWQ will plan sample this stream again during the next basinwide cycle; however, BMPs to address nonpoint source pollution problems should be put in place now to prevent further degradation and potential impairment of water quality. (Refer to Section C and Appendix VI for nonpoint source pollution program and contact information).

Chapter 8 -
Roanoke River Subbasin 03-02-08
Includes Roanoke Rapids Lake and 55 miles of the Roanoke River

8.1 Water Quality Overview

Subbasin 03-02-08 at a Glance

Land and Water Area

Total area:	513 mi^2
Land area:	473 mi^2
Water area:	40 mi^2

Population Statistics

1990 Est. Pop.:	43,392 people
Pop. Density:	91 persons / mi^2

Land Cover (%)

Forest / Wetland:	65.2
Surface Water:	2.8
Urban:	1.5
Cultivated Crop:	28.4
Pasture / Managed Herbaceous:	2.0

The upper portion of this subbasin, including Roanoke Rapids Lake, lies within the piedmont region, while the middle and lower portions are in the coastal plain. The coastal plain portion includes approximately 50 miles of the Roanoke River. The major tributaries in this subbasin are Chockoyette, Quankey, Occoneechee and Bridgers Creeks; and Conoconnara, Kehuku, Gumberry and Cypress Swamps. Municipalities include Gaston, Roanoke Rapids, Weldon, Garysburg and Halifax, as well as portions of Scotland Neck, Rich Square and Lewiston-Woodville. A map of this subbasin including water quality sampling locations is presented in Figure B-8.

Bioclassifications for sample sites in this subbasin are presented in Table B-20. Use support ratings for each applicable category in this subbasin are summarized in Table B-21 and B-22. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

With the exception of the Gaston, Roanoke Rapids and Weldon urban area, most of the land in this subbasin is forested (65 percent) or in agriculture (30 percent). The majority of the agricultural land is cultivated cropland (cotton, peanuts, tobacco and soybeans), but there are many animal operations in the area as well.

There are eleven NPDES permitted dischargers in this subbasin. The largest facilities are Champion International, Perdue Farms and the Roanoke Rapids, Weldon and NC Department of Correction's (DOC) Caledonia Prison WWTPs. All of these facilities discharge directly into the Roanoke River. DOC's Caledonia facility has significant compliance problems with BOD, fecal coliform and total suspended solids. This facility is discussed further in Part 8.5.1.

Seven facilities are required to perform toxicity tests on their discharge. Toxicity problems were observed at the Town of Halifax WWTP (discharges into Quankey Creek) and the Panda-Rosemary Corporation facility (discharges into Chockoyotte Creek) over the past two years.

Figure B-8 Lower Roanoke River Subbasin 03-02-08

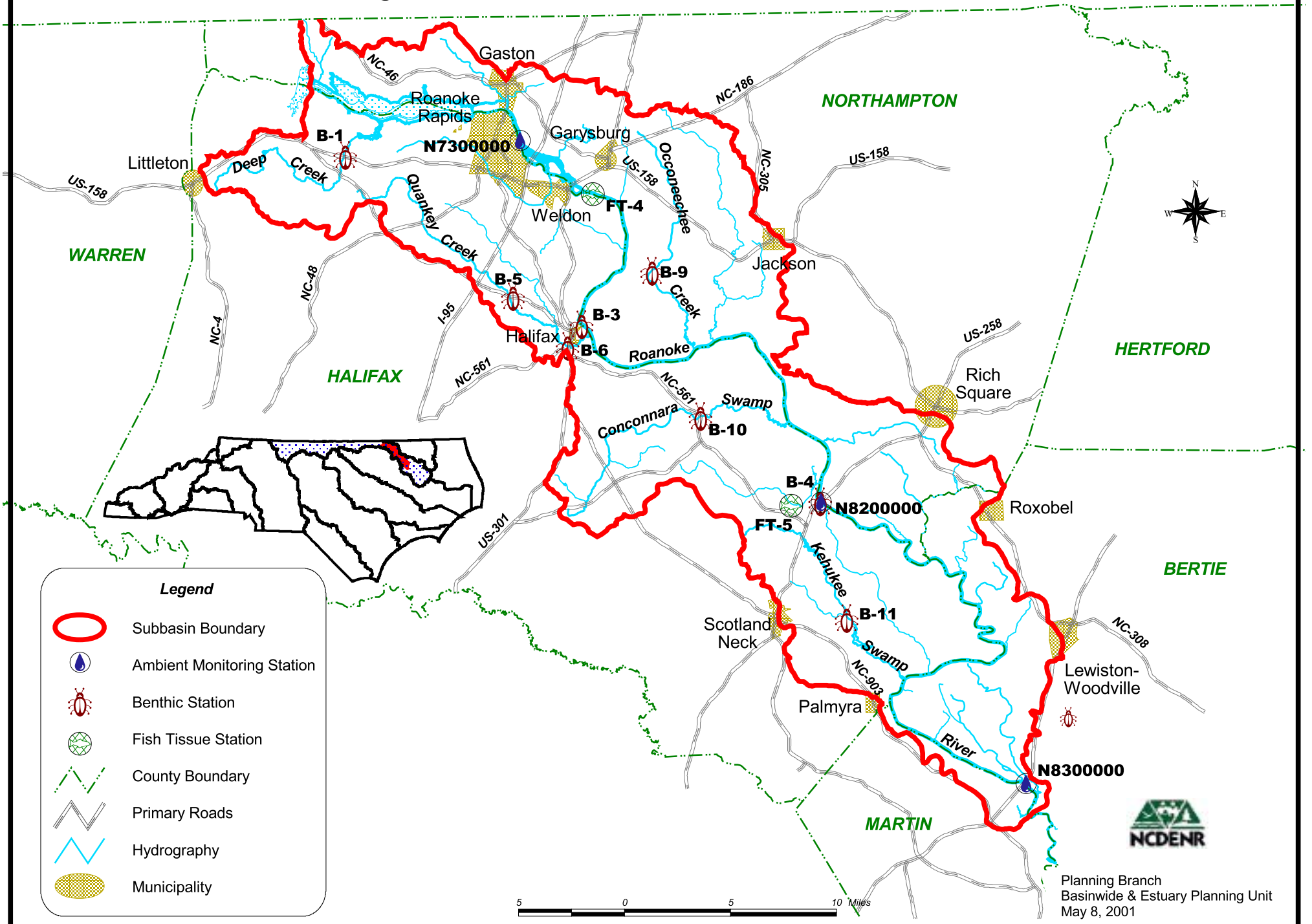


Table B-20 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-08

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
B-1	Deep Creek	Halifax	Weldon	Not Rated
B-3	Roanoke River	Halifax	Halifax	Good
B-4*	Roanoke River	Halifax	Scotland Neck	Good
B-5	Quankey Creek	Halifax	NC 903	Not Rated
B-6*	Quankey Creek	Halifax	NC 561	Fair
B-9	Occoneechee Creek	Northampton	SR 1126	Not Rated
B-10	Conoconnara Swamp	Halifax	NC 561	Not Rated
B-11	Kehukee Swamp	Halifax	SR 1804	Not Rated
Fish Tissue				
FT-4	Roanoke River	Halifax	Weldon	N/A
FT-5	Roanoke River	Halifax	Scotland Neck	N/A
Ambient Monitoring				
N7300000	Roanoke River	Halifax	Roanoke Rapids	N/A
N8200000	Roanoke River	Halifax	Scotland Neck	N/A
N8300000	Roanoke River	Martin	NC 11	N/A

* Historical data are available; refer to Appendix II.

Extensive evaluation, conducted by DWQ, of swamp streams across eastern North Carolina suggests that different criteria should be used to assess the condition of water quality in these systems. Swamp streams are characterized by slower flow, lower dissolved oxygen, lower pH, and sometimes very complex braided channels and dark-colored water. DWQ has developed draft biological criteria that may be used in the future to assign bioclassifications to these streams (as is currently done for other streams and rivers across the state). However, DWQ believes that there has been insufficient sampling of reference swamp streams to assign bioclassifications to them and use them for use support determinations in the Roanoke River basin at this time. DWQ continues to work toward preparing these criteria for future use.

The Roanoke River at Halifax was sampled for the first time in 1999 and received a Good bioclassification for benthic macroinvertebrates. The Roanoke River at Scotland Neck maintained a Good bioclassification as well. In 1994, the river also received a Good benthic bioclassification below Weldon.

The biological community in the lower portion of Quankey Creek, below the Town of Halifax WWTP, received a Fair bioclassification in both 1992 and 1999. The upper portion is swampy, and the site was not rated; but no potential impacts to water quality were observed. The lower

section of Quankey Creek is only partially supporting aquatic life/secondary recreation and is discussed in more detail in the following sections. Deep Creek, Occoneechee Creek, Conoconnara Swamp and Kehukee Swamp were not rated using macroinvertebrate data because of their swampy nature. However, some habitat degradation was noted at each site. Please refer to Section A, Chapter 4 for further discussion of habitat degradation in the Roanoke River basin.

Fish community data were collected and a mussel survey was conducted in 1995 and 1996 by Dominion (formerly North Carolina Power Company) as part of its relicensing efforts for the Lake Gaston and Roanoke Rapids hydroelectric project. Eight of the fifteen mussel species that had been historically documented or believed to be present in the lower Roanoke River were collected from a single 10-mile stretch (DENR-DWQ, May 2000).

Fish tissue samples were collected by DWQ from two sites on the Roanoke River in 1995 and 1999. Six bowfin samples from the river at Weldon had mercury concentrations greater than the EPA screening value. Metals concentrations in 21 samples of other fish species were less than federal and state criteria for fish consumption. At Scotland Neck, 23 fish were tested for mercury contamination. One largemouth bass and one bowfin had concentrations greater than EPA consumption criteria.

Roanoke Rapids Lake was the only lake monitored in this subbasin. The lake has extensive growths of nuisance aquatic macrophytes. More than 30 percent of the lake's surface area is covered with *Hydrilla* (DENR-DWQ, May 2000). Other species are also present in the lake. Secondary recreation activities, such as boating and water-skiing, are impaired in this lake, and the lake is discussed in more detail in the following sections.

Water chemistry samples are collected monthly from three sites on the Roanoke River in this subbasin: at Roanoke Rapids, near Scotland Neck and just above Hamilton. Although there was no indication of substantial water quality problems, total suspended solids and nitrate nitrogen concentrations increased in a downstream manner from Roanoke Rapids to Hamilton.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-21 Use Support Ratings Summary (1999) for Monitored Lakes (acres) in Roanoke River Subbasin 03-02-08

Use Support Category	FS	PS	NS	Total[2]
Aquatic Life/ Secondary Recreation	0	4,893	0	4,893
Fish Consumption[3]	0	4,893	0	4,893
Primary Recreation	4,893	0	0	4,893
Water Supply	4,893	0	0	4,893

Table B-22 Use Support Ratings Summary (1999) for Monitored and Evaluated[1] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-08

Use Support Category	FS	PS	NS	NR	Total[2]
Aquatic Life/ Secondary Recreation	167.9	3.4	0	180.6	351.9
Fish Consumption	0	123.7	0	0	123.7
Primary Recreation	0	0	0	0	0
Water Supply	20.5	0	0	0	20.5

[1] For the fish consumption use support category, only monitored stream miles are presented.

[2] Total stream miles/acres assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

[3] These waters are impaired because of a statewide fish consumption advisory for bowfin. Refer to Section A, Part 4.8.4 for further information.

8.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River basin plan identified three impaired waters in this subbasin. Roanoke Rapids Lake, Quankey Creek and Conoconnora Swamp are discussed below.

8.2.1 **Roanoke Rapids Lake** (4,893 acres)

1996 Recommendation(s)

In 1996, Roanoke Rapids Lake was partially supporting designated uses due to infestation of invasive aquatic plants. The lake was described as having prolific growths of aquatic macrophytes, especially *Hydrilla*, that hindered secondary recreation activities such as boating and water-skiing on large portions of the lake. Nutrient levels were moderate and the recommendation, as in the case of Lake Gaston (subbasin 03-02-07), was to assess the need for a nonpoint source pollution nutrient management plan.

Status of Progress

In recent years, there has been an increase in invasive aquatic macrophytes in Roanoke Rapids Lake. More than 30 percent of the surface area is affected by these nuisance plants (DENR-DWQ, May 2000). Moderate levels of nutrients were again observed during DWQ's 1999 lake monitoring; however, studies have shown that the most prevalent plant, *Hydrilla*, does not respond to nutrient reduction. Secondary recreation remains impaired (partially supporting) in this lake. Citizens have formed the Roanoke Rapids Lake Management Council to work toward reducing aquatic weeds in the lake.

2001 Recommendations

DWQ will work the Roanoke Rapids Lake Management Council and DWR to reduce aquatic weeds. Water quality could also benefit from nutrient reduction in this lake. Additionally, a public education campaign is recommended so that introduction of additional aquatic macrophytes from boats that have been in other waters is minimized. Refer to Section C for information about funding sources that are available for water quality improvements and education in impaired waters.

8.2.2 **Quankey Creek** (19.4 miles from source to the Roanoke River)

1996 Recommendation(s)

Two sites, above and below the Town of Halifax WWTP, were sampled during the last basin cycle at the lower end of Quankey Creek. The biological community at both sites received a Fair bioclassification. The 1996 recommendation was to evaluate impacts from a rest area along I-95 upstream.

Status of Progress

In 1999, two sites, downstream of I-95 and downstream of the Town of Halifax WWTP, were sampled by DWQ. The biological community below the Halifax WWTP again received a bioclassification of Fair. This facility has experienced compliance problems over the past decade and failed 25 percent of whole effluent toxicity tests between 1997 and 1999. Conductivity was 117 umhos (compared to 70 umhos upstream), reflecting the influence of the point source discharge. However, there is significant habitat degradation caused by channel alterations contributing to impairment of aquatic life (partially supporting) in the lower section of Quankey Creek.

The benthic community at the upstream site (that was chosen to evaluate the effects of the I-95 rest area) was not rated because the site exhibited swamp characteristics. However, the site received the highest habitat quality score of any tributary sampled in the coastal plain area of the basin. A large number of insects were collected as well as a good variety of pollution intolerant species. There was no indication of water quality impacts at this location. Based on this additional monitoring effort, the number of impaired stream miles has been reduced from 19.4 to 3.4 (from the confluence with Little Quankey Creek to the mouth at Roanoke River).

2001 Recommendations

DWQ will continue to work with the Town of Halifax to resolve problems with the WWTP discharge. The town received a grant in March 2000 to begin addressing the most critical maintenance problems at the facility, but more funding is needed to complete collection system rehabilitation and construction of new sewer lines to eliminate failing septic systems in the Town of Halifax. Refer to Part 8.5.1 for further details about NPDES discharges in this subbasin.

Additionally, DWQ will continue to monitor Quankey Creek and, as resources allow, sample Little Quankey Creek during the next basinwide sampling to assess its contribution to degraded water quality in this watershed.

8.2.3 **Conoconnora Swamp** (17.7 miles from source to the Roanoke River)

1996 Recommendation(s)
This stream was rated as impaired during the last basin cycle by using fish community data that resulted in a Fair bioclassification. The recommendation was to evaluate the contribution of agricultural runoff in the watershed and implement best management practices as necessary.

Status of Progress
Fish community data was not collected from this stream during this basin cycle. The benthic macroinvertebrate community was not rated and will remain not rated until assessment criteria can be used with confidence (refer to previous sections). While aquatic life/secondary recreation in this stream is not currently considered impaired, lower total numbers and diversity of pollution intolerant species of aquatic insects were observed during the 1999 sampling.

8.3 Status and Recommendations for Newly Impaired Waters

The majority of the lower Roanoke River in North Carolina was rated as impaired based on fish consumption advisories and recent DWQ fish tissue monitoring (1995-1999). This section outlines the potential causes and sources of impairment and provides recommendations for improving water quality.

8.3.1 **Roanoke River** (128.5 miles from the Roanoke Rapids dam to Williamston)

Current Status
The Roanoke River, from the Roanoke Rapids dam to the Albemarle Sound, is impaired because of fish consumption advisories. In this particular section of the river, from the dam to Williamston, the only advisory is due to elevated levels of mercury in bowfin (blackfish). Bowfin with levels of mercury that exceed consumption criteria were collected by DWQ in the Roanoke River near Weldon and Williamston in 1995 and 1999. Because of this advisory, this portion of the river is only partially supporting the fish consumption category. (Note: This is not a new advisory, but improved use support methodology now bases impairment for the fish consumption use support category on fish consumption advisories. See Appendix III for more information regarding use support ratings.)

2001 Recommendation(s)
DWQ will continue to monitor fish tissue in the Roanoke River and will work to identify sources of mercury. Given the global scale of mercury cycling, it may be difficult for DWQ to recognize significant reductions of mercury in fish over the short-term. The NC Department of Environment and Natural Resources (DENR) has established a Mercury Task Force that includes staff from DWQ, Division of Air Quality, Hazardous Waste, Pollution Prevention and Wildlife Resources. In addition, DWQ has established an internal Water Quality Section Work Group to stay abreast of mercury issues. Section A, Part 4.8 provides more details about mercury in the environment.

8.4 Section 303(d) Listed Waters

Currently in this subbasin, two waters are listed on the state's year 2000 303(d) list: Roanoke Rapids Lake and Quankey Creek. Roanoke Rapids Lake is listed on Part I of the 2000 303(d) list requiring DWQ to develop a TMDL/management strategy. Quankey Creek is biologically impaired. Both waters are discussed in more detail in the previous sections. The Roanoke River, along with all other waters in the basin, will likely be added to the list in 2002 based on the statewide bowfin consumption advisory. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

8.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program agency contacts are listed in Appendix VI.

Although aquatic communities in the section of Roanoke River contained in this subbasin are currently in good condition, there are several discharges and other impacts in this portion that are likely contributing to a decline in water quality downstream. These impacts are discussed in the following paragraphs.

8.5.1 NPDES Discharges

As was mentioned in this chapter's overview, the NC Department of Correction's (DOC) Caledonia Prison WWTP discharge, which is permitted to release 0.8 million gallons per day to the Roanoke River, continued to experience compliance problems over the past five years. Parameters that exceed permitted limits include BOD, fecal coliform and total suspended solids. DWQ has been working with DOC for the past eight years to correct problems with this discharge. Almost $8,000 in civil penalties have been assessed dating back to June 1993. DOC has plans to build a new constructed wetlands treatment system by December 2002. Final compliance with permit limits for this new discharge is required by July 2003.

The Town of Halifax's WWTP discharge, permitted to release up to 0.7 MGD to Quankey Creek just upstream of the Roanoke River, continued to experience both compliance (BOD and total suspended solids) and toxicity problems over the past five years. DWQ has been working with the town for more than a decade to resolve problems with this deteriorating facility. More than $8,000 in civil penalties have been assessed dating back to June 1991. The town received a grant in March 2000 to begin addressing the most critical maintenance problems at the facility, but more funding is needed to complete collection system rehabilitation and construction of new sewer lines to eliminate failing septic systems in the Town of Halifax.

8.5.2 Eroding Streambanks

There are several large areas along the Roanoke River, as well as smaller tributaries where the banks are eroding. In some areas, this erosion is severe, contributing large amounts of sedimentation to the Roanoke River. One landowner, with several hundred feet of riverbank, has agreed to work with the Albemarle-Pamlico National Estuary Program's (APNEP) Roanoke Regional Council to provide alternative water sources and fence livestock out of the Roanoke River. That project will serve as a demonstration site, once it is complete. Refer to Part 1.2.2 of Section C for details about the Roanoke Regional Council.

The DOC Caledonia facility is a prison farm, and cattle at this facility have had access to the Roanoke riverbank for several hundred feet. The Division of Soil and Water Conservation has been working with DOC to select and implement BMPs at this facility, including cattle exclusion and bank stabilization.

Section A, Chapter 4 discusses sedimentation, streambank erosion and best management practices for controlling them. Appendix VI contains descriptions of and contact information for nonpoint source pollution programs in North Carolina.

8.5.3 Phase II Stormwater Requirements

Amendments were made to the Clean Water Act in 1990 (Phase I) and most recently in 1999 (Phase II) pertaining to permit requirements for stormwater discharges associated with storm sewer systems. Part of Phase II requires some municipal storm sewer systems serving populations under 100,000, which are located in larger urbanized areas and/or that have a high population density to obtain an NPDES stormwater permit. The municipal permitting requirements are designed to lead into the formation of comprehensive stormwater management programs for municipal areas. Roanoke Rapids will be considered for inclusion under the Phase II rules because of a population greater than 10,000 and/or a population density greater than 1,000 persons per square mile. DWQ is currently developing criteria that will be used to determine whether this and other municipalities will be required to obtain a NPDES permit. Refer to Section A, Part 2.7.2 for further information.

8.5.4 Chockoyette Creek

This stream flows through and around Roanoke Rapids and Weldon in the northwestern portion of this subbasin. The stream is currently impacted by collection system overflows in Roanoke Rapids, but there is also potential for serious habitat degradation to occur as this urban area continues to grow. Roanoke Rapids is diligently working to correct the wastewater collection system problems, which essentially amounts to a complete replacement. DWQ will continue to work with the city over the next five years toward completion of this task. DWQ will also plan to sample this stream during this basinwide cycle, as resources allow.

Stormwater issues need to be addressed by Roanoke Rapids, Gaston and Weldon. This urban area is not automatically covered by the EPA's Phase II stormwater rules, based on total population and density (see part 8.5.3). However, these municipalities could begin to develop a stormwater program that addresses stormwater runoff.

Chapter 9 -
Roanoke River Subbasin 03-02-09
Includes the lowest portion of the Roanoke River and tributaries

9.1 Water Quality Overview

Subbasin 03-02-09 at a Glance

Land and Water Area

Total area:	559 mi^2
Land area:	435 mi^2
Water area:	124 mi^2

Population Statistics

1990 Est. Pop.:	58,886 people
Pop. Density:	135 persons / mi^2

Land Cover (%)

Forest / Wetland:	71.5
Surface Water:	2.4
Urban:	0.6
Cultivated Crop:	24.8
Pasture / Managed Herbaceous:	0.8

This subbasin contains the lower 83 miles of the Roanoke River and tributaries including Conoho, Indian, Hardison Mill, Welch and Conaby Creeks. Municipalities include Hamilton, Williamston, Jamesville and Plymouth. A map of this subbasin including water quality sampling locations is presented in Figure B-9.

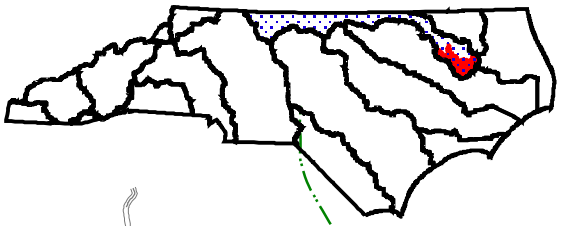
Bioclassifications for sample sites in this subbasin are presented in Table B-23. Use support ratings for each applicable category in this subbasin are summarized in Table B-24. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

This subbasin is located entirely within the coastal plain of North Carolina. Most of the land is forested (71 percent), but a significant amount is also used for agriculture (25 percent).

The lower Roanoke River is bordered by extensive floodplain forests. These "backswamps" are inundated during high flows when the river is full. Then, when the river level drops, water returns to the main channel through only a few connections, called "guts". Through the collected efforts of The Nature Conservancy, the US Fish and Wildlife Service, and the NC Wildlife Resources Commission, more than 34,000 acres of the floodplain have been brought into conservation ownership. With an additional 21,000 acres of Georgia-Pacific timberland under conservation management, an almost continuous corridor stretching from Hamilton to the Sound has been preserved (see Section C for more information).

There are nine NPDES permitted dischargers in the subbasin. The largest discharge is 82.5 MGD from Weyerhaeuser Company. Others include the Williamston WWTP and the Plymouth WWTP. All of three these discharges flow directly into the Roanoke River. The only facility in significant noncompliance during this review period was the Williamston WWTP. Four facilities are required to perform toxicity tests on their effluent. In the past, Liberty Fabrics has had the most problems, failing 42 percent of its tests. However, in 1999, none of these facilities failed a test.

Figure B-9 Lower Roanoke River Subbasin 03-02-09



HALIFAX
Lewiston-Woodville
NC-903
Palmyra
NC-308
BERTIE
Hobgood
NC-122
Conoho
US-17
NC-45
Sound
Albemarle
N9700000
Oak City
Hamilton
B-1
Roanoke
Creek
NC-308
NC-44
B-4
B-10
N9600000
FT-7
EDGECOMBE
Hassell
B-5
FT-6
B-2
N9250000
NC-42
NC-903
Williamston
Plymouth
MARTIN
N8550000
River
Creek
US-64
US-17
Jamesville
WASHINGTON
Hardison
Deep
B-8
B-9
B-6
Run
Swamp
Welch
B-7
Mill
Creek
NC-32
PITT
NC-171
BEAUFORT
NCDENR
Planning Branch
Basinwide & Estuary Planning Unit
May 8, 2001
5 0 5 10 Miles
N

Legend

- Subbasin Boundary
- Ambient Monitoring Station
- Benthic Special Studies
- Benthic Station
- Fish Tissue Station
- County Boundary
- Primary Roads
- Hydrography
- Municipality

Table B-23 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-09

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
B-1*	Roanoke River	Martin	NC 125/903	Good-Fair
B-2*	Roanoke River	Martin	Williamston	Good-Fair
B-4*	Conoho Creek	Martin	NC125/903	Not Rated
B-5	Conoho Creek	Martin	SR 1417	Not Rated
B-6	Hardison Mill Creek	Martin	NC 171	Not Rated
B-7	Hardison Mill Creek	Martin	SR 1528	Not Rated
B-8	Deep Run Swamp	Martin	NC 171	Not Rated
B-9	Welch Creek	Martin	SR 1522	Not Rated
B-10*	Roanoke River	Martin	NC 45	Not Rated
Fish Tissue				
FT-6	Roanoke River	Martin	Williamston	N/A
FT-7	Roanoke River	Martin	Near Plymouth	N/A
Ambient Monitoring				
N8550000	Roanoke River	Martin	Williamston	N/A
N9250000	Roanoke River	Martin	Above Plymouth	N/A
N9600000	Roanoke River	Bertie	Below Plymouth	N/A
N9700000	Albemarle Sound	Bertie	Batchelor Bay	N/A

* Historical data are available; refer to Appendix II.

Extensive evaluation, conducted by DWQ, of swamp streams across eastern North Carolina suggests that different criteria should be used to assess the condition of water quality in these systems. Swamp streams are characterized by slower flow, lower dissolved oxygen, lower pH, and sometimes very complex braided channels and dark-colored water. DWQ has developed draft biological criteria that may be used in the future to assign bioclassifications to these streams (as is currently done for other streams and rivers across the state). However, DWQ believes that there has been insufficient sampling of reference swamp streams to assign these bioclassifications and use them for use support determinations in the Roanoke River basin. DWQ continues to work toward preparing these criteria for future use.

Based on benthic macroinvertebrate data, the biological community in the Roanoke River has been assigned Good-Fair bioclassifications from the upper end of this subbasin to below Williamston. These data represent a slight decline compared to communities observed upstream. The lowest section of the river, above and below Plymouth, has experienced a mild temporary estuarine influence in some years, but is still regarded as a lower coastal plain freshwater river.

Macroinvertebrate data from the river below Plymouth has suggested good water quality in this section of the river, even though no bioclassification can be assigned.

All the tributaries in this subbasin are swampy and may experience periods of very little or no flow. The lower portion of Conoho Creek was found to represent nearly natural swamp conditions, while the upper portion of Conoho Creek, the upper and lower portions of Hardison Mill Creek, and Welch Creek suggested water quality or habitat problems. The most severe problems were observed in Deep Run Swamp, an area of intensive agricultural land use. These streams are discussed in more detail in Part 9.5.1 and 9.5.2.

Water chemistry samples are collected monthly from sites on the Roanoke River near Williamston and above and below Plymouth. These data have not indicated any major water quality problems in these areas, with the exception of elevated ammonia nitrogen concentrations below Plymouth (median = 0.075 mg/l).

Fish tissue samples were collected by DWQ from two sites on the Roanoke River in 1995 and 1999. Eight bowfin from the river near Williamston had mercury concentrations greater than FDA consumption criteria in 1995. In 1999, 15 of 24 samples (63 percent) of bowfin, largemouth bass and white catfish had mercury concentrations greater than EPA and FDA criteria (0.6 and 1.0 µg/g, respectively). Mercury concentrations were somewhat lower near Plymouth: four of seven (57 percent) bowfin collected in 1995 had high mercury concentrations. In 1999, four (three largemouth bass and one chain pickerel) out of 22 samples (18 percent) had concentrations which exceeded consumption criteria. The Roanoke River and Welch Creek are impaired because of fish consumption advisories and are discussed in following sections.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-24 Use Support Ratings Summary (1999) for Monitored and Evaluated[1] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-09

Use Support Category	FS	PS	NS	NR	Total[2]
Aquatic Life/ Secondary Recreation	72.8	0	0	198.3	271.1
Fish Consumption	0	25.3	13.3	0	38.6
Primary Recreation	0	0	0	11.3	11.3
Water Supply	0	0	0	0	0

[1] For the fish consumption use support category, only monitored stream miles are presented.

[2] Total stream miles assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

9.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River basin plan identified two impaired streams and a portion of the Albemarle Sound in this subbasin. These waters are discussed below.

9.2.1 **Welch Creek** (13.3 miles from source to Roanoke River**)**
Roanoke River (28.5 miles from Williamston to the Albemarle Sound**)**
Albemarle Sound (2,586 acres from Bull Bay to Harvey Point**)**

1996 Recommendation(s)
The 1996 basin plan listed Welch Creek and the Roanoke River from Williamston down to and including the Albemarle Sound as partially supporting due to a fish consumption advisory for dioxin. Weyerhaeuser Company operates a facility at the mouth of Welch Creek and originally it discharged directly to the stream. In the 1980s, it was recognized that dioxin, a carcinogenic by-product of the chlorine bleaching process, was accumulating in fish tissue. In 1988, improvements were made and the discharge was relocated to the Roanoke River. Weyerhaeuser is required by DWQ to provide extensive monitoring in the Roanoke River. The recommendation was to review this data to monitor the decline of dioxin in fish tissue.

Status of Progress
These waters remain impaired (Welch Creek – not supporting; Roanoke River and Albemarle Sound – partially supporting) because of fish consumption advisories for dioxin. No fish should be consumed from Welch Creek. Data collected by Weyerhaeuser Company indicate a decline in dioxin concentrations. Shellfish are not covered by this advisory.

2001 Recommendation(s)
DWQ, in cooperation with Weyerhaeuser Company, will continue to monitor the lower Roanoke River and Welch Creek and will work closely with the Department of Health and Human Services' Division of Public Health to lift the advisory when there is no longer a risk to human health from consumption of fish. For more information regarding fish consumption advisories, call (919) 733-3816 or visit the NC DHHS Division of Public Health website at http://www.schs.state.nc.us/epi/fish/current.html.

9.3 Status and Recommendations for Newly Impaired Waters

The majority of the lower Roanoke River in North Carolina was rated as impaired based on fish consumption advisories. This section outlines the potential causes and sources of impairment and provides recommendations for improving water quality.

9.3.1 Roanoke River (138.7 miles from the Roanoke Rapids dam to the Albemarle Sound)

Current Status
The Roanoke River, from the Roanoke Rapids dam to the Albemarle Sound, is impaired because of a statewide fish consumption advisory due to high levels of mercury in bowfin (blackfish). Bowfin with levels of mercury that exceed consumption criteria were collected by DWQ in the Roanoke River near Williamston and Plymouth in 1995 and 1999. Because of these advisories, this portion of the river is only partially supporting the fish consumption use support category. (Note: This is not a new advisory, but improved use support methodology now bases impairment for the fish consumption use support category on fish consumption advisories.)

2001 Recommendation(s)
DWQ will continue to monitor fish tissue in the Roanoke River and will work to identify sources of mercury. Given the global scale of mercury cycling, it may be difficult for DWQ to recognize significant reductions of mercury in fish over the short-term. The NC Department of Environment and Natural Resources (DENR) has established a Mercury Task Force that includes staff from DWQ, Division of Air Quality, Hazardous Waste, Pollution Prevention and Wildlife Resources. In addition, DWQ has established an internal Water Quality Section Work Group to stay abreast of mercury issues. Section A, Part 4.8 provides more details about mercury.

9.4 Section 303(d) Listed Waters

Currently in this subbasin, there are no waters listed on the state's year 2000 303(d) list. The Roanoke River and Welch Creek, along with all other waters in the basin, will be added to the state's 303(d) list of impaired waters in 2002 based on fish consumption advisories. Refer to Appendix IV for more information on the state's 303(d) list and listing requirements.

9.5 Other Issues and Recommendations

The surface waters discussed in this section are fully supporting designated uses (or not rated) based on recent DWQ monitoring; however, data revealed some impacts to water quality. Although no action is required for these streams, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies of water quality concerns regarding these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding. Nonpoint source program agency contacts are listed in Appendix VI.

9.5.1 Hardison Mill Creek
Deep Run Swamp

As was mentioned previously, the benthic macroinvertebrate communities of these two streams were sampled, but not rated by DWQ, in 1999 because of their swampy nature. However, significantly less diverse aquatic communities were observed in these streams than in other Roanoke River basin swamp stream communities. The headwaters of both streams are extensively channelized leading to severe habitat degradation in several miles of stream in these watersheds. Refer to Section A, Part 4.4 for further information and recommendations.

Chapter 10 -
Roanoke River Subbasin 03-02-10
Includes the Cashie River, Roquist Creek and tributaries

10.1 Water Quality Overview

Subbasin 03-02-10 at a Glance

Land and Water Area

Total area:	307 mi^2
Land area:	290 mi^2
Water area:	17 mi^2

Population Statistics

1990 Est. Pop.:	17,300 people
Pop. Density:	60 persons / mi^2

Land Cover (%)

Forest / Wetland:	79.2
Surface Water:	0.6
Urban:	0.3
Cultivated Crop:	19.4
Pasture / Managed Herbaceous:	0.6

The Cashie River and its tributaries including Roquist, Hoggard Mill and Wading Place Creeks are contained within this coastal plain subbasin. All streams, including the Cashie River itself, are slow moving and swampy in nature. Windsor, Askewville and a portion of Lewiston-Woodville are the only municipalities. A map of this subbasin including water quality sampling locations is presented in Figure B-10.

Bioclassifications for sample sites in this subbasin are presented in Table B-25. Use support ratings for each applicable category in this subbasin are summarized in Table B-26. Refer to Appendix III for a complete listing of monitored waters and further information about use support ratings.

Land use in the area is primarily forest with a mixture of agricultural activities. Several animal operations are located in the upper section of the Cashie River watershed. Timber is harvested in portions of the watershed as well.

There are four dischargers in the subbasin. Only the Town of Windsor's WWTP discharge, flowing into an unnamed tributary to the Cashie River, is considered major; this WWTP is also the only facility required to perform toxicity testing on its effluent. Toxicity problems have been identified over recent review periods. The Cashie River and this facility are discussed in more detail in the following sections.

Extensive evaluation, conducted by DWQ, of swamp streams across eastern North Carolina suggests that different criteria should be used to assess the condition of water quality in these systems. Swamp streams are characterized by slower flow, lower dissolved oxygen, lower pH, and sometimes very complex braided channels and dark-colored water. DWQ has developed draft biological criteria that may be used in the future to assign bioclassifications to these streams (as is currently done for other streams and rivers across the state). However, DWQ believes that there has been insufficient sampling of reference swamp streams to assign these bioclassifications and use them for use support determinations in the Roanoke River basin. DWQ continues to work toward preparing these criteria for future use.

Figure B-10 Cashie River Subbasin 03-02-10

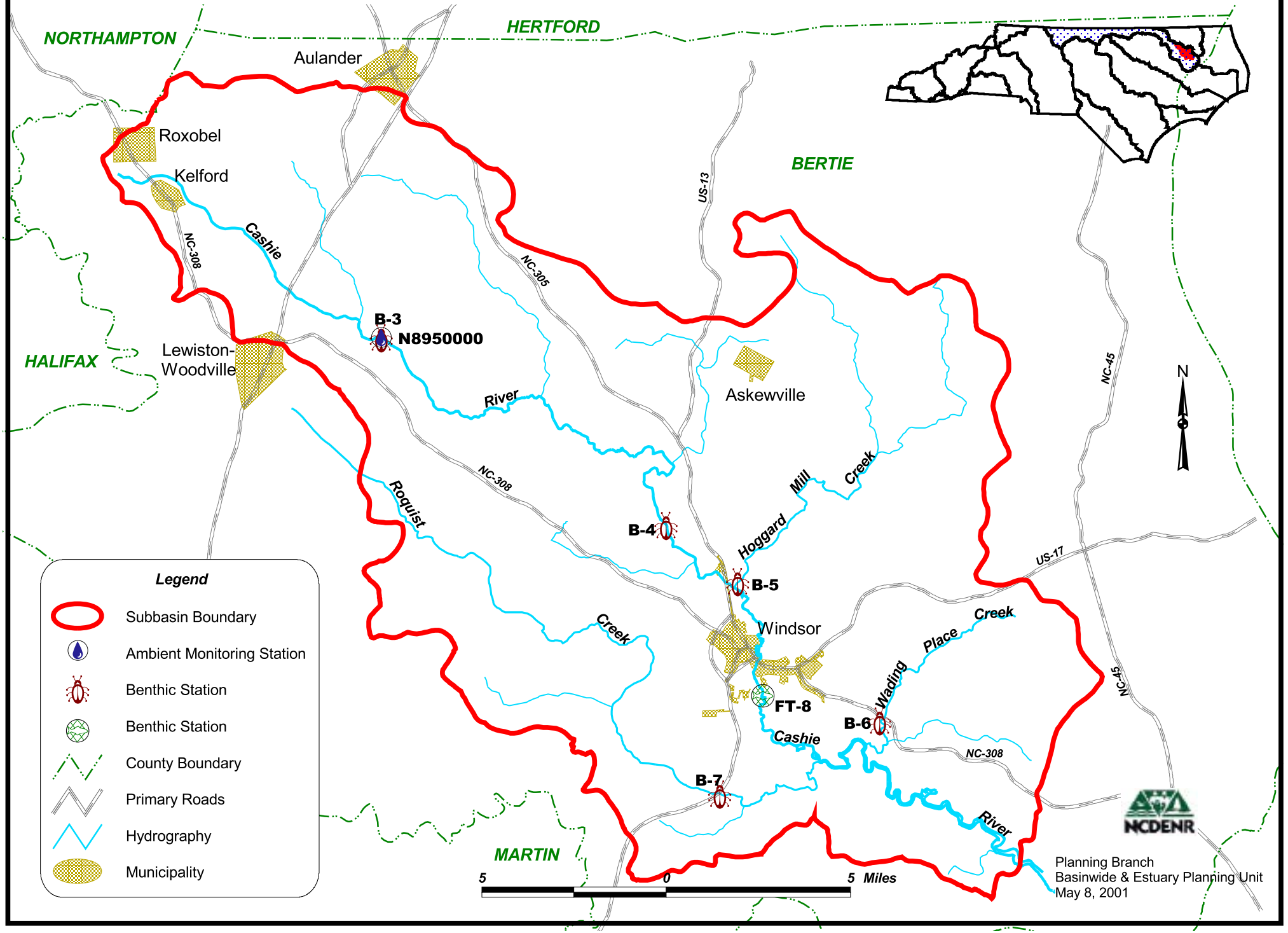


Table B-25 DWQ Monitoring Locations and Benthic Macroinvertebrate Bioclassifications (1999) for Roanoke River Subbasin 03-02-10

Site	Stream	County	Location	Bioclassification
Benthic Macroinvertebrates				
B-3*	Cashie River	Bertie	SR 1219	Not Rated
B-4	Cashie River	Bertie	SR 1257	Not Rated
B-5	Hoggard Mill Creek	Bertie	SR 1301	Not Rated
B-6	Wading Place Creek	Bertie	NC 308	Not Rated
B-7	Roquist Creek	Bertie	US 13/17	Not Rated
Fish Tissue				
FT-8	Cashie River	Bertie	Windsor	N/A
Ambient Monitoring				
N8950000	Cashie River	Bertie	SR 1219	N/A

* Historical data are available; refer to Appendix II.

Historical data are only available for sites along the Cashie River in this subbasin. All of the tributaries sampled by DWQ in 1999 were sampled for the first time. The lower Cashie River and Hoggard Mill Creek sites showed little deviation from natural swamp conditions. The upper Cashie River site, Roquist Creek and Wading Place Creek showed some signs of impacts to water quality from the watershed.

Water chemistry samples are collected monthly from the Cashie River near Lewiston-Woodville. Low dissolved oxygen concentrations occurred frequently; 55 percent of samples over the past five years were less than 4.0 mg/l. Lower pH was also observed. Iron exceeded the reference value in over 81 percent of samples; however, water passed chronic toxicity tests conducted by DWQ in July 2000. Fecal coliform exceeded the 200 colonies/100ml water quality standard in almost 22 percent of samples. Nitrogen, phosphorus and turbidity were also elevated compared to other Roanoke River coastal plain stations.

In 1999, 24 samples, representing largemouth bass, bowfin, black crappie, sunfishes and catfishes, were collected from the Cashie River above Windsor and analyzed for metals contaminants. Thirteen samples (of mainly largemouth bass and bowfin) or 54 percent of samples contained mercury concentrations exceeding EPA or FDA screening values of 0.6 µg/g and 1.0 µg/g, respectively. All other metal contaminant concentrations were less than the federal or state criteria. Refer to Appendix II for details about fish tissue collections.

For more detailed information on sampling and assessment of streams in this subbasin, refer to the *Basinwide Assessment Report - Roanoke River Basin* (DENR-DWQ, May 2000), available from DWQ Environmental Sciences Branch at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

Table B-26 Use Support Ratings Summary (1999) for Monitored and Evaluated[1] Freshwater Streams (miles) in Roanoke River Subbasin 03-02-10

Use Support Category	FS	PS	NS	NR	Total[2]
Aquatic Life/ Secondary Recreation	0	0	0	149.1	149.1
Fish Consumption	0	47.6	0	0	47.6
Primary Recreation	0	0	0	2.3	2.3
Water Supply	0	0	0	0	0

[1] For the fish consumption use support category, only monitored stream miles are presented.

[2] Total stream miles assigned to each use support category in this subbasin. Column is not additive because some stream miles are assigned to more than one category.

10.2 Status and Recommendations for Previously Impaired Waters

This section reviews use support and recommendations detailed in the 1996 basinwide plan, reports status of progress, gives recommendations for the next five-year cycle, and outlines current projects aimed at improving water quality for each water. The 1996 Roanoke River basin plan identified one impaired stream in this subbasin. The Cashie River is discussed below.

10.2.1 Cashie River (24.3 miles from source to SR 1257)

1996 Recommendation(s)

The 1996 basin plan listed the Cashie River as partially supporting. However, DWQ has since determined that this site was inappropriately rated due to the swamp characteristics of the river. The recommended strategy was to evaluate the contribution of agricultural runoff in the upper portion of the watershed and implement BMPs as needed.

Status of Progress

In 1999, verification of swamp stream characteristics at SR 1219 in Bertie County was made, and the previous bioclassifications that were inappropriately assigned to the benthic community were adjusted. Since benthos data are not currently used to determine impairment in the biological communities of swamp streams, the benthic community in the Cashie River is not rated. Therefore, aquatic life is no longer considered impaired. However, the Cashie River is impaired because of a fish consumption advisory and is discussed further in the following section.

10.3 Status and Recommendations for Newly Impaired Waters

The Cashie River was rated as impaired (partially supporting) based on the statewide bowfin consumption advisory and recent DWQ fish tissue monitoring (1995-1999). This section outlines the potential causes and sources of impairment and provides recommendations for improving water quality.

10.3.1 Cashie River (54.6 miles from source to the Roanoke River)

Current Status
Bowfin with levels of mercury that exceed the NC action level for consumption were collected by DWQ in the Cashie River above Windsor in 1999. Because of the statewide bowfin consumption advisory, this portion of the river is only partially supporting the fish consumption use support category. (Note: This is not a new advisory, but improved use support methodology now bases impairment for the fish consumption use support category on fish consumption advisories. See Appendix III for more information regarding use support ratings.)

2001 Recommendation(s)
DWQ will continue to monitor fish tissue in the Cashie River and will work to identify sources of mercury. Given the global scale of mercury cycling, it may be difficult for DWQ to recognize significant reductions of mercury in fish over the short-term. Section A, Part 4.8 provides more details about mercury in the environment.

10.4 Section 303(d) Listed Waters

Currently in this subbasin, there are no waters listed on the state's year 2000 303(d) list (not yet EPA approved). All waters in the state will likely be added to the list in 2002 as partially supporting because of the statewide bowfin consumption advisory. Appendix IV contains more information on the state's 303(d) list and listing requirements.

10.5 Other Issues and Recommendations

There are no specific other issues for surface waters in this subbasin; however, recent DWQ monitoring revealed habitat degradation impacts to aquatic life resulting from nonpoint source pollution. Although no action is required, voluntary implementation of BMPs is encouraged and continued monitoring is recommended. Section A, Chapter 4 contains general information and recommendations about habitat degradation and other water quality problems that affect more than one watershed in the basin. Additionally, education on local water quality issues is always a useful tool to prevent water quality problems and to promote restoration efforts. Nonpoint source program descriptions and agency contacts are listed in Appendix VI.

Section C

Current and Future Water Quality Initiatives

Chapter 1 -
Current Water Quality Initiatives

1.1 Workshop Summaries

In April 2000, there were three workshops held by DWQ in the Roanoke River basin at Eden, Henderson and Windsor. There were 77 people in attendance representing a variety of interests. Figure C-1 gives an estimation of groups/interests represented based on information recorded on attendance sheets.

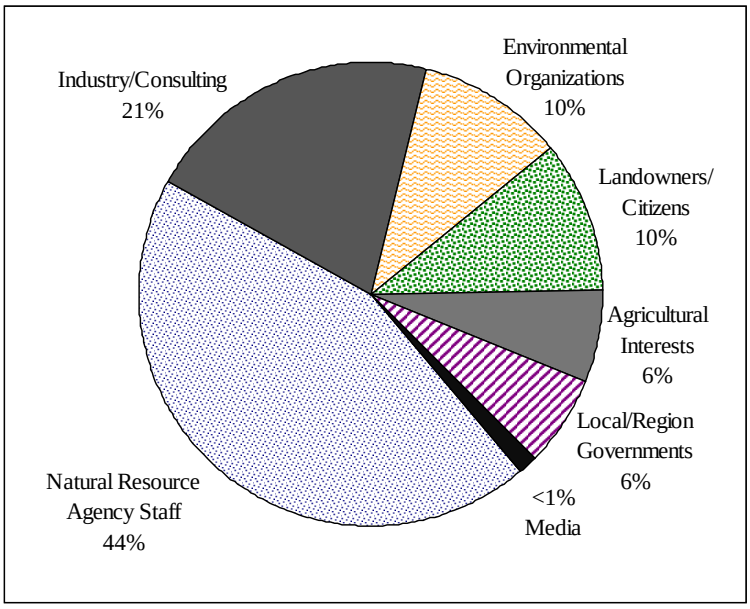


Figure C-1 Percent of Total Attendance by Various Interests at DWQ Water Quality Workshops in the Roanoke River Basin (2000)

DWQ staff gave presentations about general water quality in the Roanoke River basin, basinwide planning and the Wetlands Restoration Program. Participants at each workshop also gave brief presentations about local water quality initiatives. Workshop attendees were asked to discuss the following questions in small groups:

1. What are the main threats to water quality in the Roanoke River basin?
2. Where are the problem areas or waters?
3. What recommendations do you have for addressing these problems/waters?
4. What local agencies or organizations should be involved in addressing the problems?

A detailed outline of each small group's discussion of these questions is available upon request. Good discussion was generated at each workshop, and all of the information was considered, and in some cases incorporated, into this draft plan. The most frequently cited threats to water quality identified by workshop participants are listed below.

Important Issues Basinwide

- Sedimentation
- Nonpoint source pollution (agriculture, urban runoff, silviculture)
- Lack of local planning
- Wastewater treatment (collection system failures, discharges, failing septic systems)
- Water quantity issues (water withdrawals, interbasin transfers, flow management)
- Organic contaminants (PCBs, PBDEs, pesticides)

1.2 Federal Initiatives

1.2.1 Clean Water Act – Section 319 Program

Section 319 of the Clean Water Act provides grant money for nonpoint source demonstration projects. Approximately $1 million is available annually for demonstration and education projects across the state. 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. Information on the North Carolina 319 grant program, including application deadlines and requests for proposals, are available online at http://h2o.enr.state.nc.us/nps/bigpic.htm.

There are no projects in the Roanoke River basin that have been funded (federal Section 319 money must be matched with nonfederal dollars) through the Section 319 base program between 1990 and 2000.

1.2.2 USDA – NRCS Environmental Quality Improvement Program (EQIP)

The Environmental Quality Incentives Program provides technical, educational and financial assistance to eligible farmers and ranchers to address soil, water and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program provides assistance to farmers and ranchers in complying with federal and state environmental laws and encourages environmental enhancement. The purposes of the program are achieved through the implementation of a conservation plan which includes structural, vegetative and land management practices on eligible land. Five to ten-year contracts are made with eligible producers. Cost share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management and grazing land management.

Fifty percent of the funding available for this program will be targeted at natural resource concerns relating to livestock production. The program is carried out primarily in priority areas that may be watersheds, regions or multistate areas, and for significant statewide natural resource concerns that are outside of geographic priority areas. Northampton, Bertie, Hertford and Gates counties make up the Roanoke/Chowan EQIP Priority Area (2000). EQIP's authorized budget of $1.3 billion is prorated at $200 million per year through the year 2002.

NRCS district contacts for the Roanoke River basin are included on the nonpoint source contact sheet found in Appendix VI or visit the website at http://www.nc.nrcs.usda.gov/Programs/eqip.htm for more information.

1.2.3 US Fish and Wildlife Service - Roanoke River National Wildlife Refuge

The US Fish and Wildlife Service (FWS) is the only agency of the US Government whose primary responsibility is fish, wildlife and plant conservation. The service helps protect a healthy environment for people, fish and wildlife and helps Americans conserve and enjoy the outdoors and our living treasures. The service's major responsibilities are for migratory birds, endangered species, certain marine mammals, and freshwater and anadromous fish.

The Roanoke River National Wildlife Refuge includes forested wetlands in the lower 130 miles of the Roanoke River from the fall line at Weldon, NC downstream to the Albemarle Sound near Plymouth, NC. The 130-river miles encompass approximately 150,000 acres (235 sq. mi.) of which 33,000 acres are in the refuge acquisition boundary. Figure C-2 in Part 1.5.2 of this Section depicts these and other conservation lands in the lower Roanoke River basin.

Wetland Restoration and Protection

The refuge includes part of an extensive wetland ecosystem that contains excellent examples of several southeastern plant communities and habitat types. The refuge includes some of the more valuable wetlands for fish and wildlife, especially waterfowl, neotropical migratory birds and anadromous fish. Preliminary planning with the US Corps of Engineers regarding 5,000 acres of wetland restoration is also underway.

Fish Studies

In partnership with Dominion, NC Wildlife Resources Commission, National Marine Fisheries, NC Division of Marine Fisheries, and other divisions within the FWS, the refuge has been actively studying the use of the Roanoke River floodplain by anadromous fish species. The purpose of this study was to learn the extent to which these fish rely on the floodplain for spawning habitat and the effect that widely varying flows have on the success of spawning. The study found that hickory shad and blueback herring utilize the floodplain for spawning and nursery habitat.

Wildlife Surveys

Neotropical and resident bird species surveys were conducted during the spring and summer along established transects on the Roanoke River floodplain by the Fish and Wildlife Cooperative Extension Unit at NC State University. Refuge staff continue to monitor bird populations each spring on refuge lands at 40 established natural river levee sites. Additionally, waterfowl surveys by air are carried out each winter by FWS and state biologists to estimate numbers and species composition of wintering waterfowl at the mouth of the Roanoke River and Albemarle Sound.

Osprey Population Tracking

To monitor productivity of ospreys nesting near the Albemarle Sound and to better understand where the North Carolina population winters in South America, osprey chicks have been banded for the past four years.

Activities permitted inside the refuge are fishing, boating, hiking, photography, wildlife observation and hunting. The refuge is most easily accessed by boat. Conine Island is the only tract accessible by land. Due to the intermittent ridges and swales found within the vast floodplain, incomplete acquisition and erratic river flows, access by vehicle is restricted.

Comprehensive Conservation Planning

The US Fish and Wildlife Service is developing a management plan for the Roanoke River National Wildlife Refuge. This Comprehensive Conservation Plan is required by the National Wildlife Refuge System Improvement Act of 1997. The plan considers both land uses and management practices on the refuge. Public input, from those who use or are affected by the refuge, is currently being solicited and that input will be used to develop alternatives to current land uses and management practices.

The plans will focus on the management of habitat to support the wildlife species for which the refuge was established. They will also address public use, law enforcement, land protection, maintenance and staffing. The plan will project refuge activities for 15 years.

For additional information about this unit of the National Wildlife Refuge System, visit the website at http://southeast.fws.gov/wildlife/nwrroa.html. You may also contact refuge staff by calling (252) 794-3808 or by email roanokeriver@fws.gov.

1.3 State Initiatives

1.3.1 Albemarle-Pamlico National Estuary Program

The Albemarle-Pamlico National Estuary Program (APNEP), formerly known as the Albemarle-Pamlico Estuarine Study (APES), was among the first National Estuary Programs established by the EPA in 1987. The mission of the APNEP is to identify, restore and protect the significant resources of the Albemarle-Pamlico estuarine system. Unlike traditional regulatory approaches to environmental protection, the APNEP is a cooperative effort jointly sponsored by DENR and the EPA that targets a broad range of issues and engages local communities in the process.

The program focuses not just on improving water quality in the region's estuaries, but on maintaining the integrity of the whole system -- its chemical, physical and biological properties, as well as its economic, recreational and aesthetic values. Important components of the APNEP are the consideration of water quality, fisheries resources, land and water habitats, and the interaction of humans with the natural resources of the estuarine system. The APNEP is designed to encourage local communities to take responsibility for managing the resources in their respective jurisdictions.

Comprehensive Conservation and Management Plan

Since 1987, research generated by the APNEP has been instrumental to the development of a Comprehensive Conservation and Management Plan (CCMP). This plan is composed of recommendations for management strategies that address concerns in the Albemarle-Pamlico Sounds region and to protect the system's estuarine resources.

During the development of the CCMP, the APNEP was guided by a 95-member Management Conference that represented diverse interests. Four committees were responsible for identifying problems in the estuarine system, generating research where gaps in knowledge existed, increasing public awareness of environmental issues, and finding solutions to address those issues. As a result of these efforts, more is known about the Albemarle-Pamlico estuarine system than ever before.

One of the recommendations of the CCMP was to develop regional councils in each of the five major river basins of the Albemarle-Pamlico watershed for the purpose of fostering public input into the APNEP program. In 1995, an Executive Order was issued by the Governor of North Carolina calling for the creation of these regional councils. The Roanoke River Basin Regional Council is highlighted below.

CCMP Development Involved Diverse Interests Including:

- Federal and state government
- University researchers
- Environmental groups
- Agriculture representatives
- Forestry interests
- Industry representatives
- Developers
- Fishermen
- Local elected officials

Currently, the APNEP is administered and staffed by DWQ; however, staff works closely with the EPA's Office of Water to implement the many objectives and key management actions contained in the APNEP's CCMP.

Roanoke River Basin Regional Council

Each regional council is comprised of elected and appointed county and municipal officials, representatives from agriculture, silviculture, commercial and recreational fishing, conservation, environmental science, business/industry and tourism groups. Each council is charged with identifying and implementing a project that utilizes innovative or unique management strategies to address a priority watershed problem. Regional councils provide a forum for public, special interest and local government involvement in the APNEP.

The Roanoke River Basin Regional Council (RRBRC) met eight times in 1998 and 1999 and continues to meet in 2000. Recent meeting information is available from the APNEP website at http://h2o.enr.state.nc.us/nep/roanoke_regional_council.htm. Highlights of accomplishments thus far include:

- Generated widespread local support for a resolution recommending Congressional funding for an Army Corps of Engineers Section 216 Scoping Study to evaluate flow modifications for the John H. Kerr Reservoir system and to reevaluate operation of the project.

- The development and ongoing implementation of a demonstration project to rehabilitate and permanently protect degraded riparian land along the Roanoke River through cattle exclusion, planting of hardwood seedlings, and plans for rotational grazing.
- Initiated cooperative action by DENR and the Department of Corrections to address cattle impacts (similar to those being corrected by the demonstration project) at the Caledonia Prison Farm in Halifax County and the Odom Prison in Northampton County.
- Presentations at Coordinating Council meetings, the 1998 APNEP Public Forum, and DWQ's Roanoke River basin water quality workshop in Windsor.
- The development of a two-year Program of Work, which identified several issues of concern in the basin including: 1) negative impacts of managed flows that do not match seasonal patterns of rainfall; 2) low dissolved oxygen; 3) nutrient loads and sediment impacts; 4) problems with small wastewater treatment facilities; and 5) landowner rights and responsibilities.

For more information regarding the Albemarle-Pamlico National Estuary Program, contact Guy Stefanski by calling (919) 733-5083 ext. 585, email guy.stefanski@ncmail.net or visit the website at http://h2o.enr.state.nc.us/nep/.

1.3.2 NC Wetlands Restoration Program

The North Carolina Wetlands Restoration Program (NCWRP) is a nonregulatory program responsible for implementing wetland and stream restoration projects throughout the state. The focus of the program is to improve water quality, flood prevention, fisheries, wildlife habitat and recreational opportunities. The NCWRP is not a grant program. Instead, the program funds wetland, stream and riparian area projects directly through the Wetlands Restoration Fund.

Restoration sites are targeted through the use and development of the Watershed Restoration Plans (formerly called Basinwide Wetland and Riparian Restoration Plans). These plans are developed, in part, using information compiled in DWQ's Basinwide Water Quality Plans. The Watershed Restoration Plans are updated every five years on the same schedule as DWQ's Basinwide Water Quality Plans.

The NCWRP is also working to develop comprehensive Local Watershed Restoration Plans within the identified Priority Subbasins. These more locally-based plans will identify wetland areas, contiguous reaches of stream, and contiguous strips of buffer vegetation that, once restored, will provide significant water quality and other environmental benefits to watersheds. The NCWRP will coordinate with local community groups, local governments and others to develop and implement these plans.

The NCWRP can perform restoration projects cooperatively with other state or federal programs or environmental groups. For example, the NCWRP's efforts can complement projects funded through the Section 319 Program. Integrating wetlands or riparian area restoration components with 319 funded or proposed projects will often improve the overall water quality benefits of the project. The NCWRP actively seeks landowners within the Roanoke River basin who have restorable wetland, riparian and stream sites.

Table C-1 lists the NCWRP's targeted Local Watersheds in the Roanoke River basin. Further details about these watersheds are provided in the appropriate subbasin chapter in Section B.

Table C-1 Wetlands Restoration Program Targeted Local Watersheds (2000)

Subbasin	Targeted Local Watershed Name(s)	Targeted Local Watershed Number(s)*
03-02-01	Town Fork Creek Snow Creek Belews Creek	90010 & 90020 80010 80040
03-02-02	Big Beaver Island Creek	20010
03-02-04	Country Line Creek	32010 & 32030
03-02-06	Grassy Creek	61010
03-02-07	Smith Creek	31010
03-02-08	Chockoyette Creek Quankey Creek Conoconnara Swamp	70010 & 70020 70030 90010 & 90020
03-02-09	Hardison Mill Creek Deep Run Swamp	40010 50010
03-02-10	Cashie River Headwaters	60010

* The numbers listed are the last five digits of the 14-digit Hydrologic Unit (HU) for each Local Watershed.

For more information about participating in the NCWRP, please contact Crystal Braswell at (919) 733-5208 or visit the DWQ website at http://h2o.enr.state.nc.us/ (click on Wetlands Restoration Program).

1.3.3 Clean Water Management Trust Fund

The Clean Water Management Trust Fund 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 Roanoke River basin, four projects have been funded for a total of $2,920,000 (Table C-2).

Table C-2 Projects in the Roanoke River Basin Funded by the Clean Water Management Trust Fund (as of 7/00)

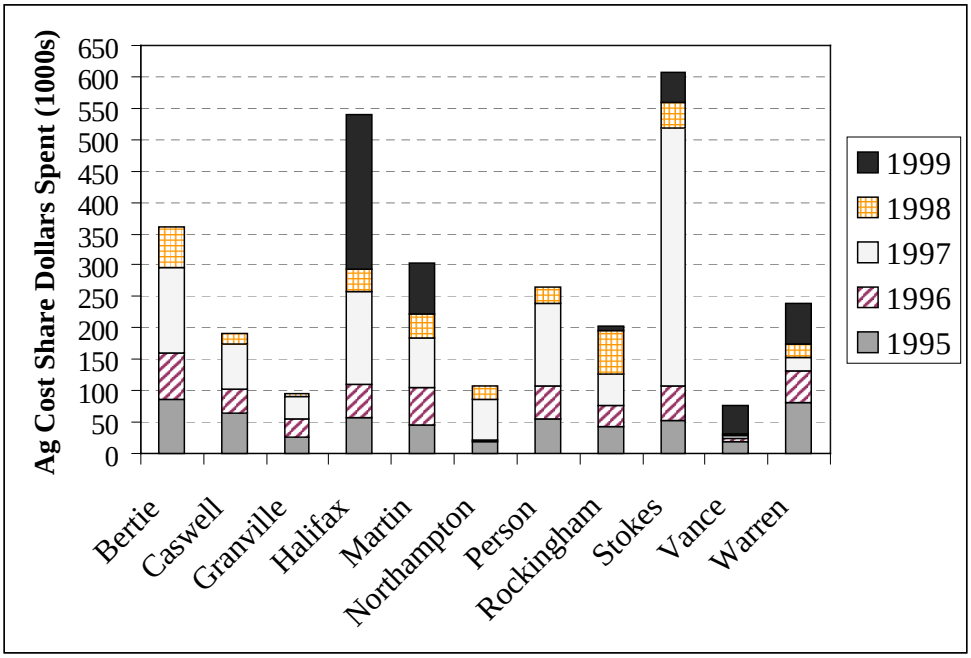
Stream or Watershed	Project	Project Lead	Amount Funded
Dan River	Land Acquisition – Buffers	Piedmont Land Conservancy	$642,000
Conaby Creek and Roanoke River	Stormwater Improvements	Town of Plymouth	$835,000
Mayo River	Wastewater Improvements	Town of Stoneville	$643,000
Gills Creek	Wastewater Improvements	Town of Stovall	$800,000

For more information on the CWMTF or these grants, call (252) 830-3222 or visit the website at www.cwmtf.net.

1.3.4 NC Agriculture Cost Share Program

The North Carolina Agriculture Cost Share Program was established in 1984 to help reduce the sources of agricultural nonpoint source pollution to the state's waters. The program helps owners and renters of established agricultural operations improve their on-farm management by using Best Management Practices (BMPs). These BMPs include vegetative, structural or management systems that can improve the efficiency of farming operations while reducing the potential for surface and ground water pollution. The Agriculture Cost Share Program is a voluntary program that reimburses farmers up to 75 percent of the cost of installing an approved BMP. The cost share funds are paid to the farmer once the planned control measures and technical specifications are completed. The annual statewide budget for BMP cost sharing is approximately 6.9 million.

Almost three million dollars were expended in the Roanoke River basin from 1995 through 1999 on a wide variety of nonpoint source pollution reduction projects. Figure C-2 presents Agriculture Cost Share Program dollars (in thousands) spent over the five-year period for each county in the North Carolina portion of the basin.



Note: 1999 data was not available for Bertie, Caswell, Granville, Northampon or Person counties.

Figure C-2 Agriculture Cost Share Program Dollars Expended (1995-1999) in Counties in the Roanoke River Basin (Source: NC Division of Soil and Water Conservation)

Soil and Water Conservation District contacts for the Roanoke River basin are included in Appendix VI or visit the website at http://www.enr.state.nc.us/DSWC/files/acs.htm for more information.

1.3.5 Coastal Habitat Protection Plans

The North Carolina Fisheries Reform Act of 1997 requires the North Carolina Department of Environment and Natural Resources to prepare Coastal Habitat Protection Plans (CHPPs) for the "long-term enhancement of coastal fisheries associated with each coastal habitat…." The plans describe the fisheries, fishery habitats and water quality affecting coastal fisheries stocks in the eight river basins that drain to the coast of North Carolina. Although staff of the Division of Marine Fisheries (DMF) is responsible for actually writing the plans, DWQ and the Wildlife Resources Commission, as well as the Divisions of Coastal Management (DCM) and Environmental Health (DEH), are heavily involved in the program. The Environmental Management, Coastal Resources and Marine Fisheries Commissions review and approve the plans, and those commissions are responsible for any new rules necessary for implementation of the plans.

The plans are organized by geographic area, with 11 management units, including the Roanoke River basin, that generally correspond with the DWQ Basinwide Planning Program units. A general source document includes regional and summary information. The management unit plans are specific to their areas, including detailed information and specific recommendations addressing conservation, habitat protection and enhancement, water quality improvement, research and monitoring, and administrative actions. A complete plan includes both the source document and the management unit plan. The first two area plans are underway in 2001: Chowan and Coastal Ocean. All CHPPs will be finalized by July 2003, then reviewed and updated every five years.

For additional information about CHPPs, contact Mike Street by calling 1-800-682-2632 (in NC) or by e-mail at mike.street@ncmail.net. You may also visit the DMF website at http://www.ncfisheries.net/habitat/chpp1.htm.

1.3.6 Virginia Department of Environmental Quality

Virginia Department of Environmental Quality (DEQ) administers the federal Clean Water Act and enforces state laws to improve the quality of Virginia's streams, rivers, bays and groundwater for aquatic life, human health and other water uses. With methods similar to those used in North Carolina, permits are issued to businesses, industries, local governments and individuals that take into account physical, chemical and biological standards for water quality. Water programs address: pollution discharges, stormwater management, groundwater, petroleum tank vessels and storage tanks, surface water, land application of treated wastes, and dredged material.

For VADEQ program and contact information, call (804) 698-4000 or toll-free in Virginia (800) 592-5482 or visit the website at http://www.deq.state.va.us/water/.

1.3.7 Partnership for the Sounds

The Partnership for the Sounds (PFS) promotes eco-tourism in the Albemarle-Pamlico region. Educational centers offer displays, exhibits, audio-visual components, hands-on activities, group programs and more, complemented by outdoor field trip opportunities in close proximity. The

new Roanoke/Cashie River Center, which promotes environmental education about the Roanoke and Cashie Rivers, is the result of the cooperative efforts of the US Fish and Wildlife Service, the Partnership for the Sounds and the Town of Windsor.

For additional information about Partnership for the Sounds or the Roanoke/Cashie River Center, call (252) 974-1044 or visit the website at http://albemarle-nc.com/pfs/.

1.4 Local Initiatives

1.4.1 Town of Windsor

Cashie River Wetlands Walk

The Cashie River winds through Bertie County for more than 20 miles, beginning and ending within the county boundaries. The river has a depth of 80 feet in places. It provides a spawning area for herring, shad and striped bass and supports game fish including redfin, pickerel, sunfish, crappie, catfish and largemouth bass. The continuous riparian areas along the river provide productive habitat and important travel corridors for wildlife.

The wetlands environment along the Cashie River are made available to the public by the Cashie River Wetlands Walk. A pedestrian bridge provides handicap access by boardwalk to the swamp floor and allows the visitor to experience the wetlands first hand. The boardwalk winds through bald cypress and water tupelos. An observation deck allows visitors to experience the wetlands at different seasons of the year. Canoe or small boat launch piers provide access to several miles of the Cashie River and river bottom ecosystem.

For additional information about the Cashie River Wetlands Walk, visit the website at http://www.albemarle-nc.com/windsor/attractn/wetwalk.htm.

1.5 Regional Organizations

1.5.1 Roanoke River Basin Association

The Roanoke River Basin Association (RRBA) is a nonprofit, 501(c)(3) tax-exempt organization whose mission is to establish and carry out a strategy for the development, use, preservation and enhancement of the resources of the Roanoke River basin in the best interest of present and future generations of basin residents. RRBA believes that basin resource conservation can co-exist with managed economic growth.

RRBA consists of hundreds of members, mostly located within the basin of the 410-mile long Roanoke River, including local governments, nonprofit, civic and community organizations, regional government entities, businesses and individuals. The RRBA:

- Works for a comprehensive planning process for managing the flow of the Roanoke River and for allocating the basin's valuable resources.
- Educates basin residents and others about the resources of the Roanoke River basin.

- Publishes a monthly newsletter, *Basin Bulletin*, for its supporters and constituents.
- Fought for over 20 years in an effort to prevent the City of Virginia Beach from diverting water from the Roanoke River at Lake Gaston.
- Participates in the Roanoke Rapids and Gaston Hydropower Relicensing Project in order to protect the interests of basin residents and businesses.
- Monitors non-basin municipalities in North Carolina and Virginia who might seek an interbasin transfer of water out of the Roanoke River basin.
- Monitors activities that might negatively impact the quality of the water resources.
- Recently urged Charlotte and Halifax counties, Virginia to adopt reasonable restrictions on swine operations in order to prevent negative impacts to the Roanoke River.
- Monitored (and continues to monitor) and reported on the impact of the PCB contamination in the Roanoke (Staunton) River, and encouraged Virginia Department of Environmental Quality to plan for remediation of that contamination. RRBA also encouraged an interim health advisory relative to the consumption of large, non-migratory, bottom-feeding fish in areas of PCB contamination and ensured that DWQ was provided information related to this contamination.
- Promotes and helps to fund recreational and safety facilities in the basin.
- Mobilized support for North Carolina's "Year of the Rivers" Highway Sign Program which, when implemented, will mark the perimeter of the Roanoke River basin with identifying highway signs.

For additional information about the Roanoke River Basin Association, visit the website at http://www.rrba.org. You may also contact Executive Director, Tom Brawner by calling (804) 577-2159 or by email info@rrba.org.

1.5.2 The Nature Conservancy

The Nature Conservancy (TNC) is a nonprofit membership corporation whose mission is to preserve the plants, animals, and natural communities that represent the diversity of life on earth by protecting the lands and waters they need to survive. TNC's goal is the long-term survival of all viable native species and natural community types (terrestrial and aquatic).

TNC designated the lower Roanoke River and floodplain as one of the "Last Great Places", a program designed to protect 75 of the nation's most biologically important ecosystems and natural communities. Working with public and private partners, the TNC-North Carolina Chapter has invested over $20 million in the conservation of the lower Roanoke River. As a result, more than 55,000 acres are in conservation ownership among TNC, US Fish and Wildlife Service, North Carolina Wildlife Resources Commission, the Georgia-Pacific/TNC Roanoke Ecosystem Partnership (refer to Part 1.6.1 for further information), and others (Figure C-3). TNC retains fee or conservation easement ownership over about 18,000 acres in the floodplain of the lower Roanoke River; however, all 55,000 acres were acquired with the TNC-North Carolina Chapter's participation. A local office to manage conservation lands on the Lower Roanoke was established in 1995. Two chapter employees are located in Windsor, NC to work with other conservation partners to ensure the long-term viability of these lands.

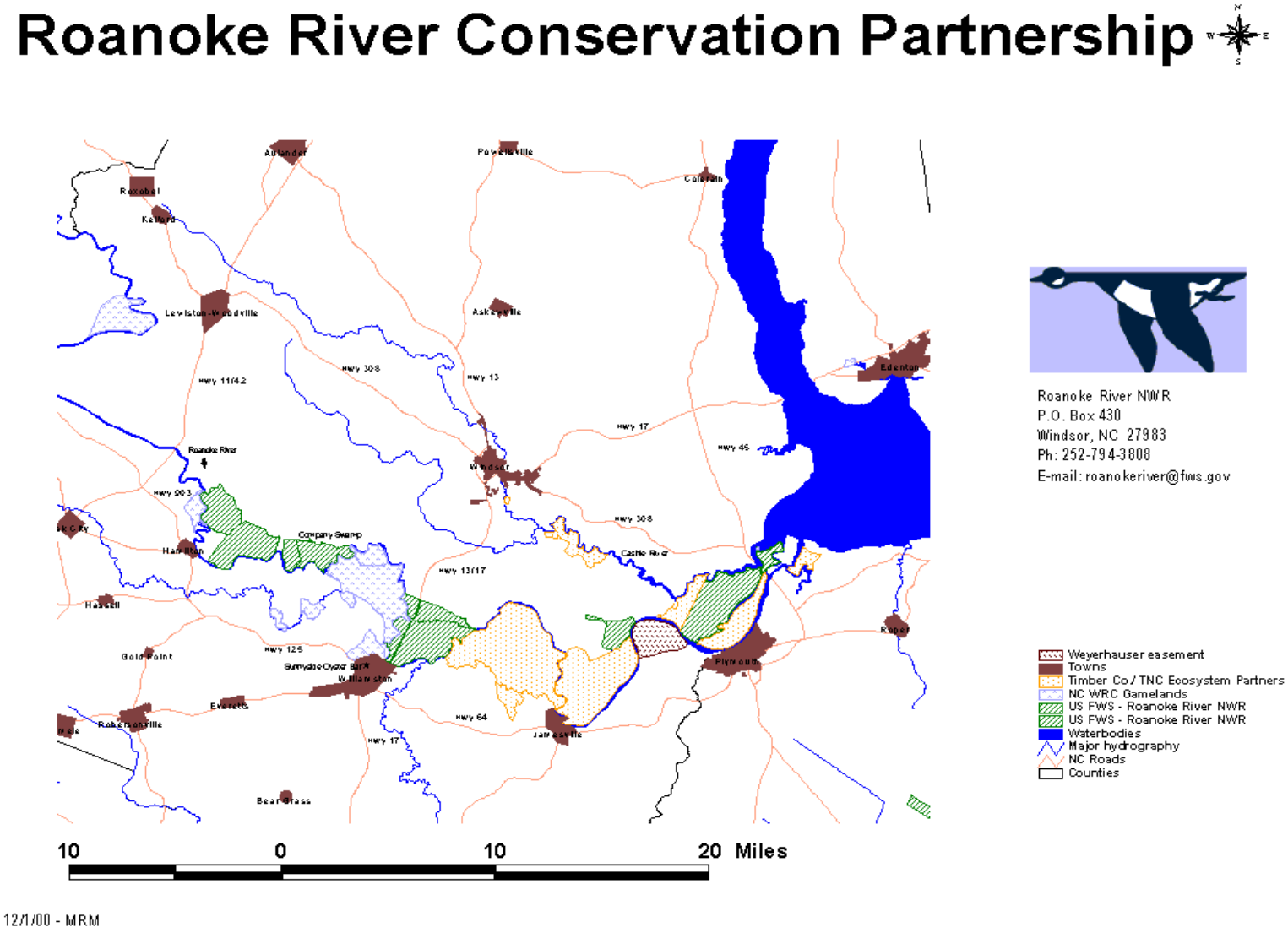


Figure C-3 Land in Conservation Ownership in the Roanoke River Basin (December 2000)

Reservoir Operations Model

TNC, the NC Division of Water Resources (DWR), and Water Resources Management, Inc. have been working together for four years to develop a Reservoir Operations Model for the Roanoke River basin. This model uses more than 60 years of unregulated (natural) inflow data for each of the five major reservoirs in the system along with the management policies provided by their managers. The model predicts hydroelectric generation and the flow in the river below Roanoke Rapids Dam on either a weekly or daily basis. The components of the management policies that can be adjusted are: 1) the releases from the reservoirs for flood control or flow augmentation; 2) desired lake levels through the year; and 3) upper and lower limitations on power generation. The management policies in place today constitute a baseline against which other policies can be compared to answer "what if" questions concerning the operation of the reservoirs.

The model is currently being upgraded to permit the evaluation of increasingly sophisticated management policies including the ability to forecast inflows on the basis of the climate record and to use such forecasts in operational decisions, a drought index to trigger changes in operations during times of very low flows, policies based on the biological state of the system, and policies that manage high as well as low flows for environmental purposes. The plan is to provide a Windows 95 [trademark] graphical user interface and to make the model available over the internet for access by any interested party.

Adaptive Management Partnership

TNC is currently advocating an Adaptive Management Partnership for the Roanoke River that would represent all of the major stakeholders along the river, including institutions with regulatory authority over natural resources, major landholders, major associations of landowners and recreation users, major industries and local governments. The goal of the partnership is to optimize management of the river for the benefit of the people, ecosystems and economies they affect.

For additional information about The Nature Conservancy's initiatives in the Roanoke River basin, contact Jeffrey Horton at the Roanoke River Project Office by calling (252) 794-1818 or by email jhorton@tnc.org.

1.5.3 Piedmont Land Conservancy

The Piedmont Land Conservancy (PLC) is a nonprofit organization dedicated to preserving natural and scenic lands, farms and open spaces in the piedmont of North Carolina to enrich the quality of life for our communities and for future generations. The PLC represents nine North Carolina counties: Alamance, Caswell, Forsyth, Guilford, Randolph, Rockingham, Stokes, Surry and Yadkin. PLC strives toward the following goals:

- To acquire and manage natural areas in piedmont North Carolina.
- To protect endangered or significant native species of flora and fauna and to preserve areas with significant topographical features.
- To maintain the ecological integrity of the region, including its air and water quality and biological diversity.

- To fulfill the human need for scenic land and open space to provide opportunities for learning from and enjoying the natural world.
- To enhance and buffer our communities.

PLC is not affiliated with any other organization and is supported entirely by members and friends in the piedmont and has more than 600 members. It is the only local land trust serving the Piedmont Triad region of North Carolina. PLC builds partnerships with public agencies, private organizations, landowners and individuals to save the best of our natural heritage. Since incorporation, the PLC has protected over 490 acres of land.

River Corridors

To protect the quality of drinking water supplies, provide recreational opportunities and to protect wildlife habitat, the PLC is targeting several major river corridors in the piedmont for protection, including the Dan, Mayo, Yadkin and Haw Rivers. In 1998, the Piedmont Land Conservancy received a $642,000 Clean Water Management Trust Fund grant to purchase riparian buffer areas along the Dan River.

Additionally, PLC conducted a study of riparian land use and condition of riparian areas along the Dan River in Stokes County. The resultant plan entitled *Riparian Corridor Conservation Design for the Upper Dan River Basin* recommends protection and restoration strategies for public and private lands within 300 feet of the Dan River in Stokes County (Bridle, May 2000).

Bog Turtle Habitat Restoration

The PLC is working together with more than 10 public and private partners to restore and protect 26 acres in Forsyth County of wetland habitat for the bog turtle. The bog turtle, weighing only 4 ounces, is one of the rarest turtle species in North America and is a state threatened species in North Carolina. Preferring mountain bog habitat, bog turtles are rare in the piedmont because most bogs have been drained for agricultural use. PLC is also working with Duke Power Company on bog turtle habitat restoration.

For additional information about the Piedmont Land Conservancy, call (910) 691-0088 or email plcland@concentric.net. You may also visit the website at http://www.greensboro.com/plc/.

1.6 Corporate Initiatives

1.6.1 Georgia-Pacific Corporation

Georgia-Pacific and The Nature Conservancy have entered into a land management agreement covering 21,000 acres of floodplain wetlands along the lower Roanoke and Cashie Rivers in North Carolina. These seven tracts of northeastern North Carolina land included in the Roanoke agreement contain high quality examples of cypress trees and other trees that naturally occur in a brownwater ecosystem. This area is also home to extensive wildlife, such as bald eagles and more than 200 other species of birds. Representatives from the US Fish and Wildlife Service and scientists from North Carolina State University are also members of the management team.

Some tracts of the 21,000 acres will be deemed high priority because of their special ecosystems. On these lands, Georgia-Pacific has agreed to relinquish its timber harvesting rights. On other tracts, timber harvesting will take place, following methods agreed to by the joint management team. Georgia-Pacific was the first forest products company to attempt statewide protection of significant natural areas in its ownership. These lands are shown on Figure C-2 in Part 1.5.2 of this section.

1.7 Citizen Efforts

1.7.1 Rockingham County Watershed Preservation Coalition, Inc.

Beginning in 1996, citizens in and around Rockingham County, NC formed the Rockingham County Watershed Preservation Coalition (RCWPC) to protect their rivers, watersheds and groundwater. The Coalition's accomplishments thus far include:

- Informed citizens and petitioned against NCDOT's planned closing of the Mayo Loop Road alongside of the Mayo River at Anglin Mill. If this road right-of-way had been lost, public access to this section of the Mayo River would have been eliminated. Due to this effort, DOT completely rebuilt the road.
- Adopted the Mayo Beach Road for cleanup under NCDOT's Adopt-a-Highway Program.
- Worked with Piedmont Land Conservancy board members, landowners and the Rockingham County Planning Department to gain approval to build (and maintain) two canoe access sites on the Mayo River.
- Formed the Mayo Association, an umbrella group of organizations and individuals dedicated to creating a park at the Anglin Mill site.
- Providing an informative, up-to-date website that links citizens to RCWPC and to resources and information that is relevant to conservation work.
- Through these avenues and projects, provided a heightened sense of awareness of aquatic resources and the importance of conservation.
- Joined NC Division of Water Resources' Stream Watch program.

For more information about the Rockingham County Watershed Prevention Coalition, email RCWPC@vnet.net or visit the website at http://www.geocities.com/Yosemite/Rapids/4604/.

1.7.2 Roanoke River Partners

Roanoke River Partners is a nonprofit organization, which helps communities along the lower Roanoke River to improve economic, environmental and social health. Specifically, the partners promote small businesses and facilitate community and regional projects which highlight and sustainably utilize the unique natural, historic and cultural resources found in the region.

One of Roanoke River Partners' main goals is to explore the potential of heritage tourism in the region. Heritage tourism is defined as historic, cultural or nature-based tourism which is educational and strives to honor and protect the resources which it uses. Examples might include a tour of local farms or a 3-day canoe trip for bird watchers through swamp forests.

Current projects include the creation of a 200-mile canoe camping trail on the Roanoke River and its tributaries. Such a trail will allow for the creation of local eco-tourism businesses such as canoe guiding services, canoe rentals, bed and breakfasts, etc.

For more information about the Roanoke River Partners, contact Crystal Baity by calling (252) 794-2793, email rrp@coastalnet.com, or visit the website at www.roanokeriver.com/partners.

Chapter 2 -
Future Water Quality Initiatives

2.1 Overall DWQ Goals for the Future

The long-term goal of basinwide management is to protect the water quality standards and uses of the surface waters in the state while accommodating reasonable economic growth. Attainment of these goals and objectives will require determined, widespread public support; the combined cooperation of state, local and federal agencies, agriculture, forestry, industry and development interests; and considerable financial expenditure on the part of all involved. With this needed support and cooperation, DWQ believes that these goals are attainable through the basinwide water quality management approach.

In addition to these efforts, DWQ will continue to pursue several programmatic initiatives intended to protect or restore water quality across the state. These include NPDES Program Initiatives, better coordination of basinwide planning, use restoration waters program for nonpoint source pollution, and improving database management and use of GIS capabilities. Summaries of these initiatives are provided below.

NPDES Program Initiatives

In the next five years, efforts will be continued to:

- improve compliance with permitted limits;
- improve pretreatment of industrial wastes discharged to municipal wastewater treatment plants so as to reduce effluent toxicity;
- encourage pollution prevention at industrial facilities in order to reduce the need for pollution control;
- require dechlorination of chlorinated effluents or use of alternative disinfection methods for new or expanding facilities;
- require multiple treatment trains at wastewater facilities; and
- require plants to begin plans for enlargement well before they reach capacity.

Long-term point source control efforts will stress reduction of wastes entering wastewater treatment plants, seeking more efficient and creative ways of recycling by-products of the treatment process (including reuse of nonpotable treated wastewater), and keeping abreast of and recommending the most advanced wastewater treatment technologies.

DWQ requires all new and expanding wastewater dischargers to submit an alternatives analysis as part of its NPDES permit application. Non-discharge alternatives, including connection to an existing WWTP or land-applying wastes, are preferred from an environmental standpoint. If the Division determines that there is an economically reasonable alternative to a discharge, DWQ may deny the NPDES permit.

DWQ will continue to make greater use of discharger self-monitoring data to augment the data it collects. Quality assurance, timing and consistency of data from plant to plant are issues of importance. Also, a system will need to be developed to enter the data into a computerized database for later analysis.

Coordinating Basinwide Planning with Other Programs

The basinwide planning process can be used by other programs as a means of identifying and prioritizing waterbodies in need of restoration or protection efforts and provides a means of disseminating this information to other water quality protection programs. For example, the plan can be used to identify and prioritize wastewater treatment plants in need of funding through DWQ's Construction Grants and Loan Program. The plans can also assist in identifying projects and waterbodies applicable to the goals of the Clean Water Management Trust Fund, Wetlands Restoration Program or Section 319 grants program. Information and finalized basin plans are provided to these offices for their use and to other state and federal agencies.

Use Restoration Waters (URW) Program for Nonpoint Source Impairment

DWQ has developed a conceptual strategy to manage watersheds with nonpoint source impairments as determined through the use support designations. In July 1998, the state Environmental Management Commission approved the Use Restoration Waters (URW) program concept which will target all NPS impaired waters in the state using a two-part approach. As envisioned, this classification will apply to all watersheds that are not supporting or partially supporting their designated uses. The program will catalyze voluntary efforts by stakeholder groups in impaired watersheds to restore those waters by providing various incentives and other support. Simultaneously, the program will develop a set of mandatory requirements for NPS pollution categories for locations where local groups choose not to take responsibility for restoring their impairments. This URW concept offers local governments an opportunity to implement site-specific projects at the local level as an incentive ("the carrot"). If the EMC is not satisfied with the progress made towards use restoration by local committees, impairment based rules will become mandatory in those watersheds ("the stick").

These mandatory requirements may not be tailored to specific watersheds but may apply more generically across the state or region. DWQ staff has developed a timeline to accomplish the following within five years from July 1998: work with stakeholder groups to develop mandatory requirements; acquire the resources needed to carry out the program; develop criteria for voluntary local programs and supporting incentive tools; and proceed through formal rule making for the mandatory requirements. The form of the URW program will be strongly influenced by the year-long stakeholder input process.

With more than 400 impaired watersheds or stream segments in the state, it is not realistic for DWQ to attempt to develop watershed specific restoration strategies for nonpoint source pollution. By involving the stakeholders in these watersheds, we believe we can catalyze large-scale restoration of impaired waters. We anticipate that one of the major implementation challenges of this new program will be educating public officials and stakeholders at the local level as to the nature and solutions to their impairments. To address this challenge, the state plans to develop a GIS-based program to help present information at a scale that is useful to local

land management officials. Other incentives that the state might provide include seed grants and technical assistance, as well as retaining the authority to mandate regulations on stakeholders who are not willing to participate.

In cases where incentives and support do not result in effective watershed restoration strategies, mandatory impairment source management requirements would be implemented in the watershed. This is not the state's preferred alternative, as it would add to state monitoring and enforcement workload. However, in areas where it is necessary, DWQ plans to implement such requirements. In the management area, DWQ would be assisted by regulatory staff from the Division of Coastal Management, Division of Environmental Health, Division of Land Resources and the Division of Marine Fisheries to insure compliance.

Improved Data Management and Expanded Use of Geographic Information System (GIS) Computer Capabilities

DWQ is in the process of centralizing and improving its computer data management systems. Most of its water quality program data (including permitted dischargers, waste limits, compliance information, water quality data, stream classifications, etc.) will be put in a central data center which will then be made accessible to most staff at desktop computer stations. Some of this information is also being submitted into the NC Geographic Data Clearinghouse (Center for Geographic Information and Analysis or CGIA). As this and other information (including land use data from satellite or air photo interpretation) is made available to the GIS system, the potential to graphically display the results of water quality data analysis will be tremendous.

Additional Research and Monitoring Needs

DWQ staff have identified some additional research and monitoring needs that would be useful for assessing, and ultimately, protecting and restoring the water quality of the Roanoke River basin. The following list is not inclusive. Rather, it is meant to stimulate ideas for obtaining more information to better address water quality problems in the basin. With the newly available funding programs (Clean Water Management Trust Fund and Wetlands Restoration Program) and the existing Section 319 grant program, it may be desirable for grant applicants to focus proposals on the following issues:

- *More resources are needed to address nonpoint sources of pollution*. Identifying nonpoint sources of pollution and developing management strategies for impaired waters, given the current limited resources available, is an overwhelming task. Therefore, only limited progress towards restoring NPS impaired waters can be expected unless substantial resources are put towards solving NPS problems.

DWQ would like to work more closely with the Conservation Districts in each county of the Roanoke River basin to identify nonpoint sources of pollution, develop land use and land cover data, and to develop water quality management strategies for impaired watersheds within the Roanoke River basin.

2.2 DWQ Compliance and Enforcement Policy Revisions

DENR began implementing a new two-stage compliance and enforcement policy in 1997. Both stages of the revised policy are in effect as of July 1, 1999. The five major elements of the policy are intended to provide a comprehensive route to strengthen enforcement and heighten compliance for all dischargers and nonpoint sources of water pollution in North Carolina. The five major components of the policy are to:

1. Foster compliance through pollution prevention, technical assistance and training, reevaluate existing grant and loan funding priority criteria, and develop recognition and incentive programs.
2. Enhance enforcement through increased penalties, penalties for sewer collection systems, reduced thresholds for noncompliance, and delegation of civil penalty assessment authority to the DWQ regional office supervisors.
3. Focus on chronic and willful violators through increased use of moratoriums on expanding and additional connections, expansion of notification to the public of violators, clarification of process of determining "noncompliance", and initiation of discussion with stakeholders on possible legislative actions.
4. Assure improvement in compliance and enforcement through development of accountability measures.
5. Find and use all available resources for compliance needs with local, state and nonprofit groups.

DENR is also in the process of conducting assessment of its enforcement programs. The goal of the assessment is to identify potential areas for improvement in DENR's efforts to enforce environmental laws and ultimately improve compliance. This effort got underway in July 1999 with two focus group meetings. If you would like to see the Scope of Work for the enforcement assessment, see DENR's web page at http://www.enr.state.nc.us/novs/scope.htm/.

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Appendix I

NPDES Discharges
and
Individual NPDES Stormwater Permits
in the
Roanoke River Basin

Table A-I-1 NPDES Dischargers in the Roanoke River Basin (as of January 2000)

Permit	Facility	County	Region	Type	Ownership	D1	D2	D3	D4	D5	MGD	Subbasin	Receiving Stream
NC0025526	Walnut Cove, Town of - WWTP	Stokes	Winston-Salem	Minor	Municipal	1	2				0.5	03-02-01	Town Fork Creek
NC0057720	Twin Lakes MHP / SSB., Inc.	Stokes	Winston-Salem	Minor	Non-Municipal	8					0.04	03-02-01	UT Timmons Creek
NC0082384	Stokes County / Danbury WWTP	Stokes	Winston-Salem	Minor	Municipal	1					0.1	03-02-01	Dan River
NC0044954	Stokes Co School / South Stokes HS	Stokes	Winston-Salem	Minor	Non-Municipal	3					0.0173	03-02-01	Little Neatman Creek
NC0044962	Stokes Co School / North Stokes HS	Stokes	Winston-Salem	Minor	Non-Municipal	3					0.0115	03-02-01	UT Dan River
NC0067091	Rayco Utilities / Mikkola Downs Subdivision	Forsyth	Winston-Salem	Minor	Non-Municipal	5					0.072	03-02-01	East Belews Creek
NC0078115	Rayco Utilities / Greystone Subdivision	Forsyth	Winston-Salem	Minor	Non-Municipal	5					0.04	03-02-01	UT Belews Creek
NC0028746	Rayco Utilities / Briarwood Subdivision	Stokes	Winston-Salem	Minor	Non-Municipal	5					0.05	03-02-01	UT Brushy Fork Creek
NC0003492	R.J. Reynolds / Walnut Cove Site	Stokes	Winston-Salem	Minor	Non-Municipal	2	16	14	26		0.02	03-02-01	Voss Creek
NC0079049	R.H. Johnson Construction Co.	Forsyth	Winston-Salem	Minor	Non-Municipal	5					0.06	03-02-01	Rough Fork
NC0035173	Kobe Copper Products, Inc.	Stokes	Winston-Salem	Minor	Non-Municipal	2	17	14	16		0.025	03-02-01	UT Dan River
NC0003441	JPS Elastomerics Corp - Carolina Plant	Stokes	Winston-Salem	Minor	Non-Municipal	14	16	2	17		0.015	03-02-01	Little Dan River
NC0056791	Horizons Residential Care Center	Forsyth	Winston-Salem	Minor	Non-Municipal	11					0.015	03-02-01	Buffalo Creek
NC0083933	Heater Utilities / Rangecrest Road	Forsyth	Winston-Salem	Minor	Non-Municipal	5					0.06	03-02-01	UT Belews Creek
NC0035599	Forsyth Co School / Walkertown Middle	Forsyth	Winston-Salem	Minor	Non-Municipal	3					0.009	03-02-01	UT West Belews Creek
NC0035602	Forsyth Co School / Walkertown Elementary	Forsyth	Winston-Salem	Minor	Non-Municipal	3					0.0102	03-02-01	UT West Belews Creek
NC0024406	Duke Power / Belews Creek Steam	Stokes	Winston-Salem	Major	Non-Municipal	14	68	69	70		0	03-02-01	West Belews Creek
NC0029777	DOC - Stokes Correctional Center	Stokes	Winston-Salem	Minor	Non-Municipal	11					0.0132	03-02-01	Flat Shoals Creek
NC0043290	Danbury, Town of - WTP	Stokes	Winston-Salem	Minor	Non-Municipal	22					not limited	03-02-01	UT Scott Branch
NC0037311	Creekside Manor Rest Home	Forsyth	Winston-Salem	Minor	Non-Municipal	11					0.01	03-02-01	UT Belews Creek
NC0060461	Carolina Water Service - Abington	Forsyth	Winston-Salem	Minor	Non-Municipal	5					0.2	03-02-01	Belews Creek
NC0046752	Carolina Water Service / Kynwood Subdivision	Forsyth	Winston-Salem	Minor	Non-Municipal	5					0.025	03-02-01	Belews Creek
NC0075027	Cains Way Mobile Home Park	Forsyth	Winston-Salem	Minor	Non-Municipal	8					0.0432	03-02-01	Ader Creek
NC0028011	Stoneville, Town of - WWTP	Rockingham	Winston-Salem	Minor	Municipal	1	55	57	64		0.25	03-02-02	Mayo River
NC0059251	Quail Acres Mobile Home Park	Rockingham	Winston-Salem	Minor	Non-Municipal	8					0.018	03-02-02	UT Hogans Creek
NC0021873	Mayodan, Town of - WWTP	Rockingham	Winston-Salem	Major	Municipal	1	38	40	50	55	3	03-02-02	Mayo River
NC0046302	Mayodan, Town of - WTP	Rockingham	Winston-Salem	Minor	Non-Municipal	21					0	03-02-02	UT Mayo River
NC0021075	Madison, Town of - WWTP	Rockingham	Winston-Salem	Minor	Municipal	1					0.775	03-02-02	Dan River
NC0060542	Gold Hill Mobile Home Park	Rockingham	Winston-Salem	Minor	Non-Municipal	8					0.0176	03-02-02	UT Hogans Creek
NC0050954	Dolly Madison Motel	Rockingham	Winston-Salem	Minor	Non-Municipal	10	13				0.012	03-02-02	Hogans Creek
NC0044750	Britthaven of Madison	Rockingham	Winston-Salem	Minor	Non-Municipal	11	40				0.025	03-02-02	Hogans Creek
NC0085022	220 Mobile Home Park	Rockingham	Winston-Salem	Minor	Non-Municipal	22					not limited	03-02-02	UT Hogans Creek
NC0002828	Zarn, Inc. - Reidsville	Rockingham	Winston-Salem	Minor	Non-Municipal	2	14	17			0.005	03-02-03	UT Lick Fork Creek
NC0027987	Vulcan Construction Materials - Stoneville	Rockingham	Winston-Salem	Minor	Non-Municipal	42	41				not limited	03-02-03	UT Buffalo Creek

Table A-I-1 NPDES Dischargers in the Roanoke River Basin (as of January 2000)

Permit	Facility	County	Region	Type	Ownership	D1	D2	D3	D4	D5	MGD	Subbasin	Receiving Stream
NC0060623	Stone Highway MHP	Rockingham	Winston-Salem	Minor	Non-Municipal	8					0.015	03-02-03	UT Buffalo Creek
NC0086665	Rockingham Power LLC / Dynegy	Rockingham	Winston-Salem	Minor	Non-Municipal	14	73				not limited	03-02-03	UT Jacob's Creek
NC0027855	Rockingham Correctional Center	Rockingham	Winston-Salem	Minor	Non-Municipal	11					0.0195	03-02-03	UT Rock House Creek
NC0036986	Rockingham Co School / Sadler Elementary	Rockingham	Winston-Salem	Minor	Non-Municipal	3					0.0027	03-02-03	UT Wolf Island Creek
NC0036951	Rockingham Co School / Happy Home	Rockingham	Winston-Salem	Minor	Non-Municipal	3					0.0035	03-02-03	UT Dan River
NC0037001	Rockingham Co School / Bethany Elementary	Rockingham	Winston-Salem	Minor	Non-Municipal	3					0.0037	03-02-03	UT Huffines Mill Creek
NC0055018	Roberts Mobile Home Park	Rockingham	Winston-Salem	Minor	Non-Municipal	8					0.0025	03-02-03	Buffalo Creek
NC0029980	Miller Brewing Company	Rockingham	Winston-Salem	Major	Non-Municipal	27	16	14	68		5.2	03-02-03	Dan River
NC0085626	Madison, Town of - WTP	Rockingham	Winston-Salem	Minor	Non-Municipal	21					0	03-02-03	UT Big Beaver Island
NC0085189	Jose's Restaurant - Sand Filter	Rockingham	Winston-Salem	Minor	Non-Municipal	10					0.005	03-02-03	UT Buffalo Creek
NC0001643	Fieldcrest Cannon / New Street	Rockingham	Winston-Salem	Major	Non-Municipal	55	2				0.5	03-02-03	Dan River
NC0025071	Eden, City - Mebane Bridge WWTP	Rockingham	Winston-Salem	Major	Municipal	1	55	78	61		13.5	03-02-03	Dan River
NC0025151	Eden, City of - Dry Creek WRP	Rockingham	Winston-Salem	Minor	Municipal	1	2	55			0.5	03-02-03	Dan River
NC0003468	Duke Power Company - Dan River	Rockingham	Winston-Salem	Major	Non-Municipal	68	69	70			0	03-02-03	Dan River
NC0077135	Curl Modular Homes / Hidden Valley	Rockingham	Winston-Salem	Minor	Non-Municipal	8	5				0.022	03-02-03	UT Lick Fork Creek
NC0078271	Betsy Jeff Penn 4-H Education	Rockingham	Winston-Salem	Minor	Non-Municipal	13					0.0084	03-02-03	Carroll Creek
NC0040011	Yanceyville, Town of - WWTP	Caswell	Winston-Salem	Minor	Municipal	1	2	10	11	55	0.45	03-02-04	Country Line Creek
NC0007323	Yanceyville, Town of - WTP	Caswell	Winston-Salem	Minor	Non-Municipal	21	0				0.015	03-02-04	Fullers Creek
NC0030180	DOC - Blanch Youth Institute #3940	Caswell	Winston-Salem	Minor	Non-Municipal	11					0.018	03-02-04	UT Country Line Creek
NC0021024	Roxboro, City of - WWTP	Person	Raleigh	Major	Municipal	1	55				5	03-02-05	Marlowe Creek
NC0003042	Roxboro, City of - WTP	Person	Raleigh	Minor	Non-Municipal	21					0	03-02-05	UT Marlowe Creek
NC0036536	Person Co BOE / Woodland Elementary	Person	Raleigh	Minor	Non-Municipal	3					0.006	03-02-05	UT South Hyco Creek
NC0036544	Person Co BOE / Bethel Hill	Person	Raleigh	Minor	Non-Municipal	3					0.006	03-02-05	UT Bamboo Creek
NC0003425	CP&L Roxboro S.E. (Power Plant)	Person	Raleigh	Major	Non-Municipal	2	14	16	17	68	0.015	03-02-05	Hyco Lake
NC0038377	CP&L Mayo S.E. (Power Plant)	Person	Raleigh	Major	Non-Municipal	2	17	68	70		21	03-02-05	Mayo Creek->Crutchfield Branch
NC0065081	Cogentrix - Roxboro	Person	Raleigh	Minor	Non-Municipal	16	17	15	68	70	0	03-02-05	UT Mitchell Creek
NC0035491	Vance Co School / E.O. Young, Jr. Elementary	Vance	Raleigh	Minor	Non-Municipal	3					0.0036	03-02-06	UT Mill Creek
NC0083101	Kerr Lake Regional Water System	Vance	Raleigh	Minor	Non-Municipal	21					0	03-02-06	UT Anderson Swamp Creek
NC0020559	Henderson-Nutbush Creek WWTP	Vance	Raleigh	Major	Municipal	1	55	64	26	78	4.14	03-02-06	Nutbush Creek
NC0032743	Granville Co School / Stovall	Granville	Raleigh	Minor	Non-Municipal	3					0.007	03-02-06	UT Gills Creek
NC0025721	Weldon, Town of - WWTP	Halifax	Raleigh	Major	Municipal	1	17	68	70		1.2	03-02-08	Roanoke River
NC0024201	Roanoke Rapids Sanitary District	Halifax	Raleigh	Major	Municipal	1	9	55	56	63	8.34	03-02-08	Roanoke River

Table A-I-1 NPDES Dischargers in the Roanoke River Basin (as of January 2000)

Permit	Facility	County	Region	Type	Ownership	D1	D2	D3	D4	D5	MGD	Subbasin	Receiving Stream
NC0025437	Rich Square, Town - WWTP	Northampton	Raleigh	Minor	Municipal	1					0.15	03-02-08	Bridgers Creek
NC0028835	Perdue Farms, Inc. / Lewiston	Bertie	Washington	Major	Non-Municipal	23					3	03-02-08	Roanoke River
NC0079014	Panda-Rosemary, L.P.	Halifax	Raleigh	Minor	Non-Municipal	37					0	03-02-08	UT Chockoyotte Creek
NC0066192	Halifax, Town - WWTP	Halifax	Raleigh	Minor	Municipal	1					0.075	03-02-08	Quankey Creek
NC0038636	Halifax Co BOE / Bakers Elementary	Halifax	Raleigh	Minor	Non-Municipal	3					0.0073	03-02-08	UT Kehukee Swamp
NC0027642	DOC - Odom Correctional Institute #3310	Northampton	Raleigh	Minor	Non-Municipal	11					0.12	03-02-08	Roanoke River
NC0029734	DOC - Halifax Correctional Center #3315	Halifax	Raleigh	Minor	Non-Municipal	11					0.018	03-02-08	Little Quankey Creek
NC0027626	DOC - Caledonia Correctional	Halifax	Raleigh	Minor	Non-Municipal	11	23	24	16	40	0.8	03-02-08	Roanoke River
NC0000752	Champion International / Roanoke Rapids	Halifax	Raleigh	Major	Non-Municipal	18	14	61			28	03-02-08	Roanoke River
NC0020044	Williamston, Town - WWTP	Martin	Washington	Major	Municipal	1					2	03-02-09	Roanoke River
NC0000680	Weyerhaeuser Company - Plymouth Mill	Martin	Washington	Major	Non-Municipal	18	14	19			82.5	03-02-09	Roanoke River
NC0068187	United Organics Corporation	Martin	Washington	Minor	Non-Municipal	14	16				0	03-02-09	UT Roanoke River
NC0020028	Plymouth, Town - WWTP	Washington	Washington	Minor	Municipal	1	3	9	10	25	0.8	03-02-09	Roanoke River
NC0002313	Plymouth, Town of - WTP	Washington	Washington	Minor	Non-Municipal	22					0	03-02-09	UT Conaby Creek
NC0023710	Liberty Fabrics, Inc.	Martin	Washington	Minor	Non-Municipal	2	14	16	55		0.45	03-02-09	Roanoke River
NC0035858	Jamesville, Town - WWTP	Martin	Washington	Minor	Municipal	1					0.15	03-02-09	Roanoke River
NC0044776	Hamilton, Town of - WWTP	Martin	Washington	Minor	Municipal	1					0.08	03-02-09	Roanoke River
NC0001961	Alamac Knit Fabrics, Hamilton	Martin	Washington	Major	Non-Municipal	55	14	15	16	2	1.5	03-02-09	Roanoke River
NC0026751	Windsor, Town of - WWTP	Bertie	Washington	Major	Municipal	1					1.15	03-02-10	UT Cashie River
NC0086215	Williford Logging, Inc.	Bertie	Washington	Minor	Non-Municipal	18	19				0	03-02-10	UT Cashie River
NC0023116	Lewiston-Woodville, Town - WWTP	Bertie	Washington	Minor	Municipal	1					0.15	03-02-10	Cashie River
NC0047007	Evans Lumber Company, Inc.	Bertie	Washington	Minor	Non-Municipal	22	16	19	14		not limited	03-02-10	UT Cashie River

NPDES DISCHARGE CODES
INDICATING TYPES OF WASTEWATER DISCHARGED

1	Domestic	Municipal
2	Domestic	Industrial / Commercial
3	Domestic	Schools
5	Domestic	Subdivisions
8	Domestic	Mobile Home Parks
9	Domestic	Hospitals
10	Domestic	Restaurants
11	Domestic	Institutions (colleges, prisons, nursing homes)
13	Domestic	Lodging (hotels, motels, campgrounds, rest areas)
14	Non-Contact cooling water/condensate	
15	Contact cooling water	
16	Boiler blowdown	
17	Cooling tower blowdown	
18	Pulp and Paper	
19	Wood products	
21	Water plants (Surface water)	
22	Water plants and Water conditioning (Groundwater)	
23	Meat processing and rendering	
24	Vegetable and Fruit processing	
25	Seafood and Fish processing	
26	Tobacco processing	
27	Beverage production	
37	Oil separator	
38	Oil refinery	
40	Laundry waste	
41	Mining and Material processing	
42	Mine dewatering	
50	Printing and Publishing	
55	Textiles	
56	Metal plating	
57	Metal finishing	
61	Car wash facilities	
63	Rubber processing	
64	Glass manufacturing	
68	Ash Ponds and Coal Piles	
69	Metal Cleaning (Steam Electric plants)	
70	Low-Volume Wastes (Steam Electric plants)	
73	Stormwater	
78	Other wastewater from Industrial and Commercial (Not otherwise listed)	

Table A-I-2 NPDES Individual Stormwater Dischargers in the Roanoke River Basin (as of January 2000)

Permit #	Facility Name	Receiving Stream	Subbasin	County
NCS000229	Roanoke Valley Projects I & II	Roanoke River	03-02-08	Halifax
NCS000106	Champion International Corporation	Roanoke River	03-02-08	Halifax
NCS000124	Georgia-Pacific Corporation	Chockoyotte Creek	03-02-08	Halifax
NCS000166	Perdue - Lewiston	UT Flag Run Gut	03-02-08	Bertie
NCS000197	Panda Rosemary LTD Partnership	Roanoke Rapids MSSS to Roanoke River	03-02-08	Halifax
NCS000289	Gilbert & Bennett Manufacturing Company	UT Kehukee Swamp	03-02-08	Halifax
NCS000325	Myers Industries - Patch Rubber	UT Roanoke River	03-02-08	Halifax
NCS000185	United Organics Corporation	UT Roanoke River	03-02-09	Martin
NCS000189	Weyerhaeuser Company	Roanoke River & Warren Neck Creek	03-02-09	Martin

Appendix II

Biological Water Quality Data Collected by DWQ

- **Benthic Macroinvertebrate Collections**
- **Fish Community Collections**
- **Fish Tissue Assessments**
- **Lakes Assessments**

Benthic Macroinvertebrate Sampling Methodology and Bioclassification Criteria

Benthic macroinvertebrates can be collected using two sampling procedures. DWQ's standard qualitative sampling procedure includes 10 composite samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leafpack sample, and visual collections from large rocks and logs. The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1-2 specimens), Common (3-9 specimens) or Abundant (≥10 specimens).

Several data analysis summaries (metrics) can be produced from standard qualitative samples to detect water quality problems. These metrics are based on the idea that unimpaired streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a biotic index.

EPT taxa richness (EPT S) is used with DWQ criteria to assign water quality ratings (bioclassifications). "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution. Higher EPT taxa richness values usually indicate better water quality. Water quality ratings are also based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI). Both tolerance values for individual species and the final biotic index values have a range of 0-10, with higher numbers indicating more tolerant species or more polluted conditions.

Water quality ratings assigned with the biotic index numbers are combined with EPT taxa richness ratings to produce a final bioclassification, using criteria for mountain/piedmont/coastal plain streams. EPT abundance (EPT N) and total taxa richness calculations also are used to help examine between-site differences in water quality. If the EPT taxa richness rating and the biotic index differ by one bioclassification, the EPT abundance value is used to determine the final site rating.

Benthic macroinvertebrates can also be collected using the DWQ's EPT sampling procedure. Four composite samples are taken at each site instead of the 10 taken for the qualitative sample: 1 kick, 1 sweep, 1 leafpack and visual collections. Only intolerant EPT groups are collected and identified, and only EPT criteria are used to assign a bioclassification.

The expected EPT taxa richness values are lower in small high quality mountain streams, <4 meters in width or with a drainage area <3.5 square miles. For these small mountain streams, an adjustment to the EPT taxa richness values is made prior to applying taxa richness criteria. Both EPT taxa richness and biotic index values also can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling (June-September). For samples collected in other seasons, EPT taxa richness can be adjusted. The biotic index values can also be seasonally adjusted for samples collected outside the summer season.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis.

Swamp Streams

Extensive evaluation, conducted by DWQ, of swamp streams across eastern North Carolina suggests that different criteria should be used to assess the condition of water quality in these systems. Swamp streams are characterized by slower flow, lower dissolved oxygen, lower pH, and sometimes very complex braided channels and dark-colored water. DWQ has developed draft biological criteria that may be used in the future to assign bioclassifications to these streams. However, validation of the swamp criteria will require collecting data for several years from swamp stream reference sites. The criteria will remain in draft form until DWQ is better able to evaluate such things as: year-to-year variation at reference swamp sites, effects of flow interruption, variation among reference swamp sites, and the effect of small changes in pH on the benthos community. Other factors, such as whether the habitat evaluation can be improved and the role fisheries data should play in the evaluation, must also be resolved. While it may be difficult to assign use support ratings to these swamp streams, these data can be used to evaluate changes in a particular stream between dates or to evaluate effects of different land uses on water quality within a relatively uniform ecoregion.

Draft swamp stream rating criteria evaluate swamp streams based on benthic macroinvertebrate data (collected in winter), fish community data and a habitat score. Benthic data collected outside of the winter high flow period are not used to assign ratings. At least two of the above referenced data types must be collected in order to assign a rating. Each of these data types is assigned a point value of 10 (Good), 5 (Fair) or 1 (Poor), and the points are averaged to assign an overall site rating (OSR): Good-Excellent (>7.5), Fair-Good (5.0-7.5), Fair (2.0-4.9) and Poor (<2.0). Ratings for the benthic macroinvertebrate communities are based entirely on the biotic index value: Good <6.99, Fair 7.75-7.00, Poor >7.75. Deep (nonwadeable) coastal rivers with little or no visible current have different EPT criteria that are being used on a provisional basis until more data can be gathered.

Flow Measurement

Changes in the benthic macroinvertebrate community are often used to help assess between-year changes in water quality. However, some between-year changes in the macroinvertebrate community may be due largely to changes in flow. High flow years magnify the potential effects of nonpoint source runoff, leading to scour, substrate instability and reduced periphyton. Low flow years may accentuate the effects of point source dischargers by providing less dilution of wastes.

For these reasons, all between-year changes in the biological communities are considered in light of flow conditions (high, low or normal) for one month prior to the sampling date. Daily flow information is obtained from the closest available USGS monitoring site and compared to the long-term mean flows. High flow is defined as a mean flow >140% of the long-term mean for that time period, usually July or August. Low flow is defined as a mean flow <60% of the long-term mean, while normal flow is 60-140% of the mean. While broad scale regional patterns are often observed, there may be large geographical variation within the state and large variation within a single summer period.

Habitat Evaluation

DWQ has developed a habitat assessment form to better evaluate the physical habitat of a stream. The habitat score has a potential range of 1-100, based on evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed for assigning ratings indicating Excellent, Good, Fair or Poor habitat.

Table A-II-1 Benthic Macroinvertebrate Data Collected in the Roanoke River Basin, 1983 - 1999 (Current basinwide monitoring sites have the map number bolded.)

Subbasin/ Stream	Location	County	Site No.	Index No.	Date	S/ EPT S	NCBI/ EPT BI	Bio Class[1]
03-02-01								
Dan R	NC 704	Stokes	B-1	22-(1)	08/99	85/41	4.19/3.30	G
					08/94	57/28	3.84/3.51	G
					07/90	94/48	4.48/3.68	E
					07/88	89/38	4.06/2.98	G
					07/86	84/37	4.00/3.17	G
					08/84	86/36	4.66/3.58	G
Dan R	SR 1695	Stokes	B-2	22-8	08/99	72/37	4.57/3.95	G
					08/94	45/20	4.75/3.87	G-F
North Double Cr	SR 1504	Stokes	B-3	22-10	08/99	-/25	-/3.97	G-F
					08/94	-/17	-/4.63	F
UT Cascade Cr (family cabins)		Stokes	B-4		06/95	37/15	4.34/1.96	G-F
Cascade Cr	SR 2012	Stokes	B-5	22-12-(2)	06/95	54/26	2.96/1.98	G
					09/90	-/23	-/2.99	G-F
Cascade Cr	Near SR 1001	Stokes	B-6	22-12-(2)	03/91	-/26	-/2.94	G
					09/90	-/26	-/3.48	G
Cascade Cr (above swimming lake)		Stokes	B-7	22-12-1	06/95	69/31	3.35/1.77	E
					03/93	-/34	-/1.61	E
					08/91	-/26	-/1.59	G
					03/91	-/35	-/1.69	E
					09/90	-/22	-/1.88	G
Indian Cr (above trail)		Stokes	B-8	22-13-(1)	03/93	-/30	-/1.47	E
					03/91	-/25	-/1.38	G
Indian Cr (below trail)		Stokes	B-9	22-13-(1)	03/93	-/34	-/1.54	E
					03/91	-/27	-/1.22	E
					09/90	-/26	-/2.57	E
Indian Cr	SR 1001	Stokes	B-10	22-13-(2)	09/90	-/22	-/2.33	G
Indian Cr	SR 1487	Stokes	B-11	22-13-(2)	09/90	-/27	-/2.76	G
Snow Cr	SR 1673	Stokes	B-12	22-20	08/00			G
					08/99	-/18	-/4.37	F
					08/94	-/22	-/4.00	G-F
Town Fk Cr	SR 1970	Stokes	B-13	22-25	09/95	-/7	-/5.95	P
Town Fk Cr	SR 1961	Stokes	B-14	22-25	09/95	89/26	5.17/4.77	G-F
Town Fk Cr	SR 1955	Stokes	B-15	22-25	09/95	-/26	-/4.69	G-F
Town Fk Cr	US 311	Stokes	B-16	22-25	02/88	-/19	-/4.43	G-F
Town Fk Cr	SR 1917	Stokes	B-17	22-25	08/94	-/15	-/4.59	G-F
					02/88	-/24	-/4.21	G-F
Neatman Cr	SR 1961	Stokes	B-18	22-25-6	09/95	-/29	-/4.27	G
UT Dan R,	US 311	Stokes	B-19	22-(28.5)	02/87	-/21	-/4.00	G-F
UT Dan R (near raceway)		Stokes	B-20	22-(28.5)	02/87	-/15	-/4.40	F
03-02-02								
Mayo R	SR 1358	Rockingham	B-1	22-30-(1)	08/99	70/32	4.26/3.44	G
					08/94	64/38	3.60/3.24	G
					08/89	79/42	4.78/4.02	G
					03/89	96/54	3.72/2.85	G
					07/87	87/40	4.78/4.10	G
					07/86	102/37	5.07/3.95	G
Mayo R	NC 770	Rockingham	B-2	22-30-(1)	03/89	-/37	-/3.49	G-F
Mayo R	US 220 Bus	Rockingham	B-3	22-30-(1)	03/89	-/44	-/3.29	G-F
Mayo R	NC 135	Rockingham	B-4	22-30-(10)	08/89	-/28	-/4.12	G
Mayo R	SR 2177	Rockingham	B-5	22-30-(10)	08/99	52/21	5.22/4.25	G-F
					09/94	71/33	4.70/4.33	G
03-02-03								
Dan R	SR 2150	Rockingham	B-1	22-(31.5)	08/89	64/26	5.50/4.66	G
					07/87	92/32	5.67/4.61	G
Dan R	SR 1761	Rockingham	B-2	22-(39)	08/91	55/26	5.07/4.30	E
					07/87	68/26	5.14/4.15	G
					07/86	61/20	5.87/4.64	G-F
					09/84	56/17	5.71/4.41	G-F
					08/83	65/22	5.53/4.70	G

Subbasin/ Stream	Location	County	Site No.	Index No.	Date	S/ EPT S	NCBI/ EPT BI	Bio Class[1]
03-02-03 (con't)								
Smith R (near NC/VA state line)	VA 922		B-3	22-40-(1)	09/84	63/21	5.74/4.42	G-F
Smith R	NC 14	Rockingham	B-4	22-40-(3)	09/99	51/18	5.23/3.67	F
					08/94	58/18	5.66/4.43	F
					07/90	81/31	5.52/4.18	G-F
					07/88	69/24	6.03/5.08	F
					07/86	57/18	6.14/4.71	F
Wolf Island Cr	NC 700	Caswell	B-5	22-48	07/88	82/24	5.81/4.82	G
					07/85	68/25	5.40/4.69	G
					08/83	76/24	5.52/4.53	G
UT Hogans Cr	VA 736	Pittsylvania	B-6	22-50	06/98	44/16	4.94/4.04	NR
					11/96	48/12	6.15/4.71	NR
UT Hogans Cr (above ponds)	Off SR 1503	Caswell	B-7	22-50	06/98	43/13	5.25/4.61	NR
					11/96	36/10	6.13/4.92	NR
UT Hogans Cr (below ponds)	Off SR 1503	Caswell	B-8	22-50	06/98	48/12	5.89/5.67	NR
					11/96	41/7	6.42/3.95	NR
Jones Cr	SR 2632	Rockingham	B-9	22-50-3	01/92	-/29	-/4.56	G
Jones Cr	SR 2571	Rockingham	B-10	22-50-3	12/87	83/27	5.55/4.50	G
03-02-04								
Dan R	NC 57	Caswell	B-1	22-39	08/99	66/32	5.42/4.54	G
Country Line Cr	NC 57	Caswell	B-2	22-56-(3.7)	08/94	-/14	-/4.42	G-F
					07/90	73/26	5.51/4.52	G
					07/87	78/26	5.77/4.95	G
					08/83	72/19	5.80/4.34	G-F
03-02-05								
Hyco Cr (North Hyco Cr)	US 158	Caswell	B-1	22-58-1	08/94	-/10	-/5.93	F
					07/90	65/20	5.91/5.27	G-F
					07/87	74/23	5.86/5.15	G-F
					07/86	78/21	5.88/5.07	G-F
Marlowe Cr	SR 1322	Person	B-2	22-58-12-6	08/99	53/9	6.34/5.74	F
					08/94	33/5	6.90/6.49	P
03-02-06								
Island Cr	SR 1445	Granville	B-1	23-4	08/94	-/17	-/5.10	G-F
L Island Cr	SR 1342	Vance	B-2	23-4-3	05/88	-/21	-/4.88	G-F
Nutbush Cr (above WWTP)	NC 39	Vance	B-3	23-8-(1)	11/94	58/12	6.89/6.13	F
					10/94	54/12	6.96/5.77	F
					05/88	44/6	7.40/6.75	F
Nutbush Cr (below WWTP)	Off NC 39	Vance	B-4	23-8-(1)	11/94	48/7	7.19/6.20	F
Nutbush Cr	SR 1317	Vance	B-5	23-8-(1)	08/99	41/8	6.72/6.75	F
					10/94	50/8	6.74/6.31	F
					08/94	44/8	6.83/6.88	F
					05/88	35/3	8.14/6.45	P
Anderson Swamp Cr	I-85	Vance	B-6	23-8-6-(1)	02/90	49/13	6.98/5.71	NR
UT Anderson Swamp Cr	US 1/158	Vance	B-7	23-8-6-(1)	02/90	18/2	7.55/7.75	NR
03-02-07								
Smith Cr	US 1	Warren	B-1	23-10	07/99	59/12	6.56/5.51	F
					08/94	53/6	6.94/6.15	F
					07/89	59/12	6.75/5.06	F
					07/86	56/10	6.22/5.13	F
					08/84	56/12	6.42/5.36	F
Sixpound Cr	SR 1306	Warren	B-2	23-13	07/99	54/14	5.50/5.04	G-F
					08/94	-/12	-/5.32	F
03-02-08								
Deep Cr	US 158	Halifax	B-1	23-24-(1)	07/99	58/11	6.40/5.17	NR
					08/94	64/13	6.36/5.70	F
Roanoke R (below Weldon)	US 158	Halifax	B-2	23-(26)	09/94	45/16	5.29/4.68	G
Roanoke R (boat access),		Halifax	B-3	23-(26)	03/99	76/28	5.26/4.36	G
Roanoke R	US 258	Halifax	B-4	23-(26)	07/99	41/19	5.21/4.76	G
					03/99	67/30	5.37/4.72	G
					09/94	45/16	4.90/4.28	G

Subbasin/ Stream	Location	County	Site No.	Index No.	Date	S/ EPT S	NCBI/ EPT BI	Bio Class[1]
03-02-08 (con't)								
Smith R (near NC/VA state line)	VA 922		B-3	22-40-(1)	09/84	63/21	5.74/4.42	G-F
					07/85	49/16	5.92/4.88	G-F
Quankey Cr	NC 903	Halifax	B-5	23-30	02/99	40/9	6.66/5.92	NR
Quankey Cr	NC 561	Halifax	B-6	23-30	09/99	-/9	-/5.51	F
Quankey Cr (above WWTP)		Halifax	B-7	23-30	12/92	51/7	6.55/5.69	F
Quankey Cr (below WWTP)		Halifax	B-8	23-30	12/92	57/9	6.41/5.28	F
Oconeechee Cr	SR 1126	Northampton	B-9	23-31	02/99	22/4	6.48/6.85	NR
Conoconnara Swp	NC 561,	Halifax	B-10	23-33	02/99	31/5	6.44/6.80	NR
					07/84	39/3	7.49/6.26	NR
Kehukee Swp	SR 1804	Halifax	B-11	23-42	09/99	-/6	-/6.19	NR
					02/99	59/8	7.10/6.44	NR
03-02-09								
Roanoke R (below Hamilton),	NC 125/903	Martin	B-1	23-(26)	03/99	61/23	5.82/4.80	G-F
					09/94	51/19	5.21/4.39	G
Roanoke R (below Williamston)	US 17	Martin	B-2	23-(26)	07/99	45/17	5.96/4.77	G-F
					03/99	73/23	6.32/5.07	G-F
					09/94	53/17	5.70/4.80	G-F
Indian Cr	SR 1108	Bertie	B-3	23-47	03/97	30/1	7.40/7.78	NR
Conoho Cr	NC 125/903	Martin	B-4	23-49	02/99	29/3	7.28/7.56	NR
					08/94	23/0	7.49/-	NR
Conoho Cr	SR 1417	Martin	B-5	23-49	02/99	39/5	6.26/4.80	NR
Hardison Mill Cr	NC 171	Martin	B-6	23-50-3	02/99	24/2	7.69/7.65	NR
Hardison Mill Cr	SR 1528	Martin	B-7	23-50-3	02/99	27/3	7.28/7.65	NR
Deep Run Swp	NC 171	Martin	B-8	23-52-1-1	02/99	21/1	7.61/7.78	NR
Welch Cr	SR 1552	Martin	B-9	23-55	02/99	32/3	7.20/6.92	NR
Roanoke R	NC 45	Bertie	B-10	23-(53)	07/99	59/9	7.35/6.56	NR
					09/94	52/9	7.52/6.08	NR
					06/92	60/8	7.48/5.82	NR
					07/90	51/10	7.48/6.23	NR
					07/88	60/7	7.93/6.62	NR
					07/86	50/8	7.68/6.77	NR
					07/85	37/4	8.16/6.50	NR
					07/84	42/6	7.63/6.18	NR
					07/83	38/6	8.07/5.42	NR
Conaby Cr	SR 1114	Washington	B-11	23-56	04/94	68/5	7.01/5.89	NR
Conaby Cr	SR 1325	Washington	B-12	23-56	04/94	41/0	7.44/-	NR
03-02-10								
Cashie R (above WWTP)	off NC 11	Bertie	B-1	24-2-(1)	06/84	37/0	8.61/-	NR
Cashie R (below WWTP)	off NC 11	Bertie	B-2	24-2-(1)	06/84	41/0	8.39/-	NR
Cashie R	SR 1219	Bertie	B-3	24-2-(1)	02/99	41/6	7.47/7.23	NR
					06/84	43/2	8.24/7.00	NR
					07/83	34/2	8.54/7.00	NR
Cashie R	SR 1257	Bertie	B-4	24-2-(1)	02/99	34/7	6.78/6.09	NR
Hoggard Mill Cr	SR 1301	Bertie	B-5	24-2-6	02/99	46/7	6.74/6.37	NR
Wading Place Cr	NC 308	Bertie	B-6	24-2-8	03/99	35/3	7.35/7.42	NR
Roquist Swp	US 13/17	Bertie	B-7	24-2-8	02/99	31/4	6.98/5.48	NR
Cashie R	SR 1500	Bertie	B-8	24-2-(9)	09/94	56/9	8.10/6.34	NR

[1] E = Excellent, G = Good, G-F = Good-Fair, F = Fair, P = Poor, and NR = Not Rated.

Fish Community Sampling Methodology and Bioclassification Criteria

At each sample site, a 600-foot section of stream is measured and selected. Fish in the delineated stretch of stream are then collected using two backpack electrofishing units and two persons netting the stunned fish. After collection, all readily identifiable fish are examined for sores, lesions, fin damage, or skeletal anomalies, measured (total length to the nearest 1 mm), and then released. Those fish that are not readily identifiable are preserved and returned to the laboratory for identification, examination, and measurement. Detailed descriptions of the sampling methods may be found on the Environmental Sciences Branch website: http://www.esb.enr.state.nc.us/BAUwww/IBI%20Methods%202.pdf.

The assessment of biological integrity using the North Carolina Index of Biotic Integrity (NCIBI) is provided by the cumulative assessment of 12 parameters or metrics. The values provided by the metrics are converted into scores on a 1, 3 or 5 scale. A score of 5 represents conditions which would be expected for undisturbed reference streams in the specific river basin or ecoregion, while a score of 1 indicates that the conditions deviate greatly from those expected in undisturbed streams of the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. Finally, the score (an even number between 12 and 60) is then used to determine the ecological integrity class, as proposed by Karr (1981), of the stream from which the sample was collected (Table A-II-2).

Table A-II-2 Original Scores, Integrity Classes, and Class Attributes for Evaluating Fish Communities Using Karr's 1981 Index of Biotic Integrity

NCIBI Scores	Integrity Classes	Class Attributes*
> 58	Excellent	Comparable to the best situations without human disturbance. All regionally expected species for the habitat and stream size, including the most intolerant forms are present, along with a full array of size classes and a balanced trophic structure.
48-52	Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant species; some species are present with less than optimal abundances or size distributions; and the trophic structure shows some signs of stress.
40-44	Fair	Signs of additional deterioration include the loss of intolerant species, fewer species, and a highly skewed trophic structure.
28-34	Poor	Dominated by omnivores, tolerant species, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; and diseased fish often present.
< 22	Very Poor	Few fish present, mostly introduced or tolerant species; and disease fin damage and other anomalies are regular.
-----	No fish	Repeated sampling finds no fish.

* Over-lapping classes share attributes with classes greater than and less than the respective IBI score.

The NCIBI has been revised since the 1997 Standard Operating Procedures were printed (NCDEHNR 1997). Recently, the focus of using and applying the NCIBI has been restricted to wadeable streams that can be sampled by a crew of four persons. The bioclassifications and criteria have also been re-calibrated against regional reference site data (Table A-II-3).

Table A-II-3 Revised Scores and Classes for Evaluating the Fish Community of a Wadeable Stream Using the NCIBI in the Piedmont Portion of the Cape Fear, Neuse, Roanoke and Tar River Basins

NCIBI Scores	NCIBI Classes
> 54	Excellent
46 - 52	Good
40 - 44	Good-Fair
34 - 38	Fair
≤ 32	Poor

The definition of the piedmont for these four river basins is based upon a map of North Carolina watersheds by Fels (1997). Specifically for the Roanoke River basin, the piedmont encompasses the entire basin above Roanoke Rapids, NC and a small area between Roanoke Rapids and Halifax, NC.

Work began in 1998 to develop a fish community boat sampling method that could be used in non-wadeable coastal plain streams. Plans are to sample 10-15 reference sites with the boat method once it is finalized. As with the benthos in swamp streams, several years of reference site data will be needed before criteria can be developed with confidence to evaluate the biological integrity of large streams and rivers, like the Roanoke River, using the fish community.

Table A-II-4 Fish Community Data Collected in the Roanoke River Basin, 1990-1999 (Sites sampled during the current five-year basinwide cycle are bolded.)

Subbasin	Waterbody	Station	County	Date	NCIBI Rating
03-02-02	Paw Paw Cr	SR 1360	Rockingham	08/90	Good
03-02-03	Wolf Island Cr	NC 700	Caswell	10/94	Excellent
03-02-04	Cane Cr	SR 1527	Caswell	10/94	Good-Fair
03-02-04	Country Line Cr	NC 57	Caswell	09/94	Good
03-02-04	Moon Cr	SR 1511	Caswell	09/94	Good
03-02-05	Marlowes Cr	SR 1322	Person	09/94	Good-Fair
03-02-06	**Grassy Cr**	**SR 1300**	**Granville**	**06/99**	**Good**
		SR 1436	Granville	06/94	Good
03-02-06	**Island Cr**	**SR 1445**	**Granville**	**06/99**	**Excellent**
				06/94	Good
03-02-06	Nutbush Cr	SR 1317	Vance	10/94	Good-Fair
03-02-07	Six Pound Cr	SR 1306	Warren	05/94	Good-Fair
03-02-07	Smith Cr	US 1	Warren	05/94	Good-Fair
03-02-08	Conoconnara Swp	NC 561	Halifax	09/94	Not Rated
03-02-08	Deep Cr	US 158	Halifax	09/94	Good
03-02-08	Kehukee Swp	SR 1804	Halifax	10/94	Not Rated
03-02-08	Quankey Cr	SR 1619	Halifax	09/94	Good-Fair
03-02-10	Cashie R	SR 1257	Bertie	10/94	Not Rated

Fish Tissue Criteria

In evaluating fish tissue analysis results, several different types of criteria are used. Human health concerns related to fish consumption are screened by comparing results with:

- Federal Food and Drug Administration (FDA) action levels.
- Environmental Protection Agency (EPA) recommended screening values.
- Criteria adopted by the North Carolina State Health Director.

Sample results which exceed these levels are a human health concern and are evaluated by the NC Division of Occupational and Environmental Epidemiology at DWQ's request. The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs, and thus, employ a "safe level" approach to fish tissue consumption. Presently, the FDA has only developed metals criteria for mercury.

The EPA has recommended screening values for target analytes which are formulated from a risk assessment procedure (EPA, 1995). These are the concentrations of analytes in edible fish tissue that are of potential public health concern. DWQ compares fish tissue results with EPA screening values to evaluate the need for further intensive site-specific monitoring.

Table A-II-5 Fish Tissue Criteria

Contaminant	FDA Action Levels	US EPA Screening Values	NC Health Director
Metals			
Cadmium	--	10.0	--
Mercury	1.0	0.6	--
Selenium	--	50.0	5.0
Organics			
Aldrin	0.3	--	--
Chlorpyrifos	--	30	--
Total chlordane [1]	--	0.08	--
Cis-chlordane	0.3	--	--
Trans-chlordane	0.3	--	--
Total DDT [2]	--	0.3	--
Dieldrin	--	0.007	--
Dioxins (total)	--	0.7	3.0
Endosulfan (I and II)	--	60.0	--
Endrin	0.3	3.0	--
Heptachlorepoxide	--	0.01	--
Hexachlorobenzene	--	0.07	--
Lindane	--	0.08	--
Mirex	--	2.0	--
Total PCBs	--	0.01	--
PCB-1254	2.0	--	--
Toxaphene	--	0.1	--

[1] Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane.

[2] Total DDT includes the sum of all its isomers and metabolites (i.e., p,p DDT, o,p DDT, DDE, and DDD).

Note: All wet weight concentrations are reported in parts per million (ppm, µg/g), except for dioxin which is in parts per trillion (ppt, pg/g).

The North Carolina State Health Director has adopted a selenium limit of 5 µg/g for issuing an advisory. Although the EPA has suggested a screening value of 0.7 ppt (pg/g) for dioxins, the State of North Carolina currently uses a value of 3.0 ppt in issuing an advisory.

Table A-II-6 Wet Weight Concentrations of Mercury (Hg), Arsenic (As) and Cadmium (Cd) in Fish Tissue from the Roanoke River Basin (1994 – 1999)

Subbasin/ Site	County	Date	Species	Total Length (cm)	Weight (g)	Hg (µg/g)	As (µg/g)	Cd (µg/g)
03-02-03								
Dan River near Eden	Rockingham	08/31/1999	*Bluegill*	16	77	0.05	ND[1]	ND[1]
			Channel catfish	35.5	358	0.10	ND	ND
			Golden redhorse	37.8	335	0.36	ND	ND
			Golden redhorse	33	387	0.17	ND	ND
			Golden redhorse	31.2	300	0.27	ND	ND
			Golden redhorse	33.5	378	0.23	ND	ND
			Golden redhorse	37.1	476	0.37	ND	ND
			Golden redhorse	34.3	426	0.17	ND	ND
			Largemouth bass	30	374	0.20	ND	ND
			Largemouth bass	28.2	304	0.13	ND	ND
			Largemouth bass	27.5	260	0.12	ND	ND
			Quillback	38.2	796	0.29	ND	ND
			Redbreast sunfish	16.3	88	0.07	ND	ND
			Redbreast sunfish	13.2	44.2	0.10	ND	ND
			Redear sunfish	15.7	73.5	0.04	ND	ND
			Golden redhorse	37.8	414	0.22	ND	ND
			Snail bullhead	30.1	369	0.03	ND	ND
			Snail bullhead	31	346	0.03	ND	ND
			White catfish	29	334	0.16	ND	ND
03-02-06								
Kerr Lake at mouth of Nutbush Cr	Vance	05/20/1999	*Bluegill*	18.4	125	0.12	ND	ND
			Chain pickerel	57	1552	0.39	ND	ND
			Chain pickerel	53	1219	0.31	ND	ND
			Largemouth bass	46.5	1470	0.56	ND	ND
			Largemouth bass	42	1121	0.51	ND	ND
			Largemouth bass	43.8	984	0.65	ND	ND
			Largemouth bass	38	671	0.41	ND	ND
			Largemouth bass	38.5	767	0.59	ND	ND
			Largemouth bass	31	500	0.35	ND	ND
			Largemouth bass	33.6	477	0.52	ND	ND
			Largemouth bass	30.5	412	0.34	ND	ND
			Largemouth bass	31.5	423	0.26	ND	ND
			Largemouth bass	29.5	401	0.28	ND	ND
			Redear sunfish	27.5	377	0.06	ND	ND
			Redear sunfish	26.8	419	0.11	ND	ND
			Redear sunfish	22	179	0.08	ND	ND
			White catfish	27	241	0.34	ND	ND
		01/28/1999	*Striped bass*	70				
			Striped bass	467				
			Striped bass	48.2				
			Striped bass	42.5				
			Striped bass	73.2				
			Striped bass	41				
			Striped bass	77.1				
			Striped bass	65				
			Striped bass	44.6				
			Striped bass	67				
			Striped bass	41.7				
			Striped bass	44.3				
			Striped bass	74.8				
			Striped bass	39.5				
			Striped bass	42.4				
			Striped bass	70.1				
			Striped bass	72.2				
			Striped bass	44.5				
			Striped bass	78.2				

Subbasin/ Site	County	Date	Species	Total Length (cm)	Weight (g)	Hg (µg/g)	As (µg/g)	Cd (µg/g)
03-02-07								
Lake Gaston near Henrico	Halifax	07/08/1999	*Bluegill*	17.5	104.6	0.05	ND	ND
			Bluegill	18.1	119.3	0.05	ND	ND
			Bluegill	14.8	76.5	0.03	ND	ND
			Channel catfish	49.2	1096	0.05	ND	ND
			Channel catfish	48.2	1013	0.21	ND	ND
			Channel catfish	48.5	1172	0.05	ND	ND
			Channel catfish	43.5	804	0.10	ND	ND
			Channel catfish	47.8	1136	0.07	ND	ND
			Largemouth bass	25	212	0.07	ND	ND
			Largemouth bass	29.5	343	0.10	ND	ND
			Largemouth bass	31.1	423	0.07	ND	ND
			Largemouth bass	36.2	612	0.29	ND	ND
			Largemouth bass	42.6	962	0.37	ND	ND
			Largemouth bass	38.2	797	0.19	ND	ND
			Largemouth bass	37.4	728	0.14	ND	ND
			Largemouth bass	40.1	979	0.24	ND	ND
			Largemouth bass	45.3	1077	0.20	ND	ND
			Largemouth bass	45	1585	0.27	ND	ND
			Yellow perch	19.7	87.3	0.05	ND	ND
			Yellow perch	24.4	169	0.12	ND	ND
03-02-08								
Roanoke River at Weldon	Halifax	05/19/99	*Bluegill*	14.9	66.6	0.07	ND	ND
			Bluegill	15.7	77.5	0.06	ND	ND
			Black crappie	25.1	254	0.28	ND	ND
			Largemouth bass	43.1	1193	0.57	ND	ND
			Largemouth bass	40.7	1095	0.33	ND	ND
			Largemouth bass	38.2	657	0.43	ND	ND
			Largemouth bass	30.2	371	0.29	ND	ND
			Largemouth bass	32.3	412	0.43	ND	ND
			Largemouth bass	29.3	330	0.33	ND	ND
			Largemouth bass	25.3	244.5	0.23	ND	ND
			Largemouth bass	21.9	139.5	0.18	ND	ND
			Redbreast sunfish	17	92	0.10	ND	ND
			Striped bass	47.5	1256	0.20	ND	ND
			Striped bass	43.8	986	0.21	ND	ND
			Striped bass	45.3	907	0.24	ND	ND
			Striped bass	42.8	732	0.20	ND	ND
			Striped bass	39.7	661	0.19	ND	ND
			Striped bass	43.1	1540	0.51	ND	ND
			White catfish	37.5	575	0.07	ND	ND
			White catfish	33.8	528	0.15	ND	ND
			Yellow perch	23.8	188	0.17	ND	ND
		09/20/1995	*Bowfin*	39.5	621	0.13	—	—
			Bowfin	42	686	0.13	—	—
			Bowfin	46	992	0.11	—	—
			Bowfin	53.5	1223	0.67	—	—
			Bowfin	64	2701	0.68	—	—
			Bowfin	57.5	2394	0.56	—	—

Subbasin/ Site	County	Date	Species	Total Length (cm)	Weight (g)	Hg (µg/g)	As (µg/g)	Cd (µg/g)
03-02-08 (con't)								
Roanoke River at Scotland Neck	Halifax	05/19/99	*Bowfin*	58	1847	0.52	ND	ND
			Bowfin	55	1417	0.47	ND	ND
			Bowfin	60.1	2010	1.1	ND	ND
			Bowfin	50	1100	0.39	ND	ND
			Bowfin	54.9	1429	0.41	ND	ND
			Bowfin	49.5	1349	0.57	ND	ND
			Bluegill	17.5	116	0.14	ND	ND
			Channel catfish	54.8	1654	0.15	ND	ND
			Channel catfish	43.5	641	0.10	ND	ND
			Largemouth bass	40.2	966	0.71	ND	ND
			Largemouth bass	32.5	533	0.46	ND	ND
			Largemouth bass	31.2	412	0.52	ND	ND
			Redbreast sunfish	18.9	167	0.06	ND	ND
			Striped bass	49	1245	0.26	ND	ND
			Striped bass	45.2	1004	0.28	ND	ND
			Striped bass	48	1128	0.20	ND	ND
			Striped bass	47	1082	0.11	ND	ND
			Striped bass	45	1054	0.18	ND	ND
			Striped bass	43.2	835	0.15	ND	ND
			Striped bass	43.5	901	0.10	ND	ND
			Striped bass	41.1	652	0.26	ND	ND
			White catfish	36	712	0.42	ND	ND
			White catfish	28.7	305.5	0.19	ND	ND
03-02-09								
Roanoke River at Plymouth	Washington	07/21/1999	*Bowfin*	55.5	1738	0.56	ND	ND
			Bowfin	52.5	1321	0.47	ND	ND
			Bowfin	45.7	837	0.50	ND	ND
			Bowfin	42.5	690	0.31	ND	ND
			Bluegill	17.9	133.6	0.07	ND	ND
			Chain pickerel	47.8	640	0.64	ND	ND
			Largemouth bass	41.6	1165	0.44	ND	ND
			Largemouth bass	44.1	1282	0.53	ND	ND
			Largemouth bass	39.3	924	0.68	ND	ND
			Largemouth bass	37.6	759	0.48	ND	ND
			Largemouth bass	37.2	797	0.40	ND	ND
			Largemouth bass	37.1	821	0.64	ND	ND
			Largemouth bass	39	619	0.84	ND	ND
			Largemouth bass	37.6	703	0.49	ND	ND
			Largemouth bass	33.2	484	0.42	ND	ND
			Largemouth bass	28.9	342	0.45	ND	ND
			Largemouth bass	36.2	639	0.36	ND	ND
			Redear sunfish	25.5	313	0.13	ND	ND
			Redear sunfish	26.1	338	0.22	ND	ND
			Redear sunfish	19.4	140	0.12	ND	ND
			Yellow perch	23.6	190.3	0.20	3.9	ND
			Yellow perch	20.1	119	0.16	ND	ND
		07/06/1995	*Bowfin*	44.8	900	0.43	—	—
			Bowfin	54	1500	0.37	—	—
			Bowfin	54.7	1700	0.45	—	—
			Bowfin	52.1	1200	0.6	—	—
			Bowfin	67.1	3000	1	—	—
			Bowfin	69.5	3500	1.5	—	—
			Bowfin	72.6	3900	1.2	—	—

Subbasin/ Site	County	Date	Species	Total Length (cm)	Weight (g)	Hg (µg/g)	As (µg/g)	Cd (µg/g)
03-02-09 (con't)								
Roanoke River at US-17	Martin	07/06/1999	*Bowfin*	57.3	1815	0.65	ND	ND
			Bowfin	57	1959	0.76	ND	ND
			Bowfin	65.1	2633	1.3	ND	ND
			Bluegill	23	290	0.30	ND	ND
			Bluegill	18.8	150.5	0.30	ND	ND
			Bluegill	17.6	132	0.17	ND	ND
			Bluegill	16.8	99	0.27	ND	ND
			Largemouth bass	44.8	1226	1.3	ND	ND
			Largemouth bass	42.1	1090	1.4	ND	ND
			Largemouth bass	36.5	853	0.86	ND	ND
			Largemouth bass	39.7	894	0.94	ND	ND
			Largemouth bass	37.1	850	0.76	ND	ND
			Largemouth bass	35.1	692	0.94	ND	ND
			Largemouth bass	33	574	0.82	ND	ND
			Largemouth bass	33.8	704	0.75	ND	ND
			Largemouth bass	33	525	0.68	ND	ND
			Largemouth bass	26.4	253	0.44	ND	ND
			Largemouth bass	22.5	155	0.35	ND	ND
			Redear sunfish	20.9	187	0.19	ND	ND
			White catfish	38	768	0.64	ND	ND
			White catfish	35	588	0.67	ND	ND
			White catfish	36.2	610	0.39	ND	ND
			White catfish	33.1	518	0.67	ND	ND
			White catfish	33.2	408	0.31	ND	ND
		07/06/1995	*Bowfin*	51.1	110	0.85	—	—
			Bowfin	53	1200	0.84	—	—
			Bowfin	54.5	1300	0.85	—	—
			Bowfin	53.3	1300	0.84	—	—
			Bowfin	54.1	1200	0.98	—	—
			Bowfin	69.5	2800	2.4	—	—
			Bowfin	58.1	1700	1.2	—	—
			Bowfin	67.3	2400	2.2	—	—
03-02-10								
Cashie River at Windsor	Bertie	07/21/1999	*Bowfin*	54.5	1426	1.5	ND	ND
			Bowfin	53	1495	1.5	ND	ND
			Bowfin	53	1468	1.3	ND	ND
			Bowfin	50.5	1239	1.0	ND	ND
			Bowfin	41	663	0.69	ND	ND
			Bowfin	41.5	649	0.67	ND	ND
			Bluegill	22.1	202	0.68	ND	ND
			Bluegill	16.8	205	0.31	ND	ND
			Bluegill	15.5	78	0.20	ND	ND
			Black crappie	22.1	183.5	0.45	ND	ND
			Black crappie	19.9	118	0.24	ND	ND
			Brown bullhead	37.5	694.3	0.17	ND	ND
			Chain pickerel	39.6	435	0.80	ND	ND
			Largemouth bass	50.7	2201	1.4	ND	ND
			Largemouth bass	51.5	2185	1.9	ND	ND
			Largemouth bass	42	1088	0.64	ND	ND
			Largemouth bass	33.7	503	1.1	ND	ND
			Largemouth bass	29	350	0.58	ND	ND
			Largemouth bass	30.1	420	0.44	ND	ND
			Largemouth bass	27	285	0.42	ND	ND
			Largemouth bass	29.8	325	0.65	ND	ND
			Largemouth bass	27.4	279	0.44	ND	ND
			Largemouth bass	25.1	219	0.49	ND	ND
			Yellow bullhead	32.3	498	0.56	ND	ND

[1] ND = non-detect; detection level for arsenic = 1.0 µg/g and for cadmium = 0.1 µg/g.

Table A-II-7 Wet Weight Concentrations of PCBs in Fish Tissue from John H. Kerr Reservoir at the Mouth of Nutbush Creek, Vance County (1999)

Date Sampled	Species	Total Length (mm)	Weight (g)	PCB (µg/g)[1]
01/28/1999	*Striped bass*	467	---	ND
01/28/1999	*Striped bass*	482	---	ND
01/28/1999	*Striped bass*	425	---	ND
01/28/1999	*Striped bass*	732	---	ND
01/28/1999	*Striped bass*	410	---	ND
01/28/1999	*Striped bass*	771	---	ND
01/28/1999	*Striped bass*	650	---	ND
01/28/1999	*Striped bass*	446	---	ND
01/28/1999	*Striped bass*	670	---	ND
01/28/1999	*Striped bass*	417	---	ND
01/28/1999	*Striped bass*	443	---	ND
01/28/1999	*Striped bass*	748	---	ND
01/28/1999	*Striped bass*	395	---	ND
01/28/1999	*Striped bass*	424	---	ND
01/28/1999	*Striped bass*	701	---	ND
01/28/1999	*Striped bass*	722	---	ND
01/28/1999	*Striped bass*	445	---	ND
01/28/1999	*Striped bass*	782	---	0.162
01/28/1999	*Striped bass*	700	---	0.222
05/20/1999	*Largemouth bass*	465	1470	ND
05/20/1999	*Largemouth bass*	420	1121	ND
05/20/1999	*Largemouth bass*	438	984	ND
05/20/1999	*Largemouth bass*	380	671	ND
05/20/1999	*Largemouth bass*	385	767	ND

[1] ND = not detected; detection level was 0.125 µg/g.

Lakes Assessments

Numerical indices are often used to evaluate the trophic state of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey. The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), Secchi depth (SD in inches), and chlorophyll a (CHL in µg/L). Lakewide means for these parameters are used to produce a NCTSI score for each lake, using the equations:

TONScore = ((Log (TON) + 0.45)/0.24)*0.90

TPScore = ((Log (TP) + 1.55)/0.35)*0.92

SDScore = ((Log (SD) – 1.73)/0.35)*-0.82

CHLScore = ((Log (CHL) – 1.00)/0.48)*0.83

NCTSI = TONScore + TPScore + SDScore + CHLScore

In general, NCTSI scores relate to trophic classifications (Table A-II-8). When scores border between classes, best professional judgment is used to assign an appropriate classification. NCTSI scores may be skewed by highly colored water typical of dystrophic lakes. Some variation in the trophic state of a lake between years is not unusual because of the potential variability of data collections which usually involve sampling a limited number of times during the growing season.

Table A-II-8 Lakes classification criteria

NCTSI Score	Trophic Classification
< -2.0	Oligotrophic
-2.0 – 0.0	Mestrophic
0.0 – 5.0	Eutrophic
> 5.0	Hypereurtrophic

Appendix III

Use Support Methodology
and
Use Support Ratings

Multiple-Category Use Support Methods

DRAFT June 4, 2001

A. Introduction to Use Support

Surface waters are classified according to their best intended uses. Determining how well a waterbody supports its uses (*use support* status) is an important method of interpreting water quality data and assessing water quality.

Surface waters are rated *fully supporting* (FS), *partially supporting* (PS) or *not supporting* (NS). The terms refer to whether the classified uses of the water (i.e., aquatic life protection, recreation and water supply) are being met. For example, waters classified for fishing and secondary contact recreation (Class C for freshwater or SC for saltwater) are rated FS if data used to determine use support did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as PS or NS, depending on the degree of degradation. Waters rated PS or NS are considered to be impaired. Waters lacking data, or having inconclusive data, are listed as not rated (NR). More specific methods are presented in Part C of this appendix.

Historically, the non-impaired category was subdivided into fully supporting and fully supporting but threatened (ST). ST was used to identify waters that were fully supporting but had some notable water quality concerns and could represent constant, degrading or improving conditions. North Carolina's past use of ST was very different from that of the US Environmental Protection Agency (EPA), which uses it to identify waters that demonstrate declining water quality (EPA Guidelines for Preparation of the Comprehensive State Water Quality Assessments [305(b) Reports] and Electronic Updates, 1997). Given the difference between the EPA and North Carolina definitions of ST and the resulting confusion that arises from this difference, North Carolina no longer subdivides the non-impaired category. However, these waters and the specific water quality concerns remain identified in the basin plans so that data, management and the need to address the identified concerns are not lost.

B. Interpretation of Data and Information

Data used in the use support assessments include biological data, chemical/physical data, lakes assessment data, fish consumption advisories from the NC Department of Health and Human Services, and swimming advisories and shellfish sanitation surveys from the NC Division of Environmental Health (as appropriate). Available land cover and land use information is also used, along with water supply reports from regional water treatment plant consultants.

Although there is a general procedure for analyzing the data and information for determining use support ratings, each waterbody is reviewed individually, and best professional judgment is applied during these determinations. Assessments are made on either a monitored (M) or evaluated (E) basis depending on the level of information available. Refer to Part E for more information on the basis of assessments.

When interpreting the use support ratings, it is important to understand its associated limitations and degree of uncertainty. The assessments are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Rather, the intent of use support assessments is

to gain an overall picture of water quality, to describe how well surface waters support the uses for which they were classified, and to document the potential contribution made by different pollution sources.

C. Assessment Methodology

Beginning in 2000 with the *Roanoke River Basinwide Water Quality Plan*, DWQ assesses ecosystem health and human health risk through several use support categories. Six categories are used to assess this approach: aquatic life and secondary recreation, fish consumption, shellfish harvesting, primary recreation, water supply and "other" uses. These categories are tied to the primary classifications applied to NC rivers and streams. A single water could have more than one use support rating corresponding to one or more of the multiple use support categories, as shown in the table below. For many waters, a use support category will not be applicable (N/A) to the best use classification of that water (e.g., swimming is not a best use of a Class C water). A full description of the stream classifications is available in the DWQ document titled: *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina*.

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

Many types of information are used to determine use support ratings and to identify causes and sources of use support impairment. A use support data file is maintained for each of the 17 river basins. In these files, stream segments are listed as individual records. All existing data pertaining to a stream segment are entered into its record. The following describes the data and methodologies used to make use support assessments for the surface water classifications (described in Section A, Chapter 3) using the six use support categories. These methods will continue to be refined, as additional information becomes available.

Aquatic Life and Secondary Recreation Use Support

The aquatic life and secondary recreation use support category is an ecosystem approach to assess whether aquatic life (benthic macroinvertebrates and fish) can live in and reproduce in the waters of the state and whether waters support secondary recreation (i.e., wading, boating and minimal human body contact with water). This category is applied to all waters of the state. Biological data, ambient monitoring data and NPDES discharger data are all considered in

assessing the aquatic life and secondary recreation use support category. The following is a description of each data type and methods used to assess how well a water is meeting the criteria for aquatic life and secondary recreation protection.

Biological Data

There are two main types of biological data: benthic marcoinvertebrates and fish community. Where recent data for both benthic macroinvertebrates and fish communities are available, both are evaluated in assessing use support. It is important to note that where both ambient data and biological data are available, biological data are given greater weight.

Benthic Macroinvertebrate Bioclassification

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic macroinvertebrate sample based on the number of taxa present in the pollution intolerant aquatic insects groups of *Ephemeroptera, Plecoptera* and *Trichoptera* (EPTs) and the Biotic Index (BI), which summarizes tolerance data for all taxa in each collection. The benthos bioclassifications are translated to use support ratings according to the following scheme:

Bioclassification	Use Support Rating
Excellent	Fully Supporting (FS)
Good	Fully Supporting (FS)
Good-Fair	Fully Supporting (FS)
Fair	Partially Supporting (PS)
Poor	Not Supporting (NS)

Due to the increased emphasis put on Fair or Poor bioclassifications and the borderline nature of some bioclassifications, sites should be resampled within 12-24 months after a Fair rating is obtained in 1999 and beyond, if this Fair rating will result in a lower use support rating or if data are from a site never sampled before. This resampling will be done to validate the Fair bioclassification. Such sites will not be given a use support rating until the second sample is obtained. The table below shows how a final use support rating is obtained for sites that are resampled.

New Benthic Macroinvertebrate Classifications (1999 and Beyond) and Data Causing a Decline in Use Support Ratings				
Pre-1999 Bioclassification	**1st sample Bioclassification**	**Draft Use Support Rating**	**2nd sample Bioclassification**	**Final Use Support Rating**
N/A	Fair	NR; resample	Good-Fair, Good or Excellent	FS
N/A	Fair	NR; resample	Fair	PS
N/A	Fair	NR; resample	Poor	NS
N/A	Poor	NS	N/A	NS
Good-Fair, Good or Excellent	Fair	NR; resample	Good-Fair, Good or Excellent	FS
Good-Fair, Good or Excellent	Fair	NR; resample	Fair	PS
Good-Fair, Good or Excellent	Fair	NR; resample	Poor	NS
Good-Fair, Good or Excellent	Poor	NS	N/A	NS

N/A – Not Applicable NR = Not Rated

The use of benthic macroinvertebrate data can be limited in some waters. The accumulation of swamp stream data over nearly a decade suggests that not all swamp streams support similar fauna. The development of swamp stream criteria is complex, and one set of criteria is likely not appropriate for all swamp streams. Benthic macroinvertebrate data will not be used in waters characterized or classified by DWQ as swamp waters until the biological rating criteria for these waters can be used with confidence.

Benthic macroinvertebrate data are not used to develop use support ratings for estuarine waters because the data have not been found to be suitable for use support assessment due to the influence of salinity and bottom substrate on the benthic community structure and the difficulty in determining the aerial extent of a rating from an estuarine macroinvertebrate site.

Benthic macroinvertebrate data are use to provide bioclassifications for high elevation trout streams. These benthos data, while not a direct measure of the trout population, are a robust measure of stream integrity. Loss of canopy, increase in stream temperature, increased nutrients, toxicity and increased sedimentation will affect the benthos and fish community. For these reasons, the benthos bioclassifications provide a valuable assessment of the integrity of trout waters.

Fish Community Bioclassification

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 index incorporates information about species richness and composition, indicator species, trophic function, abundance and condition, and reproductive function. The index is translated to use support rating according to the following scheme:

NCIBI	Use Support Rating
Excellent	Fully Supporting (FS)
Good	Fully Supporting (FS)
Good-Fair	Fully Supporting (FS)
Fair	Partially Supporting (PS)
Poor	Not Supporting (NS)

The NCIBI was recently revised by DWQ (NCDENR, 2001). Currently, the focus of using and applying the NCIBI is restricted to wadeable streams that can be sampled by a crew of four persons. Infrequently, larger wadeable streams can be sampled if there is a crew of six persons. The bioclassifications and criteria have also been recalibrated against regional reference site data (BAU, 2000a, 2000b and 2001).

Criteria and ratings are applicable only to wadeable streams in the following river basins: Broad, Catawba, Savannah, Yadkin-Pee Dee, Cape Fear, Neuse, Roanoke, Tar-Pamilco, French Broad, Hiwassee, Little Tennessee, New and Watauga. In the Cape Fear, Neuse, Roanoke and Tar River basins, the criteria and ratings are only applicable to streams in the piedmont portion of these basins. The definition of the "piedmont" for these four river basins is based upon a map of North Carolina watersheds (Fels, 1997). Specifically:

- In the Cape Fear River basin -- except for the streams draining the Sandhills in Moore, Lee and Harnett counties; the entire basin upstream of Lillington, NC.
- In the Neuse River basin -- the entire basin above Smithfield and Wilson, NC, except for the south and southwest portions of Johnston County and the 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, NC, except for the lower southeastern one-half of Halifax County and the extreme eastern portion of Nash County.

Criteria and ratings 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, cold water 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 non-wadeable and large streams and rivers throughout the state.

New Fish Community Classifications (1999 and Beyond) and Data Causing a Decline in Use Support Ratings				
Pre-1999 Bioclassification	**1st sample Bioclassification**	**Draft Use Support Rating**	**2nd sample Bioclassification**	**Final Use Support Rating**
N/A	Fair	NR; resample	Good-Fair, Good or Excellent	FS
N/A	Fair	NR; resample	Fair	PS
N/A	Fair	NR; resample	Poor	NS
N/A	Poor	NS	N/A	NS
Good-Fair, Good or Excellent	Fair	NR; resample	Good-Fair, Good or Excellent	FS
Good-Fair, Good or Excellent	Fair	NR; resample	Fair	PS
Good-Fair, Good or Excellent	Fair	NR; resample	Poor	NS
Good-Fair, Good or Excellent	Poor	NS	N/A	NS

N/A = Not Applicable; NR = Not Rated; FS = Fully Supporting, PS = Partially Supporting, and NS = Not Supporting.

Ambient Monitoring Data

Chemical/physical water quality data are collected through the DWQ Ambient Monitoring System. These data are downloaded from the ambient database, the Surface Water Information Management System, for analysis. Total number of samples and percent of samples exceeding the NC standards are used for use support ratings along with other data or alone when other data are not available. Where both ambient data and biological data are available, biological data are given greater weight.

When reviewing ambient data, a five-year window of data that ends on August 31 of the year of biological sampling is used. For example, if a basin is sampled in 2000, then the five-year window for the basin would be September 1, 1995 to August 31, 2000. Selected ambient parameters are used to assess aquatic life/secondary recreation use support. These parameters include NH_3, dissolved oxygen, pH, Cl, As, Cd, Cr, Ni and Pb. These parameters are measured against standards for a minimum of ten samples as follows:

Standards Violation	Rating
Criterion exceeded ≤10%	Fully Supporting
Criterion exceeded 11-25%	Partially Supporting
Criterion exceeded >25%	Not Supporting

Data for copper, iron and zinc are not used according to the percent criterion exceeded scheme outlined above. These metals have action level standards because they are generally not bioaccumulative and have variable toxicity to aquatic life depending on chemical form, solubility and stream characteristics. In order for an action level standard to be violated, there must be a toxicological test that documents an impact on a sensitive aquatic organism. The action level standard is used to screen waters for potential problems with copper, iron and zinc.

Metals data for Cu and Fe are screened at the 85th percentile of five years of ambient data ending on August 31 of the year of biological sampling. Sites, other than estuarine and swamp waters, with an 85th percentile of ≥20 µg/l of Cu and/or ≥2000 µg/l of Fe are identified and flagged for instream chronic toxicity testing by DWQ. Chronic toxicity testing in estuarine and swamp waters is not ecologically meaningful. Criteria are still being developed for zinc. If a stream does not have biological data that would deem a FS rating, then the stream can be rated PS or NS for aquatic life if instream chronic toxicity is found. Criteria for evaluating instream chronic toxicity are three chronic pass/fail tests over three months using *Ceriodaphnia*. Three fails result in a NS rating, and two fails result in a PS rating.

It is important to note that some waters may exhibit characteristics outside the appropriate standards due to natural conditions (e.g., many swamp waters are characterized by low pH and dissolved oxygen). These natural conditions do not constitute a violation of water quality standards.

NPDES Discharger Data

Aquatic Toxicity Data

For facilities that perform Whole Effluent Toxicity (WET) tests per state NPDES discharge permit requirements, a review of the results of a five-year window of data that ends on August 31 of the year of biological sampling is used. For example, if a basin is sampled in 2000, then the five-year window for the basin would be September 1, 1995 to August 31, 2000. If a stream with a WET test facility has not been sampled for instream chronic toxicity, biological community data or has no ambient data, and that facility has ≥3 fails in the most recent 2 years, the stream is not rated. If failures continue, DWQ will work with the facility to correct the failures and assess stream impacts before the next basin sampling cycle begins with either a biological survey or instream chronic toxicity testing, if possible.

Discharge Effluent Data

NPDES effluent data are reviewed by analyzing monthly averages of water quality parameters over a two-year period (date ending on August 31 of the year of biological sampling). Prior to May 31, 2000, facilities are screened for criterion 40% in excess of state standards for conventional pollutant limitations or 20% in excess of state standards for toxic pollutants for two or more months during two consecutive quarter review periods or chronic violations of either conventional or toxic pollutant limitations for four or more months during 2 consecutive quarter review periods. After May 31, 2000, facilities are screened for criterion 20% in excess of state standards for both conventional and toxic pollutants for two or more months during two consecutive quarter review periods or chronic violations of either conventional or toxic pollutant limitations for four or more months during 2 consecutive quarter review periods. Streams with discharges that are in excess of permit limits will not be rated if no biological or ambient monitoring data are available. Therefore, streams will not be rated PS or NS based on effluent data alone. Appropriate DWQ staff will be given a list of these facilities for follow-up.

In special situations, where there are currently insufficient biological data available, the basinwide planner will make a request of the DWQ Environmental Sciences Branch to determine whether a biological survey is appropriate. If a biological survey is appropriate, the stream

rating will be determined by the bioclassification resulting from the survey. If a biological survey is not appropriate, then the stream will be given a NR rating.

Problem Parameters

Where an ambient parameter is identified as a potential concern, the parameter is listed in the DWQ database and use support summary table. Where habitat degradation is identified by DWQ biologists based on site visits, it is listed and attempts are made to identify the type of habitat degradation (e.g., sedimentation, loss of woody habitat, loss of pools, loss of riffles, channelization, lack of riparian vegetation, streambed scour and bank erosion). Habitat evaluation methods are being developed to better identify specific types of habitat degradation.

Sources

General nonpoint sources (NP) and point sources (P) of pollution are identified where there is sufficient information.

Basis of Assessment

FS ratings are extrapolated up tributaries from monitored streams when no problematic dischargers or change in land use/cover are identified. The FS rating may be applied to unmonitored tributaries where there is little land disturbance (e.g., national forests). Problem parameters or sources (except general NPS) are not applied to unmonitored tributaries. PS or NS ratings are not extrapolated to unmonitored tributaries. Refer to Part E for more information.

Fish Consumption Use Support

The fish consumption use support category is a human health approach to assess whether humans can safely consume fish from a water. This use support category is applied to all waters of the state. The use support rating is assigned using fish consumption advisories issued by the NC Department of Health and Human Services.

If a limited fish consumption advisory is posted at the time of use support assessment, the water is rated PS. If a no consumption advisory is posted at the time of use support assessment, the water is rated NS. The current statewide fish consumption advisory for bowfin due to elevated levels of mercury in fish tissue is an exception. For this reason, the fish consumption use support rating for all waters of the state is PS. However, it is recognized that bowfin only live and reproduce in waters of the piedmont and coastal plain. In order to separate out other fish consumption advisories and to identify actual bowfin populations with high levels of mercury, only waters with fish tissue monitoring data are presented on the use support maps and in the use support summary tables. A review of the present methods for assessing the fish consumption use support category is being conducted, and methods could be modified to take in account fish tissue and fish population data.

Only those waters that have been monitored for fish tissue and do not have an advisory are rated FS. Only waters sampled from 1989 on are considered, because these waters were sampled using more rigorous methods than those sampled before this date. All waters not monitored or evaluated and without advisories are not rated.

Primary Recreation Use Support

In addition to the use support categories applicable to Class C and SC waters, the primary recreation use support category will be assessed for all Class B, Class SA and Class SB waters where data are available. This use support category is a human health approach to assess whether waters support primary recreation activities such as swimming, water-skiing, skin diving, and similar uses involving human body contact in an organized or frequent basis. The use support rating is based on swimming advisories issued by local health departments and by the NC Division of Environmental Health (DEH) beach monitoring program.

Freshwaters

Fecal coliform bacteria data are used to assess Class B waters. Each January, the geometric mean for ambient stations in Class B waters for the prior sampling year is obtained and a screen is conducted for waters with geometric means >200 colonies per 100 ml. Monitored Class B waters are rated FS if the geometric mean is ≤200 colonies per 100 ml. If the geometric mean is >200 colonies per 100 ml during the past year, fecal coliform bacteria are noted as a problem parameter, and a request is made of the DWQ regional office to sample this water 5 times/30 days in June during non-runoff events, if possible. If this 5 times/30-day monitoring, as required to assess the NC standard, indicates a geometric mean above 200 colonies per 100 ml, then the data are sent to DEH for consideration of posting swimming advisories. The DWQ regional office should continue to sample the stream 5 times/30 days during the months of July and August and send the data to DEH. Because North Carolina's fecal coliform bacteria standard is 200 colonies per 100 ml for the geometric mean of *five samples taken in a thirty-day period*, fecal coliform bacteria are listed as a cause of impairment for the 303(d) list only when additional sampling has determined that the standard is being exceeded.

If a water is posted with an advisory for at least two months in the past five years ending on August 31 of the year of biological sampling, it is rated as PS unless DEH staff believes that the cause of fecal problems is not persistent. Those waters posted as "Do Not Swim" for more than two months in the past five years are rated NS. Class B waters without fecal or advisory data are not rated.

DWQ attempts to determine if there are any inland swimming areas monitored by county or local health departments. County or local health departments are asked to list those waters with swimming advisories posted for at least two months in the past five years ending on August 31 of the year of biological sampling.

Estuarine waters

DEH fecal coliform data are used to assess estuarine (SA and SB) waters. Each January, DEH submits a letter to DWQ stating which coastal waters were posted with an advisory reporting an increased risk from swimming during the prior year. Those Class SA or SB waters with an advisory for at least two months in the past five years ending on August 31 of the year of biological sampling are rated PS, unless DEH staff believes that the cause of fecal problems is not persistent. Those waters posted as "Do Not Swim" for more than two months in the past five years are rated NS. If DEH has no data on a water, that water will not be rated. If ambient data show fecal coliform bacteria geometric mean of >200 colonies per 100 ml, then a request is

made of the DWQ regional office to sample this water 5 times/30 days in June during non-runoff events, if possible. If this 5 times/30-day monitoring, as required to assess the NC standard, indicates a geometric mean above 200 colonies per 100 ml, then the data are sent to DEH for consideration of posting swimming advisories. The DWQ regional office should continue to sample the water 5 times/30 days during the months of July and August and send the data to DEH. Because North Carolina's fecal coliform bacteria standard is 200 colonies per 100 ml for the geometric mean of *five samples taken in a thirty-day period*, fecal coliform bacteria are listed as a cause of impairment for the 303(d) list only when additional sampling has determined that the standard is being exceeded.

Water Supply Use Support

This use support category is used to assess all Class WS waters. The water supply use support category is a human health approach to assess whether a water can be safely consumed after adequate treatment. Most drinking water supplies in NC are drawn from human-made reservoirs that often have multiple uses.

Water supply use support is assessed using information from the seven regional water treatment plant (WTP) consultants. Each January, the WTP consultants will submit a spreadsheet listing each closure and water intake switch-over for every water treatment plant in their region. This spreadsheet will describe the length and time of the event, contact information for the WTP, and the cause of the closure or switch.

Use support for water supply will be fine-tuned to determine what closures/switches were due to water quality concerns. Those closures/switches due to water quantity and reservoir turnovers will not be considered for use support. The frequency and duration of closures/switches due to water quality concerns are considered when assessing use support. In general, North Carolina's surface water supplies are in good condition and most, if not all, will be rated FS. Specific criteria for rating waters PS or NS are yet to be determined.

Other Uses: All Waters in the State

This category of use will be assessed infrequently but could be applied to any water in the state. Examples of uses that fall into this category are aesthetics and industrial and agricultural water supply. This category allows for the assessment of any use that is not considered by aquatic life and secondary recreation, primary recreation, fish consumption, shellfish harvesting or water supply.

D. Use of Outside Data

DWQ actively solicits outside data and information in October prior to the basinwide sampling year. The solicitation allows for approximately 60 days to submit data. 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 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 draft 2000 303(d) report and shown in the table below.

Level 1 data can be used in the same fashion as DWQ data to determine use support ratings. Level 2 or Level 3 data may be used to help identify causes of pollution and problem parameters. They may also be used to limit the extrapolation of use support ratings up or down a stream 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

E. Monitored vs. Evaluated

Assessments are made on either a monitored (M) or evaluated (E) basis depending on the level of information that was available. Because a monitored rating is based on the most recent five-year window and site-specific data, it is treated with more confidence than an evaluated rating.

FS ratings are extrapolated up tributaries to monitored streams where there are no dischargers with permit violations or changes in land use/cover. Problem parameters or sources (except general NPS) are not applied to unmonitored tributaries. PS or NS ratings are not applied to unmonitored tributaries. Refer to the following summary for the basis of assigning use support ratings.

Summary of Basis for Assigning Use Support Ratings to Freshwater Streams

Overall Basis	Specific Basis	Description
Monitored	Monitored (M)	Monitored stream segments[a] with data[b] ≤5[c] years old.
	Monitored/Evaluated (ME)	Stream segment[a] is unmonitored, but is assigned a use support rating based on another segment of same stream for which data[b] ≤5[c] years old are available.
Evaluated	Evaluated (E)	Unmonitored streams that are direct or indirect tributaries to monitored stream segments rated FS. Must share similar land use to the monitored stream segment.
	Evaluated/Old Data (ED)	Monitored stream segments[a] with available data[b] >5[c] years old.
Not Rated	Not Rated (NR)	Insufficient or no data available to determine use support. Includes unmonitored streams that are direct or indirect tributaries to stream segments rated PS or NS.

a) A stream segment is a stream, or a portion thereof, listed in the Classifications and Water Quality Standards for a river basin. Each segment is assigned a unique identification number (index number).
b) Major data sources include benthic macroinvertebrate bioclassifications and chemical/physical monitoring data.
c) From the year that basin monitoring was done.

F. Nutrient Enrichment Issues

The complex and dynamic ecosystem interactions that link chemical and physical water quality parameters and biological response variables must be considered when evaluating use support. In general, North Carolina assesses use support by determining if a water's *uses*, such as water supply, fishing and recreation, are met. Violations of water quality standards in lakes or estuaries are not equated with use impairment unless uses are not met. In following this approach, use support for aquatic life propagation, maintenance of biological integrity, recreation and water supply can be holistically evaluated.

One of the main causes of impacts to lakes and estuaries is nutrient enrichment, or eutrophication. Several water quality variables may help to describe the level of eutrophication. These include pH, chlorophyll *a*, dissolved oxygen, phosphorus, nitrogen, turbidity, total dissolved gases and other quantitative indicators, some of which have specific water quality standards. It is generally agreed that excessive amounts of nitrogen and phosphorus are the principal culprits in eutrophication related use impairment. These variables are important concerns; however, climate, hydrology and biological response factors (chlorophyll, phytoplankton, fish kills, etc.) are also essential to evaluate because they may control the frequency of episodes related to potential use impairment. In addition, many of North Carolina's lakes are human-made reservoirs that do not mimic natural systems.

North Carolina does not determine eutrophication related use impairment with the quantitative assessment of an individual water quality variable (i.e., chlorophyll *a*). Likewise, North Carolina does not depend on a fixed index composed of several water quality variables, which does not have the flexibility to adapt to numerous hydrological situations, to determine use impairment. Instead, the weight of evidence approach is most appropriate to determine use support in terms of nutrient enrichment in lakes. This approach can be flexibly applied depending on the amount and quality of available information. The approach uses the following sources of information:

- multiple quantitative water quality variables (e.g., dissolved oxygen, chlorophyll *a*)
- third party reports
- analysis of water quality complaints
- algal bloom reports
- macrophyte observations
- reports from water treatment plant operators
- reports from lake associations
- fish kill reports
- taste and odor observations
- aesthetic complaints
- frequency of noxious algal activity
- reports/observations of the NC Wildlife Resources Commission, NC Division of Marine Fisheries and other agencies

References

North Carolina Department of Environment & Natural Resources (NCDENR). Division of Water Quality (DWQ). Environmental Sciences Branch. Biological Assessment Unit. 2001a. *Fish Community Metric Re-Calibration and Biocriteria Development for the Western and Northern Mountains (French Broad, Hiwassee, Little Tennessee, New and Watauga River Basins)*. Raleigh.

____. 2001b. *Standard Operating Procedure. Biological Monitoring. Stream Fish Community Assessment and Fish Tissue.* Raleigh.

_____. 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. Raleigh.

_____. 2000b. *Fish Community Metric Re-Calibration and Biocriteria Development for the Outer Piedmont (Cape Fear, Neuse, Roanoke and Tar River Basins)*. October 17, 2000. Raleigh.

Fels, J. 1997. *North Carolina Watersheds Map*. North Carolina State University Cooperative Extension Service. Raleigh.

Aquatic Life/Secondary Recreation Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Miles	Rating	Basis	Problem Parameter(s)	Potential Source(s)
DAN RIVER (NC portion)	From North Carolina-Virginia State Line to Big Creek	03-02-01	20.2	FS	M	Turbidity	
DAN RIVER	From Big Creek to US Hwy. 311 in Stokes County	03-02-01	23.5	FS	M		
North Double Creek	From source to Dan River	03-02-01	14.0	FS	M	Habitat degradation	Agriculture
Cascade Creek	From source to backwaters of swimming lake	03-02-01	0.8	FS	M		
Cascade Creek	From backwaters of swimming lake to Dan River	03-02-01	4.3	FS	M		
Snow Creek	From source to Dan River	03-02-01	18.9	FS	M	Habitat degradation	Agriculture
Town Fork Creek	From source to Timmons Cr.	03-02-01	8.0	NS	M	Habitat degradation	Minor Non-municipal Point Source, Agriculture, Hydromodification
Neatman Creek	From source to Town Fork Creek	03-02-01	12.7	FS	M	Habitat degradation	
Belews Creek (Kernersville Lake)	From a point 0.5 mile upstream of backwaters of Kernersville Lake to Town of Kernersville Water Supply Dam	03-02-01	0.5	FS	M		
Mayo River	From North Carolina-Virginia State Line to a point 0.6 mile downstream of Hickory Creek	03-02-02	3.6	FS	M		
Mayo River	From a point 0.6 mile downstream of Hickory Creek to a point 0.9 mile downstream of Avalon Dam	03-02-02	10.8	FS	ME		
Mayo River	From a point 0.9 mile downstream from Avalon Dam to dam at Mayodan Water Supply Intake	03-02-02	0.5	FS	ME		
Mayo River	From dam at Mayodan Water Supply Intake to Dan River	03-02-02	2.4	FS	M	Habitat degradation	Urban Runoff/Storm Sewers, Land Development

Aquatic Life/Secondary Recreation Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Miles	Rating	Basis	Problem Parameter(s)	Potential Source(s)
DAN RIVER	From a point 0.7 mile upstream of Jacobs Creek to a point 0.8 mile downstream of Matrimony Creek	03-02-03	14.2	PS	M	Turbidity	Instream Mining, Agriculture, Land Development
DAN RIVER (NC portion)	From Mill Branch to last crossing of North Carolina-Virginia State Line	03-02-03	7.5	FS	M	Turbidity	
Smith River	From North Carolina-Virginia State Line to a point 0.8 mile downstream of Rockingham County SR 1714 (Aiken Road)	03-02-03	2.8	PS	ME	Habitat degradation	Sources Outside State Jurisdiction or Borders
Smith River	From a point 0.8 mile downstream of Rockingham County SR 1714 (Aiken Road) to Fieldcrest Mills Water Supply Intake	03-02-03	0.5	PS	ME	Habitat degradation	Sources Outside State Jurisdiction or Borders, Urban Runoff/Storm Sewers
Smith River	From Fieldcrest Mills Water Supply Intake to Dan River	03-02-03	1.8	PS	M	Habitat degradation	Sources Outside State Jurisdiction or Borders, Urban Runoff/Storm Sewers
Country Line Creek	From a point 1.0 mile downstream of Nats Fork to dam at Farmer Lake (Town of Yanceyville water supply intake located 1.8 mile upstream of N.C. Hwy. 62)	03-02-04	3.5	FS	M	Habitat degradation	Land Development, Silviculture
Hyco River, including Hyco Lake	From source in Hyco Lake to dam of Hyco Lake, including tributary arms	03-02-05	0.2	FS	M		
Hyco Creek (North Hyco Creek)	From source to Hyco Lake, Hyco River	03-02-05	16.8	FS	M	Habitat degradation	Land Development, Silviculture
Hyco River	From dam of Hyco Lake to North Carolina-Virginia State Line, including all portions in North Carolina	03-02-05	6.8	FS	M		

Aquatic Life/Secondary Recreation Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Miles	Rating	Basis	Problem Parameter(s)	Potential Source(s)
Marlowe Creek	From source to Storys Creek	03-02-05	10.9	PS	M	Unknown toxicity Habitat degradation	Minor Industrial Point Source Municipal Collection System Overflows, Urban Runoff/Storm Sewers, Land Development
Mayo Creek (Maho Creek) (Mayo Reservoir)	From source to dam of Mayo Reservoir	03-02-05	6.5	FS	M		
Grassy Creek (Grass Creek)	From source to John H. Kerr Reservoir at Granville County SR 1431	03-02-06	18.3	FS	M		
Island Creek (Island Creek Reservoir)	From source to North Carolina-Virginia State Line	03-02-06	6.4	FS	M		
Nutbush Creek (Including Nutbush Cr Arm of John H. Kerr Reservoir)	From source to Crooked Run	03-02-06	4.6	PS	M	Unknown toxicity Habitat degradation Nutrients	Major Municipal Point Source Municipal Collection System Overflows, Urban Runoff/Storm Sewers, Land Development Source Unknown
Nutbush Creek Arm of John H. Kerr Reservoir	From Crooked Run to North Carolina-Virginia State Line	03-02-06		FS	M		
Smith Creek	From source to North Carolina-Virginia State Line	03-02-07	10.4	PS	M	Habitat degradation	Agriculture
ROANOKE RIVER (Lake Gaston)	From North Carolina-Virginia State Line to a line across Lake Gaston following the Warren-Northampton County Line	03-02-07	0.1	FS	M		
Sixpound Creek	From source to Lake Gaston, Roanoke River	03-02-07	6.3	FS	M		
ROANOKE RIVER (Lake Gaston)	From a line across Lake Gaston following the Warren-Northampton County Line to a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam	03-02-07	5.2	FS	M	Aquatic Weeds	

Aquatic Life/Secondary Recreation Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Miles	Rating	Basis	Problem Parameter(s)	Potential Source(s)
ROANOKE RIVER (Roanoke Rapids Lake	From a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam to Roanoke Rapids Dam	03-02-07 03-02-08	4,893 acres	PS	M	Aquatic Weeds	
Deep Creek	From source to a point 0.5 mile upstream of mouth	03-02-08	11.6	NR	M		
ROANOKE RIVER	From Roanoke Rapids Dam to a point 0.6 mile upstream of N.C. Hwy. 48 bridge	03-02-08	1.6	FS	ME		
ROANOKE RIVER	From a point 0.6 mile upstream of N.C. Hwy. 48 bridge to a line across river 50 feet downstream of N.C. Hwy. 48 (City of Roanoke Rapids, Town of Weldon water supply intakes)	03-02-08	1.7	FS	ME		
ROANOKE RIVER	From a line across the river 50 ft downstream of NC Hwy 48 bridge to the confluence of Sandy Run Cr at the Bertie/Northampton/Halifax Co. line	03-02-08	50.1	FS	M		
ROANOKE RIVER	From the confluence of Sandy Run Cr at the Bertie/ Northampton/Halifax Co. line to the 18 mile marker at Jamesville	03-02-08	70.3	FS	M	Habitat degradation	Hydromodification, Erosion and Sedimentation
Quankey Creek	From source to Little Quankey Creek	03-02-08	16.0	NR	M		
Quankey Creek	From Little Quankey Creek to Roanoke River	03-02-08	3.4	PS	M	Habitat degradation	Hydromodification
Occoneechee Creek	From source to Roanoke River	03-02-08	14.6	NR	M		
Conoconnara Swamp	From source to Roanoke River	03-02-08	17.71	NR	M	Habitat degradation	Agriculture

Aquatic Life/Secondary Recreation Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Miles	Rating	Basis	Problem Parameter	Potential Source(s)
Kehukee Swamp (White Millpond)	From source to Roanoke River	03-02-08	10.6	NR	M		
Conoho Creek	From source to Martin Co 1417 below Beaverdam Cr	03-02-09	24.5	NR	M	Habitat degradation	Agriculture
Conoho Creek	From Martin Co 1417 to Roanoke River	03-02-09	7.0	FS	M		
Hardison Mill Creek	From source to Sweetwater Creek	03-02-09	19.9	NR	M	Habitat degradation	Agriculture, Hydromodification
Deep Run Swamp	From source to Gardners Creek	03-02-09	9.4	NR	M	Habitat degradation	Agriculture, Hydromodification
ROANOKE RIVER	From 18 mile marker at Jamesville to Albemarle Sound (Batchelor Bay)	03-02-09	18.3	FS	M		
Welch Creek	From source to Roanoke River	03-02-09	13.3	NR	M		
ALBEMARLE SOUND (Batchelor Bay)	West of a line extending from a point of land 0.3 mile north of mouth of Morgan Swamp in a southerly direction to a point of land on the eastside of the mouth of Roanoke River	03-02-09	2,586 acres	FS	M		
Cashie River	From source to Bertie County SR 1225	03-02-10	15.2	NR	M		
Cashie River	From Bertie County SR 1225 to a point 1 mile upstream from Bertie Co. SR 1500	03-02-10	30.1	NR	M		
Hoggard Mill Creek	From source to Cashie River	03-02-10	7.4	NR	M		
Roquist Creek	From source to Cashie River	03-02-10	26.3	NR	M	Habitat degradation	
Wading Place Creek	From source to Cashie River	03-02-10	7.4	NR	M	Habitat degradation	

Fish Consumption Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis	Problem Parameter
East Belews Creek (East Belews Creek Arm of Belews Lake)	From backwaters of Belews Lake (Forsyth County SR 2140) to Southern Railroad Bridge	30201	B	0.5	PS	M	Fish consumption advisory Statewide Bowfin
Arm of Belews Lake immediately southeast of Belews Lake Dam	Entire Arm	30201	WS-IV&B	3,500 acres	PS	M	Fish consumption advisory Statewide Bowfin
Hyco River, including Hyco Lake below elevation 410	From source in Hyco Lake to dam of Hyco Lake, including tributary arms below elevation 410	30205	WS-V&B	3,750 acres	PS	M	Fish consumption advisory Statewide Bowfin & Selenium
ROANOKE RIVER	From Roanoke Rapids Dam to a point 0.6 mile upstream of N.C. Hwy. 48 bridge	30208	WS-IV	1.6	PS	ME	Fish consumption advisory Statewide Bowfin
ROANOKE RIVER	From a point 0.6 mile upstream of N.C. Hwy. 48 bridge to a line across river 50 feet downstream of N.C. Hwy. 48	30208	WS-IV CA	1.7	PS	ME	Fish consumption advisory Statewide Bowfin
ROANOKE RIVER	From the confluence of Sandy Run Cr at the Bertie/Northampton/Halifax Co. line to the 18 mile marker at Jamesville	30208	C	70.3	PS	M	Fish consumption advisory Statewide Bowfin
ROANOKE RIVER	From a line across the river 50 ft downstream of NC Hwy 48 bridge to the confluence of Sandy Run Cr at the Bertie/Northampton/Halifax Co. line	30208	C	50.1	PS	M	Fish consumption advisory Statewide Bowfin
ROANOKE RIVER	From 18 mile marker at Jamesville to Albemarle Sound (Batchelor Bay)	30209	C Sw	18.3	PS	M	Fish consumption advisory Statewide Bowfin & Dioxin
Welch Creek	From source to Roanoke River	30209	C Sw	13.3	NS	M	Fish consumption advisory Statewide Bowfin & Dioxin
ALBEMARLE SOUND (Batchelor Bay)	West of a line extending from a point of land 0.3 mile north of mouth of Morgan Swamp in a southerly direction to a point of land on the eastside of the mouth of Roanoke River	30209	B Sw		PS	ME	Fish consumption advisory Statewide Bowfin & Dioxin

Fish Consumption Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis	Problem Parameter
Cashie River	From source to Bertie County SR 1225	30210	C Sw	15.2	PS	ME	Fish consumption advisory Statewide Bowfin
Cashie River	From source to Bertie County SR 1225	30210	C Sw	15.2	PS	ME	Fish consumption advisory Statewide Bowfin
Cashie River	From Bertie County SR 1225 to a point 1 mile upstream from Bertie Co. SR 1500	30210	C Sw	30.1	PS	M	Fish consumption advisory Statewide Bowfin
Cashie River	From a point 1.0 mile upstream from Bertie County SR 1500 to the Thoroughfare (The Gut between Cashie and Roanoke Rivers)	30210	B Sw	2.3	PS	ME	Fish consumption advisory Statewide Bowfin
Cashie River	From the Thoroughfare (The Gut between Cashie and Roanoke Rivers) to N.C. Hwy. 45	30209	C Sw	5.8	PS	ME	Fish consumption advisory Statewide Bowfin
Cashie River	From N.C. Hwy. 45 to Albemarle Sound (Batchelor Bay)	30209	B Sw	1.2	PS	ME	Fish consumption advisory Statewide Bowfin

Primary Recreation Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis
Cascade Creek	From source to backwaters of swimming lake	03-02-01	B ORW	0.8	FS	ME
Cascade Creek	From backwaters of swimming lake to Dan River	03-02-01	B	4.3	FS	M
Arm of Belews Lake immediately southeast of Belews Lake Dam (Below elevation 725)	Entire Arm	03-02-01	WS-IV&B	3,500 acres	FS	M
Hyco River, including Hyco Lake below elevation 410	From source in Hyco Lake to dam of Hyco Lake, including tributary arms below elevation 410	03-02-05	WS-V&B	3,750 acres	FS	M
South Hyco Creek (Lake Roxboro)	From backwaters of Lake Roxboro to dam at Lake Roxboro	03-02-05	WS-II&B	3.6	FS	M
Nutbush Creek Arm of John H. Kerr Reservoir	From Crooked Run to North Carolina-Virginia State Line	03-02-06	B	21,700 acres	FS	M
Little Nutbush Creek	From source to Nutbush Creek Arm of John H. Kerr Reservoir	03-02-06	B	1.3	FS	ME
Dodson Creek (Dobson Creek)	From source to Nutbush Creek Arm of John H. Kerr Reservoir	03-02-06	B	0.7	FS	ME
Case Quarry Creek	From source to Nutbush Creek Arm of John H. Kerr Reservoir	03-02-06	B	1.1	FS	ME
Dix Branch (Dicks Creek)	From source to Nutbush Creek Arm of John H. Kerr Reservoir	03-02-06	B	1.0	FS	ME
ROANOKE RIVER (Lake Gaston)	From North Carolina-Virginia State Line to a line across Lake Gaston following the Warren-Northampton County Line	03-02-07	WS-V&B	10,100 acres	FS	M
ROANOKE RIVER (Lake Gaston)	From a line across Lake Gaston following the Warren-Northampton County Line to a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam	03-02-07	WS-IV&B	3,300 acres	FS	M
ROANOKE RIVER (Roanoke Rapids Lake)	From a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam to Roanoke Rapids Dam	03-02-07	WS-IV&B CA	4,893 acres	FS	M
ALBEMARLE SOUND (Batchelor Bay)	West of a line extending from a point of land 0.3 mile north of mouth of Morgan Swamp in a southerly direction to a point of land on the eastside of the mouth of Roanoke River	03-02-09	B Sw	2,586 acres	FS	M

Water Supply Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis
DAN RIVER	From Big Creek to US Hwy. 311 in Stokes County	03-02-01	WS-V	23.5	FS	M
Unnamed Tributary at Camp Sertoma	From source to a point 0.6 mile upstream of Stokes County SR 2011	03-02-01	WS-II	0.3	FS	ME
Unnamed Tributary at Camp Sertoma	From a point 0.6 mile upstream of Stokes County SR 2011 to Camp Sertoma raw water intake (Lat: 36 24’ 02" Long: 80 18’ 25")	03-02-01	WS-II CA	0.6	FS	ME
DAN RIVER	From a point 0.2 mile downstream of Town Fork Creek to a point 0.3 mile upstream of Reed Creek	03-02-01	WS-IV	9.2	FS	M
Eurins Creek	From source to Dan River	03-02-01	WS-IV	5.9	FS	ME
Belews Creek	From source to a point 0.5 mile upstream of backwaters of Kernersville Lake	03-02-01	WS-IV	0.2	FS	ME
Belews Creek (Kernersville Lake)	From a point 0.5 mile upstream of backwaters of Kernersville Lake to Town of Kernersville Water Supply Dam	03-02-01	WS-IV CA	0.5	FS	M
Belews Creek (including Belews Lake below elevation 725)	From a point 1.8 mile downstream of the Forsyth-Stokes County Line to Dan River, excluding the Arm of Belews Lake described below which are classified "WS-IV&B"	03-02-01	WS-IV	0.7	FS	M
West Belews Creek (West Belews Creek Arm of of Belews Lake)	From a point 0.4 mile downstream of Powerplant to Belews Creek	03-02-01	WS-IV	2.0	FS	ME
Arm of Belews Lake immediately southeast of Belews Lake Dam	Entire Arm	03-02-01	WS-IV&B	3,500 acres	FS	M
DAN RIVER	From a point 0.3 mile upstream of Reed Creek to Rockingham County SR 1138 (Madison water supply intake)	03-02-02	WS-IV CA	0.6	FS	M
Reed Creek	From source to a point 0.3 mile upstream of mouth	03-02-02	WS-IV	7.8	FS	ME
Reed Creek	From a point 0.3 mile upstream of mouth to Dan River	03-02-02	WS-IV CA	0.4	FS	ME
DAN RIVER	From Rockingham County SR 1138 to a point 0.7 mile upstream of Jacobs Cr.	03-02-02	WS-V	9.1	FS	M

Water Supply Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis
Mayo River	From North Carolina-Virginia State Line to a point 0.6 mile downstream of Hickory Creek	03-02-02	WS-V	3.6	FS	M
Mayo River	From a point 0.6 mi downstream of Hickory Creek to a point 0.9 mi downstream of Avalon Dam	03-02-02	WS-IV	10.8	FS	M
Pawpaw Creek	From a point 1.3 mile upstream of Rockingham County SR 1360 to Mayo R.	03-02-02	WS-IV	1.8	FS	ME
Means Creek	From source to Mayo River	03-02-02	WS-IV	4.2	FS	ME
Boaz Creek	From source to Mayo River	03-02-02	WS-IV	4.5	FS	ME
Unnamed Tributary near Stoneville	From source to Mayo River	03-02-02	WS-IV	4.3	FS	ME
Mayo River	From a point 0.9 mile downstream from Avalon Dam to dam at Mayodan Water Supply Intake	03-02-02	WS-IV CA	0.5	FS	M
DAN RIVER	From a point 0.7 mile upstream of Jacobs Creek to a point 0.8 mile downstream of Matrimony Creek	03-02-03	WS-IV	14.2	FS	M
Jacobs Creek	From N.C. Hwy. 704 to Dan River	03-02-03	WS-IV	1.8	FS	ME
Massy Creek	From source to Dan River	03-02-03	WS-IV	3.7	FS	ME
Rock House Creek	From Rockingham Countly SR 2381 to Dan River	03-02-03	WS-IV	6.5	FS	ME
Roach Creek	From source to Dan River	03-02-03	WS-IV	5.7	FS	ME
Whetstone Creek	From source to Dan River	03-02-03	WS-IV	2.4	FS	ME
Buffalo Creek	From source to Dan River	03-02-03	WS-IV	10.2	FS	ME
Matrimony Creek (NC portion)	From source to Dan River	03-02-03	WS-IV	11.2	FS	ME
Bear Creek	From source to North Carolina-Virginia State Line	03-02-03	WS-IV	0.8	FS	ME
Jones Branch (Jones Creek)	From North Carolina-Virginia State Line to Matrimony Creek	03-02-03	WS-IV	0.6	FS	ME
Little Matrimony Creek	From source to Matrimony Creek	03-02-03	WS-IV	4.7	FS	ME
Poplar Creek	From North Carolina-Virginia State Line to Matrimony Creek	03-02-03	WS-IV	1.4	FS	ME
Boiling Springs Branch	From source to Matrimony Creek	03-02-03	WS-IV	0.64	FS	ME

Water Supply Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis
DAN RIVER	From a point 0.8 mile downstream of Matrimony Creek to Mill Branch (Town of Eden water supply intake)	03-02-03	WS-IV CA	0.60	FS	M
Mill Branch	From source to Dan River	03-02-03	WS-IV	0.30	FS	ME
Smith River	From North Carolina-Virginia State Line to a point 0.8 mile downstream of Rockingham County SR 1714 (Aiken Road)	03-02-03	WS-IV	2.8	FS	M
Martin Creek	From source to North Carolina-Virginia State Line	03-02-03	WS-IV	1.6	FS	M
Smith River	From a point 0.8 mile downstream of Rockingham County SR 1714 (Aiken Road) to Fieldcrest Mills Water Supply Intake	03-02-03	WS-IV CA	0.5	FS	M
Country Line Creek	From source to a point 1.0 mile downstream of Nats Fork	03-02-04	WS-II	12.0	FS	ME
Hostler Branch	From source to Country Line Creek	03-02-04	WS-II	5.1	FS	ME
Nats Fork	From source to Country Line Creek	03-02-04	WS-II	2.4	FS	ME
Country Line Creek	From a point 1.0 mile downstream of Nats Fork to dam at Farmer Lake	03-02-04	WS-II CA	3.5	FS	M
Fullers Creek	From source to a point 0.8 mile upstream of Yanceyville water supply dam	03-02-04	WS-II	1.0	FS	ME
Fullers Creek	From a point 0.8 mi upstream of Yanceyville water supply dam to Yanceyville water supply dam	03-02-04	WS-II CA	0.6	FS	ME
Hyco River, including Hyco Lake below elevation 410	From source in Hyco Lake to dam of Hyco Lake, including tributary arms below elevation 410	03-02-05	WS-V&B	0.2	FS	M
South Hyco Creek	From source to backwaters of Lake Roxboro	03-02-05	WS-II	5.3	FS	M
Sugartree Creek	From source to South Hyco Creek	03-02-05	WS-II	5.0	FS	ME
South Hyco Creek (Lake Roxboro)	From backwaters of Lake Roxboro to dam at Lake Roxboro	03-02-05	WS-II&B	3.6	FS	M
South Hyco Creek	From dam at Lake Roxboro to a point 0.6 mile downstream of Double Creek	03-02-05	WS-II	4.0	FS	M
Double Creek	From source to South Hyco Creek	03-02-05	WS-II	4.68	FS	ME

Water Supply Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis
Broachs Mill Creek	From source to Double Creek	03-02-05	WS-II	5.52	FS	ME
Snipe Creek	From source to Broachs Mill Creek	03-02-05	WS-II	3.22	FS	ME
South Hyco Creek	From a point 0.6 mile downstream of Double Creek to Hyco Lake, Hyco River (City of Roxboro water supply intake)	03-02-05	WS-II CA	0.75	FS	ME
Storys Creek	From source to a point 0.9 mile downstream of N.C. Hwy. 57	03-02-05	WS-II	3.13	FS	ME
Storys Creek [Roxboro City Lake (Lake Issac Walton)]	From a point 0.9 mile downstream of N.C. Hwy. 57 to Roxboro City Lake Dam	03-02-05	WS-II CA	1.2	FS	M
Satterfield Creek	From source to a point 0.5 mile downstream of N.C. Hwy. 57	03-02-05	WS-II	2.4	FS	ME
Satterfield Creek	From a point 0.5 mile downstream of N.C. Hwy. 57 to Roxboro City Lake, Storys Creek	03-02-05	WS-II CA	0.6	FS	ME
Lick Branch	From source to a point 0.6 mile upstream of mouth	03-02-05	WS-II	0.7	FS	ME
Lick Branch	From a point 0.6 mile upstream of mouth to Roxboro City Lake, Storys Cr.	03-02-05	WS-II CA	0.6	FS	ME
Mayo Creek (Maho Creek) (Mayo Reservoir)	From source to dam of Mayo Reservoir	03-02-05	WS-V	6.5	FS	M
Anderson Swamp Creek (Including Anderson Swamp Creek Arm of John H. Kerr Reservoir)	From source to a point 0.6 mile upstream of Vance County SR 1374	03-02-06	WS-III&B	4.1	FS	ME
Anderson Swamp Creek (Including Anderson Swamp Creek Arm of John H. Kerr Reservoir)	From a point 0.6 mile upstream of Vance County SR 1374 to Mill Creek	03-02-06	WS-III&B CA	0.6	FS	ME
ROANOKE RIVER (Lake Gaston)	From North Carolina-Virginia State Line to a line across Lake Gaston following the Warren-Northampton County Line	03-02-07	WS-V&B	10,100 acres	FS	M
ROANOKE RIVER (Lake Gaston)	From a line across Lake Gaston following the Warren-Northampton County Line to a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam	03-02-07	WS-IV&B	3,300 acres	FS	M

Water Supply Use Support Summary Table – Roanoke River Basin

Name	Description	Subbasin	Classification	Miles	Rating	Basis
Mill Creek	From source to Lake Gaston, Roanoke River	03-02-07	WS-IV	3.0	FS	ME
Poe Creek	From source to Lake Gaston, Roanoke River	03-02-07	WS-IV	2.1	FS	ME
Jimmies Creek (Jimmies Run)	From North Carolina-Virginia State Line to Lake Gaston, Roanoke River	03-02-07	WS-IV	1.1	FS	ME
ROANOKE RIVER (Roanoke Rapids Lake)	From a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam to Roanoke Rapids Dam	03-02-07	WS-IV&B CA	4,893 acres	FS	M
Black Gut Creek	From source to Devils Branch	03-02-08	WS-IV	1.4	FS	ME
Black Gut Creek	From Devils Branch to Roanoke Rapids Lake, Roanoke River	03-02-08	WS-IV CA	1.0	FS	ME
Devils Branch (Double Branch)	From source to Black Gut Creek	03-02-08	WS-IV	2.5	FS	ME
Deep Creek	From source to a point 0.5 mile upstream of mouth	03-02-08	WS-IV	11.6	FS	ME
Deep Creek	From a point 0.5 mile upstream of mouth to Roanoke Rapids Lake, Roanoke River	03-02-08	WS-IV CA	0.6	FS	ME
ROANOKE RIVER	From Roanoke Rapids Dam to a point 0.6 mile upstream of N.C. Hwy. 48 bridge	03-02-08	WS-IV	1.6	FS	ME
ROANOKE RIVER	From a point 0.6 mile upstream of N.C. Hwy. 48 bridge to a line across river 50 feet downstream of N.C. Hwy. 48 (City of Roanoke Rapids, Town of Weldon water supply intakes)	03-02-08	WS-IV CA	1.7	FS	ME

Appendix IV

303(d) Listing
and
Reporting Methodology

303(d) LISTING AND REPORTING REQUIREMENTS

What is the 303(d) List?

Section 303(d) of the Clean Water Act (CWA) requires states to develop a comprehensive public accounting of all impaired waters. North Carolina's list of impaired waters must be submitted to EPA by April 1 of every even year (40 CFR 130.7). The list includes waters impaired by pollutants, such as nitrogen, phosphorus and fecal coliform bacteria, and by pollution, such as hydromodification and habitat degradation. The source of impairment might be from point sources, nonpoint sources or atmospheric deposition. Some sources of impairment exist across state lines. North Carolina lists impaired waters regardless of whether the pollutant or source of pollution is known and whether the pollutant/pollution source(s) can be legally controlled or acted upon by the State of North Carolina. More complete information can be obtained from *North Carolina's Draft 2000 303(d) List* (http://h2o.enr.state.nc.us/mtu/), which can be obtained by calling the Planning Branch of DWQ at (919) 733-5083.

303(d) List Development

Generally, there are three steps to preparing North Carolina's 303(d) list. They are: 1) gathering information about the quality of North Carolina's waters; 2) screening those waters to determine if any are impaired and should be listed; and 3) prioritizing listed waters for TMDL development. The following subsections describe each of these steps in more detail.

Sources of Information

North Carolina considers all practical existing and readily available data and information in preparing the 303(d) list. Sources solicited for "existing and readily available data and information" include, but are not limited to the following:

- The previous 303(d) list.
- Basinwide Water Quality Management Plans and Assessment Reports.
- 305(b) reports.
- 319 nonpoint source pollution assessments.
- Waters where specific fish or shellfish consumption bans and/or advisories are currently in effect.
- Waters for which effluent toxicity test results indicate possible or actual excursions of state water quality standards.
- Waters identified by the state as impaired in its most recent Clean Lakes Assessment.
- Drinking water source water assessments under the Safe Drinking Water Act.
- Trend analyses and predictive models used for determining numeric and narrative water quality standard compliance.
- Data, information and water quality problems reported from local, state or federal agencies, Tribal governments, members of the public and academic institutions.

Listing Criteria

Waters whose use support ratings were not supporting (NS) or partially supporting (PS) based on monitored information in the 305(b) report are considered as initial candidates for the 303(d) list. Waters that were listed on the previously approved 303(d) list are evaluated and automatically included if the use support rating was NS, PS or not rated (NR).

Guidance from EPA on developing the 1998 303(d) lists indicates that impaired waters without an identifiable problem parameter should not be included on the 303(d) list. However, DWQ feels that waters listed in the 305(b) report as impaired for biological reasons, where problem parameters have not been identified, should remain on the 303(d) list. The Clean Water Act states that chemical, physical and biological characteristics of waters shall be restored. The absence of an identified cause of impairment does not mean that the water should not receive attention. Instead, DWQ should resample or initiate more intensive studies to determine why the water is impaired. Thus, biologically impaired waters without an identified cause of impairment are on the draft 2000 303(d) list.

Assigning Priority

North Carolina has developed a TMDL priority ranking scheme that reflects the relative value and benefits that a water provides to the state. The priority ranking system is designed to take into account the severity of the impairment, especially when threats to human health, endangered species or the designated uses of the water are present.

A priority of High, Medium or Low has been assigned to all waters on Parts 1, 4, 5 and 6 of the list (the following section describes these parts in more detail). A high priority is assigned to all waters that are classified as water supplies. A high priority is also automatically assigned to all waters harboring species listed as endangered or threatened under the federal Endangered Species Act (ESA). A medium priority has minimally been assigned to waters harboring state listed endangered and threatened species. As a way of addressing anti-degradation concerns, classified Outstanding Resource Waters and High Quality Waters start at the medium priority. The remaining waters on the list are prioritized according to severity of the impairment.

New Format of the List

North Carolina has begun to make the structural changes prescribed in EPA's July 13, 2000 final TMDL rule. The *Draft 2000 § 303(d) List* reflects many of these changes. EPA's final rule will likely eventually require 303(d) lists to be divided into four sections. North Carolina's 2000 list has been divided into six parts and reflects comments made on the proposed rules by North Carolina and other states. This 6-part format meets the requirements of existing rules, and future lists will meet requirements of revised federal rules (when implemented). A summary of each part of the list is provided below. A more detailed discussion is found in the preface to the actual list document.

Part 1 - Waters impaired by a *pollutant* as defined by 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." TMDLs will be submitted for all water/pollutant combinations listed in Part 1.

Part 2 - Waters 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" in the CWA section 502(19). EPA believes that in situations where the impairment is not caused by a *pollutant*, a TMDL is generally not the appropriate solution to the problem. In keeping with the principle that the § 303(d) list is an

accounting of all impaired waters; however, these types of waters will remain on Part 2 of the list until water quality uses and standards are attained by some other means.

Part 3 - Waters for which EPA has approved or established a TMDL and water quality standards have not yet been attained.
Monitoring data will be considered when evaluating Part 3 waters for potential delisting. Waters will be moved to Part 1 of the list if updated information and data demonstrate that the approved TMDL is inadequate.

Part 4 - Waters for which TMDLs are not required.
Other required regulatory controls (e.g., NPDES permit limits, Phase I Federal Stormwater Permits, etc.) are expected to attain water quality standards by the next regularly scheduled listing cycle.

Part 5 - Biologically impaired waters with no identified cause of impairment.
Roughly half of the waters on North Carolina's § 303(d) list appear on Part 5. Identification of the cause(s) of impairment will precede movement of these waters to Parts 1 and 2 of the list. EPA recognized that in specific situations the data are not available to establish a TMDL and that these specific waters might be better placed on a separate part of the 2000 § 303(d) list (64 FR, 46025). Data collection and analysis will be performed in an attempt to determine a cause of impairment. North Carolina's proposed plan for managing biologically impaired waters can be found in the preface to Part 5 of the list.

Part 6 – The *proper technical conditions* do not yet exist to develop a TMDL.
"*Proper technical conditions* refers 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). These are waters that would otherwise be on Part 1 of the list. In the proposed TMDL regulations, EPA again recognized that in some specific situations the data, analyses or models are not available to establish a TMDL and that these specific waters might be better off on a separate part of the 2000 § 303(d) list (64 FR, 46025). North Carolina seeks EPA technical guidance in developing technically defensible TMDLs for these waters. DWQ has included fecal impaired shellfish waters on this part of the list. North Carolina's approach to managing shellfish waters impaired because of fecal coliform violations is outlined in the preface to Part 6 of the list.

Scheduling TMDLs

North Carolina will submit TMDLs for each water within 13 years of its first listing starting with the EPA-approved 1998 § 303(d) list. TMDLs for waters first listed in 1998 or earlier will be developed by 2011. As a general rule, TMDLs will be addressed according to highest priority in accordance with the rotating basinwide planning approach. Due to the wide range of complexities encountered in TMDL development, TMDLs will not necessarily be submitted to EPA in order of priority.

TMDLs on Part 1 of the § 303(d) list 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 and "buy-in". Others

need to have a technical strategy budgeted and scheduled. Some are almost ready for submittal to EPA for approval. As the current regulations require, North Carolina has listed waters targeted for TMDL development within the next two years. There are no targeted waters in the Roanoke River basin at this time.

North Carolina has used "biological impairment" to place the majority of waters on the § 303(d) list. Additional consideration and data collection are necessary if the establishment of a TMDL for waters on Part 5 is to be expected. It is important to understand that the identification of waters on Part 5 of the list does not mean that they are low priority waters. The problem parameter identification (PPI) approach is a high priority for the State of North Carolina. However, it should be noted that it may take significant resources and time to determine the cause of impairment. The PPI approach is also a declaration of need for more data and more time to adequately define the problems and whether they are affected by *pollution*, *pollutants* or a combination.

North Carolina believes it to be both practical and honest to schedule TMDL development for only those waters where we have some information about the cause of impairment. Scheduling TMDLs for waters that may not be impaired by a *pollutant* is misleading and counterproductive.

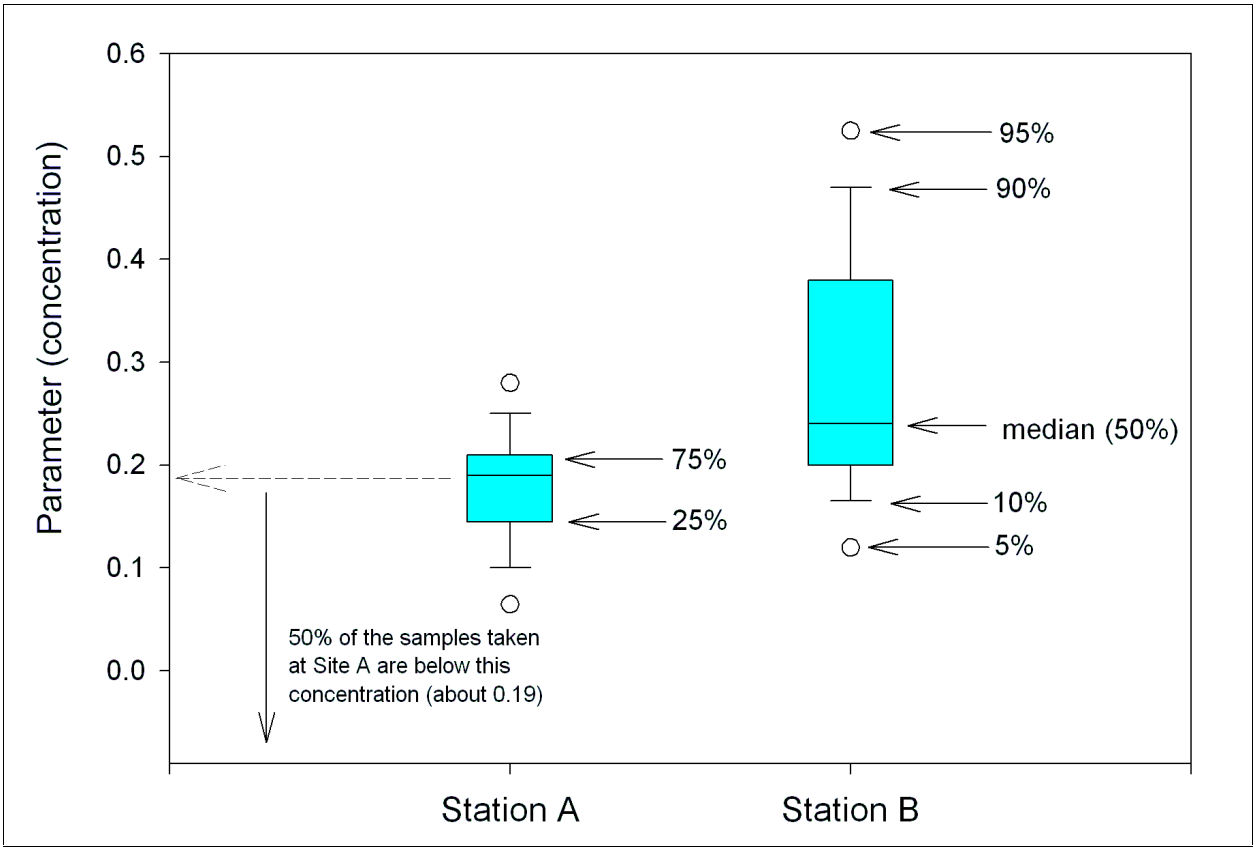
Delisting Waters

North Carolina relies heavily on the existing § 305(b) reporting methodology to complete the § 303(d) process. In general, waters will be removed from the § 303(d) list when data show that a water is fully supporting its uses. In some cases, mistakes have been discovered in the original listing decision and the mistakes are being corrected. Waters appearing on the previously approved § 303(d) list will be removed from the § 303(d) lists under the following circumstances:

- An updated § 305(b) use support rating of fully supporting.
- Applicable water quality standards are being met (i.e., no longer impaired for a given *pollutant*).
- The basis for putting the water on the list is determined to be in 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.
- Typographic listing mistakes (i.e., the wrong water was identified).

Appendix V

Explanation of Box Plots



Box plots (or box and whisker plots) show the distribution of measurements of a parameter. Here the distribution of measurements of a hypothetical parameter are compared between Station A and Station B. The percentage of measurements at or below a particular concentration are indicated on the figure. Note that the median and variation of measurements taken at Station B are greater than the median of Station A.

Appendix VI

Roanoke River Basin Nonpoint Source Program Description and Contacts

Statewide Nonpoint Source Management Program Description

The North Carolina Nonpoint Source Management Program consists of a broad framework of federal, state and local resource and land management agencies. More than 2,000 individuals administer programs that are directly related to nonpoint source pollution management within the state. A range of responsibilities have been delegated to county or municipal programs including the authority to inspect and permit land clearing projects or septic system performance. In the field of agriculture, a well established network of state and federal agricultural conservationists provide technical assistance and program support to individual farmers.

Staff in the DWQ Water Quality Section's Planning Branch lead the Nonpoint Source Management Program, working with various agencies to insure that program goals are incorporated into individual agencies' management plans. The goals include:

1. Coordinate implementation of state and federal initiatives addressing watershed protection and restoration.
2. Continue to target geographic areas and waterbodies for protection based upon best available information.
3. Strengthen and improve existing nonpoint source management programs.
4. Develop new programs that control nonpoint sources of pollution not addressed by existing programs.
5. Integrate the NPS Program with other state programs and management studies (e.g., Albemarle-Pamlico National Estuary Program).
6. Monitor the effectiveness of BMPs and management strategies, both for surface and groundwater quality.

Coordination between state agencies is achieved through reports in the *North Carolina Nonpoint Source Management Program Update*. Reports are intended to keep the program document current and develop a comprehensive assessment identifying the needs of each agency to meet the state nonpoint source program goals. Annual reports are developed to describe individual program priorities, accomplishments, significant challenges, issues yet to be addressed, and resource needs. A copy of the latest Annual Report (FY1998) is available online at http://h2o.enr.state.nc.us/nps/nps_mp.htm.

The nature of nonpoint source pollution is such that involvement at the local level is imperative. Basinwide water quality plans identify watersheds that are impaired by nonpoint sources of pollution. Identification, status reports and recommendations are intended to provide the best available information to local groups and agencies interested in improving water quality. The plans also make available information regarding federal, state and local water quality initiatives aimed at reducing or preventing nonpoint source pollution.

The following table is a comprehensive guide to contacts within the state's Nonpoint Source Management Program. For more information, contact Alan Clark at (919) 733-5083 ext. 570. Most employees of the Department of Environment & Natural Resources, including Division of Water Quality, Division of Land Resources, and the Division of Forest Resources, can be reached by email using the following formula: firstname.lastname@ncmail.net.

Agriculture

USDA Natural Resources Conservation Service:

Part of the US Department of Agriculture, 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.

Area 2 Conservationist	Mike Suggs	704-637-2400	600 West Innes Street, Salisbury, NC 28144
Area 3 Conservationist	Ruth Kirby & Livia Marques-Cooper	919-734-0961	Federal Building, Room 108, 134 North John Street, Goldsboro, NC 27530-3676
County	**District Conservationist**	**Phone**	**Address**
Bertie	Paula A. Ashley	252-794-5305	Bertie County Office Building, Room 211, 106 Dundee St., PO Box 566, Windsor, NC 27983-0566
Caswell	Warren H. Mincey	336-694-4581	Agriculture Building, Main Street, PO Box 96, Yanceyville, NC 27379
Granville	Diana Lewis	919-693-4603	PO Box 10, Oxford, NC 27565
Halifax	J. Wayne Short	252-583-3481	Halifax County Agricultural Center, Hwy 301, PO Box 8, Halifax, NC 27839
Martin	Rupert W. Hasty, Jr.	252-792-4350	104 Kehukee Park Road, PO Box 483, Williamston, NC 27892-0483
Northampton	Tony R. Short	252-534-2591	Northampton County Administrative Building, Hwy 305, PO Box 218, Jackson, NC 27845-0218
Person	Vilma Mendez-Colombani	910-997-8244	123 Caroline Street, Suite 300, Rockingham, NC 28379
Rockingham	John I. Timmons	336-342-8225	Rockingham County Government Center, 371 NC 65, PO Box 201, Wentworth, NC 27375-0201
Stokes	Reginald F. Liddell	336-593-2846	Old Courthouse Building, Hwy 89, PO Box 98, Danbury, NC 27016
Vance		252-438-5727	County Office Building, Room 1, 305 Young Street, Henderson, NC 27536
Warren	Dallas L. Shackleford	252-257-3836	Route 1, Box 486-D, Warrenton, NC 27589-9651

Agriculture

Soil & 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. For detail information, please visit the web site of the Division of Soil and Water Conservation at http://www.enr.state.nc.us/DSWC/files/do.htm.

County	Board Chairman	Phone	Address
Bertie	John W. Stallings	252-794-2183	1001 Stokes Avenue, Windsor, NC 27983
Caswell	James R. Blackwell	336-694-4581	Agriculture Building, PO Box 96, Yanceyville, NC 27379
Granville	Bobby E. Greene	919-693-4907	6561 Huntsboro Road, Oxford, NC 27565
Halifax	Kenneth Brantley	252-537-2206	3959 Hwy. 158, Roanoke Rapids, NC 27808
Northampton	William M. Stephenson	252-539-2236	Route 1, Box 301, Garysburg, NC 27831
Rockingham	Rupert O. Jones, Jr.	336-349-7754	180 Jonesland Trail, Reidsville, NC 27320-9183
Stokes	Banner Shelton	336-983-5584	Route 3, Box 228-C, King, NC 27021
Vance	John D. Parrish	252-492-8425	101 Quail Ridge, Henderson, NC 27536
Warren	Alvis P. Fleming	252-586-3635	225 Sunny Acres, Littleton, NC 27850

*** 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; and provides administrative and technical assistance related to soil science and engineering. Distributes Wetlands Inventory maps for a small fee.

Central Office	David B. Williams	919-715-6103	Archdale Building, 512 North Salisbury Street, Raleigh, NC 27626
Area 2, Winston-Salem	Marlene Salyer	336-771-4600	585 Waughton Street, Winston-Salem, NC 27107
Area 3, Winston-Salem	Gerald Dorsett	336-771-4600	585 Waughton Street, Winston-Salem, NC 27107
Area 4, Raleigh	Steve Bennett	919-571-4700	1628 Mail Service Center, Raleigh, NC 27699-1628
Area 5, Washington	George Stewart	252-946-6481	943 Washington Square Washington, NC 27889

NCDA Regional Agronomists:

The NC Department of Agriculture 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.

Central Office	Dr. Donald Eaddy	919-733-7125	2 West Edenton Street, Raleigh, NC 27601
Region 4	Tim Hall	910-324-9924	104 Jaclane Drive, Clinton, NC 28502-3867
Region 5	Rick Morris	910-866-5485	3184 Old NC 41, Bladenboro, NC 28320
Region 7	Kevin Johnson	919-736-1799	PO Box 1970, Pikeville, NC 27863
Region 8	Robin Watson	336-570-6850	1709 Fairview Street, Burlington, NC 27215
Region 9	David Dycus	919-776-9338	5022 Henley Road, Sanford, NC 27330
Region 10	Tim Hambrick	336-386-4602	192 Davis Road, Mount Airy, NC 27030

Education

NC Cooperative Extension Service:

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

County	Contact Person	Phone	Address
Bertie	William J. Griffin	252-794-5317	102 Dundee Street, PO Box 28, Windsor, NC 27983
Caswell	Larry Whitt	336-694-4158	126 Court Square, Yanceyville, NC 27379
Granville	Johnsie Cunningham	919-603-1350	PO Box 926, Oxford, NC 27565
Halifax	Patricia Peele	252- 583-5161	Halifax County Agricultural Center, 359 Ferrell Lane, PO Box 37, Halifax, NC 27839
Martin	J.B. Coltrain	252-792-1621	PO Box 1148, 205 E. Main Street, Williamston, NC 27892
Northampton	Cynthia Brown	252-534-2711	J.W. Faison Administrative Building, PO Box 636, Hwy. 305 N., Jackson, NC 27845
Person	Derek Day	336- 599-1195	304 South Morgan Street, Room 123, Roxboro, NC 27573
Rockingham	Scott Shoulars	336-342-8230	Rockingham County Center, PO Box 200, Wentworth, NC 27375-0200
Stokes	Jeffrey Boyles	336-593-8177	PO Box 460, Danbury, NC 27016
Vance	Harold Thompson	252-438-8188	Vance County Office Building, PO Box 1028, 305 Young Street, Henderson, NC 27536
Warren	Philip McMillan	919-257-3640	Warren County Center, PO Box 708, Warrenton, NC 27589

Forestry

*** 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.

Water Quality Forester Districts 5,7,10,11	Don Watson	919-732-8105	3314 NC 86 South, Hillsborough, NC 27278
Central Office	Moreland Gueth	919-733-2162	1616 Mail Service Center, Raleigh, NC 27699-1616

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.

Central Office	Mel Nevills	919-733-4574	1612 Mail Service Center, Raleigh, NC 27699-1621
Raleigh Region	John Holley	919-571-4700	1628 Mail Service Center, Raleigh, NC 27699-1628
Washington Region	Floyd Williams	252-946-6481	943 Washington Square Mall, Washington, NC 27889
Winston-Salem Region	Matthew Gantt	336-771-4600	585 Waughton Street, Winston-Salem, NC 27107

Local Erosion and Sedimentation Control Ordinances:

Several local governments in the basin have qualified to administer their own erosion and sedimentation control ordinances for construction.

Forsyth Co/Winston-Salem	Jeff Kopf	336-727-2388	100 Liberty Walk, Winston-Salem, NC 27101
City of Henderson	Frank Frazier	252-431-6026	PO Box 1434, Henderson, NC 27536
Guilford County	Earl Davis	336-373-3803	PO Box 3427, Greensboro, NC 27402
Orange County	Ren Ivins	919-732-8181	PO Box 8181, Hillsborough, NC 27278

General Water Quality

*** DWQ Water Quality Section:**

Coordinate the numerous nonpoint source programs carried out by many agencies; coordinate the French Broad and Neuse 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.

NPS Planning	Alan Clark	919-733-5083 x570	1617 Mail Service Center, Raleigh, NC 27699-1617
Urban Stormwater	Bradley Bennett	919-733-5083 x525	1617 Mail Service Center, Raleigh, NC 27699-1617
Modeling	Adugna Kebede	919-733-5083 x515	1617 Mail Service Center, Raleigh, NC 27699-1617
Monitoring	Jimmie Overton	919-733-9960 x204	1621 Mail Service Center, Raleigh, NC 27699-1621
Wetlands	John Dorney	919-733-1786	1621 Mail Service Center, Raleigh, NC 27699-1621
Animal Operations	Dennis Ramsey	919-733-5083 x528	1617 Mail Service Center, Raleigh, NC 27699-1617
Classifications/Standards	Jeff Manning	919-733-5083 x579	1617 Mail Service Center, Raleigh, NC 27699-1617

*** 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.

Raleigh Region	Ken Schuster	919-571-4700	1628 Mail Service Center, Raleigh, NC 27699-1628
Washington Region	Jim Mulligan	252-946-6481	943 Washington Square Mall, Washington, NC 27889
Winston-Salem Region	Larry Coble	336-771-4600	585 Waughton Street, Winston-Salem, NC 27107

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.

Central Office	Frank McBride	919-528-9886	PO Box 118, Northside, NC 27564

US 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.

Ask for the project manager covering your county.

Wilmington Field Office	Ernest Jahnke	910-251-4511	Post Office Box 1890, Wilmington, NC 28402-1890
Raleigh Field Office	Ken Jolly	919-876-8441 x22	6508 Falls of the Neuse Road, Suite 120, Raleigh, NC 27615

*** DWQ Groundwater Section:**

Groundwater classifications and standards; enforcement of groundwater quality protection standards and cleanup requirements; review of permits for wastes discharged to groundwater; issuance of well construction permits; underground injection control; administration of the underground storage tank (UST) program (including the UST Trust Funds); well head protection program development; and ambient groundwater monitoring.

Central Office	Carl Bailey	919-733-3221	1636 Mail Service Center, Raleigh, NC 27699-1636
Raleigh Region	Jay Zimmerman	919-571-4700	3800 Barrett Drive, Suite 101, Raleigh, NC 27609
Washington Region	Willie Hardison	252-946-6481	943 Washington Square Mall, Washington, NC 27889
Winston-Salem Region	Sherri Knight	336-771-4600	585 Waughton Street, Winston-Salem, NC 27107

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.

Central Office	Brad Atkinson	919-733-0692	401 Oberlin Road, Suite 150, Raleigh, NC 27605

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.
- Technical assistance to local health departments, other state agencies, and industry on soil suitability and other site considerations for on-site wastewater systems.

Central Office	Steve Steinbeck	919-570-6746	2728 Capital Boulevard, Raleigh, NC 27604
Raleigh Region		919-571-4700	3800 Barett Drive, Raleigh, NC 27609
Washington Region	Bob Uebler	252-946-6481 ext. 330	943 Washington Square Mall, Washington, NC 27889
Winston-Salem Region	Scott Greene	336-431-6736	585 Waughtown Street, Winston Salem, NC 27107

County	Primary Contact	Phone	Address
Bertie	Ron Freeman	252-794-5322	502 Barringer Street, Windsor, NC 27983
Caswell	Anne Scott	336-694-6841	County Park Road, PO Drawer H-189, Yanceyville, NC 27379
Granville	Dr. Rodwell Drake	919-693-1333	PO Box 367, 101 Hunt Street, Oxford, NC 27565
Halifax	June Conway-Alston	252-586-5154	PO Box 10, 204 Evans Road, Hollister, NC 27844
Martin	Lalitha Tallapaka	252-799-3030	10 West Liberty Street, Williamston, NC 27892
Northampton	Sheila Josnson	252-534-5841	237 North Church Street Extesion, PO Box 635, Jackson, NC 27845
Person	Lisa Richarson	336-597-2204	1011 N. Madison Boulevard, Roxboro, NC 27573
Rockingham	Mark Langle	336-342-8132	371 NC 65, Suite 204, PO Box 204, Wentworth, NC 27375-8143
Stokes	Jim Oakley	336-593-2402	PO Box 187, 1009 N. Main Street, Danbury, NC 27016
Vance	Jackie Sergent	919-693-2141	PO Box 367, 101 Hunt Street, Oxford, NC 27565
Warren	Jennifer Jones	252-257-2116	544 West Ridgeway Street, Warrenton, NC 27589

* Most employees of the Department of Environment & Natural Resources, including Division of Water Quality, Division of Land Resources, and Division of Forest Resources, can be reached by email using the following formula: firstname.lastname@ncmail.net.

- **DENR Raleigh Regional Office covers the following counties:** Granville, Halifax, Northampton, Person, Vance and Warren.
- **DENR Washington Regional Office cover the following counties:** Bertie, Martin and Washington.
- **DENR Winston-Salem Regional Office covers the following counties:** Caswell, Forsyth, Rockingham, Stokes and Surry.

Appendix VII

Glossary
of
Terms and Acronyms

Glossary

§	Section.
30Q2	The minimum average flow for a period of 30 days that has an average recurrence of one in two years.
7Q10	The annual minimum 7-day consecutive low flow, which on average will be exceeded in 9 out of 10 years.
anadromous	A species of fish that migrates to spawn in freshwater after spending most of its life in an estuary or ocean. Examples for the Roanoke River basin are the American Shad and the Striped Bass.
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.
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 overenrichment 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).
conductivitiy	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.
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.
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.
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.
FS	Fully supporting. A rating given to a waterbody that fully supports its designated uses and generally has good or excellent water quality.
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 waterbody that has a use support rating of partially supporting (PS) or not supporting (NS) its uses.

impervious	Incapable of being penetrated by water; non-porous.
kg	Kilograms. To change kilograms to pounds multiply by 2.2046.
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.
meotrophic	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.
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.
NS	Not supporting. A rating given to a waterbody that does not support its designated uses and has poor water quality and severe water quality problems. Both PS and NS are called impaired.
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.
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.
PS	Partially supporting. A rating given to a waterbody that only partially supports its designated uses and has fair water quality and severe water quality problems. Both PS and NS are called impaired.
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).
silviculture	Care and cultivation of forest trees; forestry.
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.
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.
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.
WWTP	Wastewater treatment plant.