ROANOKE RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN

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FOREWORD

Clean water is critical to the health, economic well-being and quality of life of those living or working in the Roanoke River basin. Most water users throughout the basin, including industry, agriculture and the basin's 260,000 residents, rely on surface water for basic needs such as water supply and/or disposal of treated wastewater. In addition, many businesses and residents of the Roanoke basin rely directly or indirectly on the basin's lakes and 2,400 miles of rivers and streams to meet their recreational needs and provide a source of living. To these groups and the public they serve, it is important that the basin's waters support viable fisheries, that the waters be relatively safe (low risk of contracting water-borne disease) and that they be aesthetically desirable (free of objectionable colors, odors and smells). Yet maintaining clean water becomes increasingly difficult and more expensive as the population grows, as land develops and as competition for its resources heighten.

Protection of surface waters in the Roanoke Basin represents a tremendous challenge. Over 60 percent of the basin is in Virginia. That portion that is in North Carolina has two distinct parts - the western section which occurs in the Piedmont and contains trout waters, and the eastern portion which flows through the coastal plain to Albemarle Sound and includes one of the largest intact and least disturbed bottomland hardwood forests in the mid-Atlantic region. The North Carolina portion of the basin covers 3,600 square miles and includes 37 municipalities and all or portions of 16 counties.

The majority of the surface waters in the basin are of good quality with only 9 percent of the assessed streams considered impaired. Of the impaired streams, nonpoint sources of pollution are suspected to contribute to the majority (or 83 percent) of the impairment. Fish consumption advisories contributed to impairment in the lower Roanoke (dioxin) and two lakes in the Dan River drainage (selenium). Measures have been taken in each of these cases to halt additional inputs of these contaminants through improvements in industrial treatment and operations.

Preserving and enhancing the quality of water in the basin is beyond the capabilities of any one agency or group. State and federal government regulatory programs will play an important part, but much of the responsibility will be at the local level. Those who live, work and recreate in the basin have the most at stake.

This document provides a summary of the causes and sources of water pollution in the basin, the status of the basin's water quality, a summary of water quality rules and statutes that apply to water quality protection in the basin, and recommended measures to protect and enhance the quality of the surface waters in the Roanoke River basin to protect the uses outlined above. The Roanoke River Basinwide Water Quality Management Plan will be used as a guide by the NC Division of Water Quality in carrying out its water quality program responsibilities in the basin. Beyond that, it is hoped that the plan will provide a framework for cooperative efforts between the various stakeholders in the basin toward a common goal of protecting the basin's water resources while accommodating reasonable economic growth.

EXECUTIVE SUMMARY

NORTH CAROLINA'S BASINWIDE APPROACH TO WATER QUALITY MANAGEMENT - PURPOSE OF ROANOKE RIVER BASIN PLAN

Basinwide management is a watershed-based water quality management initiative being implemented by the North Carolina Division of Water Quality (DWQ). The *Roanoke River Basinwide Water Quality Management Plan* (Roanoke Plan) is the eighth in a series of basinwide water quality management plans that will be prepared by DWQ for all seventeen of the state's major river basins by the year 1998. The plan will be used as a guide by DWQ in carrying out its water quality program duties and responsibilities in the Roanoke River Basin.

A basinwide management plan report is prepared for each basin in order to communicate to policy makers, the regulated community and the general public the state's rationale, approaches and long-term water quality management strategies for each basin. The draft plans are circulated for public review and comment and are presented at public meetings in each basin. The plan for a given basin is completed and approved prior to the scheduled date for basinwide permit renewals in that basin. The plans are then to be evaluated, based on follow-up water quality monitoring, and updated at five year intervals.

The Roanoke Plan is due for completion in July of 1996 and will be updated in the year 2001. Basinwide NPDES permitting is scheduled to commence in January 1997.

BASINWIDE GOALS

The primary goals of DWQ's basinwide program are to 1) identify and restore full use to impaired waters, 2) identify and protect highly valued resource waters, and 3) manage problem pollutants throughout the basin to protect water quality standards while accommodating reasonable economic growth. In addition, DWQ is applying this approach to each of the major river basins in the state as a means of better identifying water quality problems; developing appropriate management strategies; maintaining and protecting water quality and aquatic habitat; assuring equitable distribution of waste assimilative capacity for dischargers; and improving public awareness and involvement in management of the state's surface waters.

PUBLIC WORKSHOPS

Two public workshops were held in March of 1995 in Halifax and Yanceyville to familiarize stakeholders in the basin with DWQ's basinwide approach and to solicit their comments for the basin plan. In addition, at the request of the Kerr-Tar Council of Government, an additional workshop was held on Kerr Lake in November for local professionals involved in different capacities with water quality management. The workshops in March, which had a combined total of 115 participants, were co-sponsored by the North Carolina Cooperative Extension Service (CES) and DWQ. A summary of these workshops is provided in Appendix IV of the plan. Priority issues and recommended actions identified by two or more discussion groups included:

- Flow in the Roanoke River below Roanoke Rapids Dam
- Increase public education and involvement of local stakeholders
- Better control of nonpoint sources of pollution
- Interstate cooperation and coordination
- Positive economic incentives for water quality management/balance economics and environment

ROANOKE BASIN OVERVIEW

The Roanoke River Basin begins in the Blue Ridge Mountains of Virginia and flows in a generally southeastern direction into the Albemarle Sound in North Carolina. Figure 1 provides a general view of the basin in North Carolina. Roughly 64% of the drainage area of the Roanoke is in Virginia.

The North Carolina portion of the Roanoke River Basin is composed of two major parts: the Dan River and its tributaries in the western section, upstream of Kerr Lake, and the Roanoke River as it enters North Carolina in the eastern section. The Roanoke River itself enters North Carolina in the form of Lake Gaston and then flows into Roanoke Rapids Lake before regaining its riverine form and flowing to the Albemarle Sound. The North Carolina portion of the basin contains twelve lakes, all of which are man-made reservoirs.

There are 16 counties and 37 municipalities located in whole or in part in the basin. Based on 1990 census data, the population of the basin is 263,661 people. 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 78 persons per square mile versus a statewide average of 123 persons per square mile. The percent population growth over the past ten years (1980 - 1990) was 15% versus a statewide average of 12.7%

Over half of the land in the river basin is forested. Statistics provided by the US Department of Agriculture, Natural Resources Conservation Service indicate that during the last decade there has been an increase in the amount of developed land and a decrease in the amount of cultivated cropland.

In the Roanoke River Basin, there are 366 permitted NPDES dischargers, 116 of which are general permits or stormwater discharge permits. Of the total 366 dischargers 19 are municipalities and 38 are industries. The total permitted flow for all facilities is 184 million gallons per day (MGD).

Based on evaluation of consumptive water use (i.e., water lost to the basin by interbasin transfer, cooling water evaporation, etc.) by the North Carolina Division of Water Resources, the basin is expected to see a 240 percent increase in annual average water loss from the basin through consumptive uses between 1980 and 2010. Use of Lake Gaston water by Virginia Beach is currently being challenged by the State of North Carolina.

ASSESSMENT OF WATER QUALITY IN THE ROANOKE RIVER BASIN

An assessment of water quality data collected by DWQ and others reveals that the Roanoke River Basin has generally good water quality. Below is a summary of some key monitoring data that reflect water quality in the basin. A more detailed presentation of this information can be found in Chapter 4.

Summary of Biological Indicators

Benthic Macroinvertebrates - These are primarily bottom-dwelling aquatic insect larvae such as species of stoneflies, mayflies and caddisflies. Measurements of the number, types and diversity of these organisms at strategic sampling sites is an important means of assessing water quality.

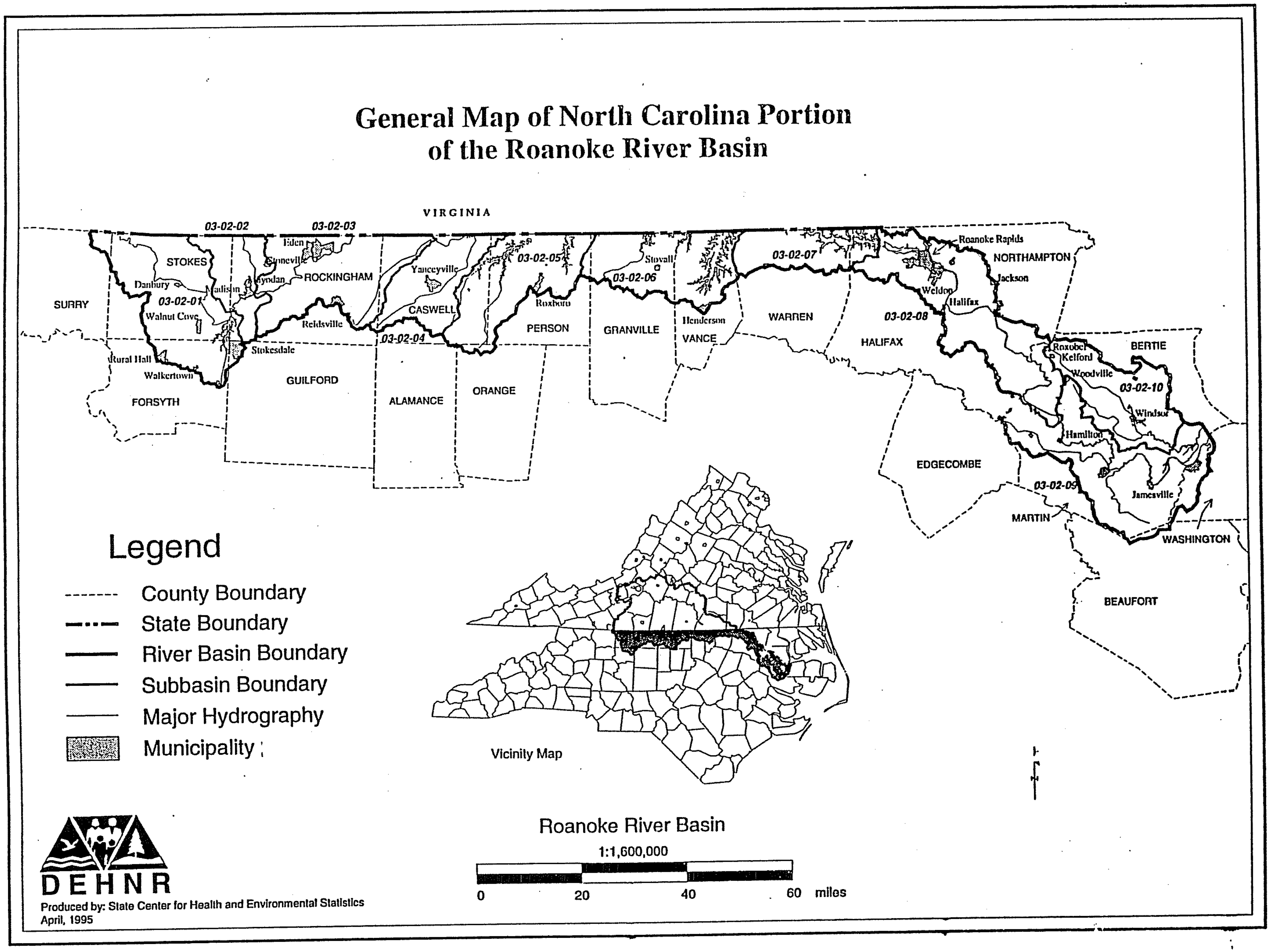

Figure 1. General Map of the Roanoke River Basin

In the Roanoke River Basin a total of 104 benthic macroinvertebrate collections at 55 sites have been made between 1983 and 1994. High flows during the summer of 1994 prevented collections at some sites, and these flows sometimes complicated evaluations of the data that were collected. The entire benthos data set suggests primarily Good (33% of samples) to Good-Fair (27%) water quality in the basin. Excellent bioclassifications (10% of samples) have been recorded in portions of the Dan River and Mayo River and tributaries in Hanging Rock State Park. Nonpoint and point source pollution impacts resulted in the Fair bioclassifications (18%) scattered throughout the Roanoke River basin. Poor biological ratings for the upper Cashie River were recorded primarily from older data. Recent extensive work on swamp streams, such as the Cashie River and its tributaries, suggests that different criteria should be used for such slow-flowing, swamp-like systems; therefore, those Poor bioclassifications in the Cashie may not accurately reflect the natural conditions of water quality. DWQ is developing a biotic index for swamp waters.

Fish Community Evaluations - Fish community structure (IBI) analyses were performed on data from 31 sites in the Roanoke River Basin collected by DWQ, the NC Wildlife Resources Commission and Fritz Rohde of the NC Division of Marine Fisheries. These data indicated Good to Excellent water quality for the majority (24) of the sites sampled. Areas of Fair water quality included Marlowe Creek, Quankey Creek, Conoconnara Creek and the Cashie River. Locations of, and summary information for, all of the IBI samples collected in the Roanoke basin can be found in maps and tables located in sections 4.4.1 and 4.4.10 of Chapter 4.

In the summer of 1995, there was a fish kill in the Roanoke River. Due to heavy rainfall in June, a variety of factors including flood control operations of the US Army Corps of Engineers, prolonged back swamp flooding, high ambient air temperatures and the draining of hypoxic swamp water into the main stem of the river contributed to the mortality of fish. Thousands of fish, including striped bass, were killed. Fortunately, a report to the Atlantic States Marine Fisheries Commission states that the 7,000 striped bass killed represents only 0.4% of the population estimated to be present in the system, and thus should have little impact on the ongoing recovery of striped bass. Efforts being made to prevent fish kills of this nature in the future are discussed briefly at the end of this executive summary (Future Initiatives) and in more detail in Chapter 7. Control of water flow in the lower Roanoke River is an important issue in the basin.

Fish Tissue Analyses - Fish tissue samples were collected at 21 sites from 1980 to 1994 within the Roanoke drainage consisting of 502 observations. Samples were collected as part of the DWQ's ambient fish tissue monitoring program or were collected as part of special studies.

Fish samples collected within the Roanoke drainage show sporadic elevations in tissue contaminants. Metals and/or organic contaminants exceeded state or federal criteria at 12 of 21 (57%) stations, although the exceedences were infrequent. Organic contaminants were detected in fish at five (24%) of the sites and exceeded EPA criteria at five sites. All organics results remained below federal Food and Drug Administration (FDA) criteria throughout the drainage. Dioxin contamination exceeded North Carolina's limit of 3 ppt at four (19%) of the sites. Most metals contaminants were non-detectable or present at trace levels; however, five (24%) of the sites contained fish individuals with mercury contamination exceeding EPA and/or FDA criteria. Significant mercury contamination was most often associated with older, top predator fish species. Elevations in contaminants suggest a need for further sampling, but may not indicate human health or ecological concerns.

Fish consumption advisories have been issued for several waterbodies within the Roanoke Drainage. Belews Lake (Stokes and Rockingham counties) and Hyco Reservoir (Caswell and Person counties) remain under limited advisories for certain fish species due to selenium contamination. The advisories recommend that the general population eat no more than one meal per week of fish from the lakes and that children and women of childbearing age do not consume fish from the locations. The Roanoke River from Williamston to Albemarle Sound, as well as all of Welch Creek, are posted with an advisory for all species due to dioxin contamination. In the Roanoke River the advisories recommend consumption of no more than 2 meals per month for the general public and no consumption for children and women of childbearing age. In Welch Creek, no consumption is advised. Additional inputs of selenium and dioxin to the affected water bodies have been reduced or eliminated. Fish advisories will remain in effect until monitoring indicates that levels are within the FDA criteria.

Lakes Studies - One measure of water quality in lakes is the North Carolina Trophic State Index (NCTSI). This is a numerical index that is used to evaluate the trophic status of lakes. Trophic status is a relative measure of nutrient enrichment and productivity. Oligotrophic lakes are those that have the lowest levels of enrichment and generally have good clarity and no problems with algal blooms. At the other end of the spectrum are eutrophic lakes which have a lot of plant productivity which can cause nuisance problems and have little clarity in the water column.

Only Hanging Rock Lake was monitored intensively during the growing seasons of 1991 through 1993 as part of a reference lake program to determine if this lake was representative of a minimally impacted lake in this region of the state. All of the lakes in the Roanoke River Basin were sampled most recently in 1994.

Lakes designated as oligotrophic include Hanging Rock Reservoir, Belews Lake, Mayo Lake, Lake Gaston, and Roanoke Rapids Reservoir. Kernersville Reservoir, Hyco Reservoir and Kerr Reservoir are considered mesotrophic. Eutrophic lakes include Farmer Lake, Lake Roxboro, and Roxboro Lake. White Millpond has been designated hypereutrophic.

Use-Support Ratings

Another important method for assessing surface water quality is to determine whether the quality is sufficient to support the uses for which the waterbody has been classified by the state. All surface waters in the state have been assigned a classification. These classifications are discussed in Section 2.7 of Chapter 2. The word *uses* refers to activities such as swimming, fishing and water supply. DWQ has collected extensive chemical and biological water quality monitoring data throughout the basin, some of which is summarized above. All data for a particular stream segment have been assessed to determine the overall *use support* rating; that is, whether the waters are *fully supporting*, *partially supporting* or *not supporting* their uses. A fourth rating, support-*threatened,* applies where all uses are currently being supported but water quality conditions are marginal. Streams referred to as *impaired* are those rated as either partially supporting or not supporting their uses. Use support ratings in the Roanoke River basin, described more fully in Chapter 4, are summarized below for freshwater streams and lakes.

Freshwater Streams and Rivers - Of the 2,390 miles of freshwater streams and rivers in the Roanoke basin, use support ratings were determined for 92% or 2,206 miles. Of this total, 83% were rated as supporting their uses, 9% were considered impaired and 8% were not evaluated. Of those waters rated as supporting their uses, approximately one third (or 27% of all streams) were considered threatened.

SUPPORTING........................ 83%
  Fully supporting (56%)
  Support-threatened (27%)
IMPAIRED..............................9%
  Partially supporting (9%)
  Not supporting (0%)
NOT EVALUATED:....................8%

Fish consumption advisories resulted in a partially supporting rating for 62 stream miles (29% of total impaired stream miles). Sediment contributed to the impairment of 38 stream miles (18% of total impaired streams).

Lakes

Twelve lakes in the Roanoke basin totaling 42,268 acres were monitored and assigned use support ratings. Of these 12 lakes, five are fully supporting their uses, three are support threatened and four are partially supporting their uses. The table below presents those lakes that are support-threatened or partially supporting their uses along with the causes for the ratings. Belews lake and Hyco lake are currently rated partially supporting due to fish consumption advisories. Runoff from coal ash ponds resulted in elevated levels of selenium in fish tissue. Corrective measures to prevent further runoff have been put into place, and the lakes continue to be monitored for selenium. Roanoke Rapids Reservoir is currently rated partially supporting due to a severe problem with aquatic macrophyte infestation which has impaired boat navigation on the lake. Lake Gaston is also partially supporting because of aquatic macrophyte infestation.

LAKE NAME	STATUS	CAUSES
Kerr Reservoir	Threatened	Elevated Nutrients, Algae Blooms, Violations of the State water quality standard for dissolved gases
Roxboro Lake	Threatened	Algal Blooms
White Millpond	Threatened	Algal Blooms, Elevated Nutrients, Aquatic Macrophytes
Belews Lake	Partially Supporting	Restricted Fish Consumption Advisory (Selenium)
Hyco Reservoir	Partially Supporting	Restricted Fish Consumption Advisory (Selenium)
Lake Gaston	Partially Supporting	Aquatic Weeds Infestation
Roanoke Rapids Res.	Partially Supporting	Aquatic Weeds Infestation

MAJOR WATER QUALITY ISSUES AND RECOMMENDATIONS

Several water quality issues emerge as being of particular importance in light of factors such as the degree of water quality degradation, the value of the resources being impacted and the number of users potentially affected. Those issues considered most significant on a basinwide scale are presented below along with recommended corrective or research actions.

The following discussion presents strategies for mitigating and further studying water quality problems in the Roanoke River basin. DWQ recognizes that flow rates in the basin will most likely change over time from a variety of influences ranging from climactic change to water use. Increases in consumptive uses will tend to reduce flows and such reductions generally exacerbate water quality problems. Assessing the effects of flow changes is a complex issue unto itself. ~~North Carolina / Virginia Power will model flows in parts of the basin as part of the relicensing of~~ the Gaston-Roanoke Rapids project (see Future Initiatives in the Roanoke Basin, below). The results of this work will provide a better understanding of basin hydrology. Although this basinwide plan provides a comprehensive study of, and strategy based on, the present conditions in the basin, it does not provide for potential water quality impacts and other effects stemming from future changes in flow conditions.

A. SEDIMENTATION

Sedimentation is a major contributing cause of water quality use support impairment in the Roanoke River Basin as it is throughout most of the state. It is estimated that 38 miles of major streams are impaired by sedimentation. Three subbasins in which sediment-impaired streams are identified include:

Subbasin 01 (Upper Dan River watershed in Stokes and Forsyth Counties): 20 miles
Subbasin 05 (Tributaries to Hyco and Mayo Reservoirs in Person and eastern Caswell Counties: 6.2 miles
Subbasin 07 (Tributaries to Lake Gaston in Warren County): 11 miles

The major sources include construction, urban development, agriculture, forestry and mining. There are 19 programs administered by various local, state and federal agencies which have been developed to control sediment from these activities.

DWQ is using the basinwide approach to draw attention to this issue to work more closely with the responsible agencies to find ways of continuing to improve erosion and sediment control.

Recommendations for Improving Erosion and Sediment Control

- Continue to promote effective implementation and maintenance of erosion and sediment control measures by contractors, developers, farmers and other land owners. Education and stewardship are keys. Even the best-designed plans will not work if those responsible for maintaining silt fences, ground cover, settling ponds, grassed waterways, etc. are not carrying out those responsibilities either due to lack of understanding or lack of respect for the resource.
- Evaluate effectiveness of enforcement of existing sediment control programs.
- Encourage more widespread adoption of erosion and sediment control programs by local governments, especially in rapidly developing areas. Coastal counties can include recommendations to address erosion and sedimentation in development of land use plans under the Coastal Area Management Act. Other city and county governments that have not adopted programs can be still become involved through local education efforts, maintaining publicly-owned lands, and coordinating with other agencies such as local soil and water conservation districts and NC Division of Land Resources to identify and correct problems.
- Promote public education at the state and local level on the impacts of sedimentation and the need for improved sediment control. The cumulative effects of a number of small projects can significantly degrade water quality and habitat downstream.
- Evaluate existing sedimentation and erosion control rules and statutes for possible strengthening at the state and local level. Examples include limiting the area of disturbed land on a given site and reducing the time period for reestablishing vegetation on denuded areas.
- Maintaining vegetated stream buffers along fields and in urban areas is an excellent means of controlling sedimentation and other nonpoint source pollution.

B. TOXIC SUBSTANCES

Point source discharges will be allocated chemical specific toxics limits and monitoring requirements based on a mass balance technique discussed in the Instream Assessment Unit's Standard Operating Procedures manual and in Appendix III of this report. Any available data are used at permit renewal to determine which toxic parameters need to be limited in the NPDES permit. Whole effluent toxicity limits are also assigned to all major discharges and any discharger of complex wastewater.

Nonpoint source strategies to be implemented through the municipal and industrial NPDES stormwater program should also be helpful in reducing toxic substance loading to surface waters. Industries are being required to control runoff from their sites and to cover stockpiles of toxic materials that could pose a threat to water quality.

In the Roanoke River basin there are three specific areas that have been impacted by toxics in the form of fish advisories. These areas are being addressed as described as follows:

Belews Lake (Subbasin 01)

In 1975, Duke Power Company began operating a coal burning power plant at Belews Lake. Water was used to sluice the ash residue and routed to a settling pond which in turn discharged to Belews Lake. In 1978 it was determined that this practice resulted in an unexpected concentration of selenium by the aquatic food chain organisms in the lake. Selenium bioaccumulation blocked reproduction in warm water fish species indigenous to the Belews Creek/Belews Lake system.

Since the late 70's, NCDWQ has worked with Duke Power to resolve this problem. In 1984, the power plant was converted from a wet ash sluicing system to a damp disposal system which offers the advantage of having no excess water to be treated and discharged. Thus, the ash basin effluent was removed from the reservoir. Bottom ash sluice which offers little or no chemical leaching was routed directly to the Dan River with a selenium NPDES permit limitation. As part of the conversion process, NCDWQ required Duke Power to extensively monitor the Dan River to assess the impact the new discharge may have on water quality and selected biota.

NCDWQ and Duke Power continue to monitor Belews Lake and the Dan River. Selenium concentrations in the water column of these streams are well below the 5 ug/l standard. Selenium concentrations in Belews Lake fish have exhibited a decreasing trend in recent years. The 1988 fish consumption advisory was recently revised from all species to only include common carp, redear sunfish and crappie. Belews Lake is currently considered in "recovery status." In the Dan River, data indicate that selenium concentrations are well below levels which result in reproductive failure, and well below levels considered safe for human consumption. Benthic macroinvertebrate sampling conducted by Duke Power indicate no effect of the discharge to the macroinvertebrate community of the Dan River. Belews Lake will remain listed as an *impaired* stream until such time the fish consumption advisory is lifted.

Hyco Lake (Subbasin 05)

Carolina Power & Light Company (CP & L) built the Hyco Reservoir in 1965 and started operating the Roxboro Steam Electric Plant in 1966. The original wet fly ash sluicing system discharged to the reservoir. After a decline in the sport fishery, studies were conducted in the late 1970's which documented bioaccumulation of selenium in the lake's food chain.

In 1985, the North Carolina water quality standard for selenium was reduced from 10 ug/l to 5 ug/l. In light of this, NCDWQ developed a model to determine a new selenium NPDES permit limitation that would protect the selenium water quality standard in the reservoir. The analysis resulted in a more stringent permit limitation for selenium. In 1986 CP&L began conversion of the plant to a dry fly ash system to reduce selenium concentrations at the effluent. The new system has been operational since January 1990.

CP&L is required by the NPDES permit to provide long-term chemical and biological monitoring of the lake and to assess trends in selenium concentrations in the water, sediment, and tissue of aquatic organisms. NCDWQ also collects biological and chemical data in the reservoir. Selenium concentrations in the water column have remained below the State water quality standard since 1990 and selenium levels in fish tissue continue to decline. In May 1995, a partial lifting of the consumption advisory was issued. Common carp, white catfish and green sunfish remain in the fish consumption advisory. Hyco Lake will remain listed as an *impaired* stream until such time the fish consumption advisory is completely lifted.

Roanoke River (from Williamston to Batchelor Bay) and Welch Creek (Subbasins 08 and 09)

Weyerhaeuser Paper Company operates a paper mill near Plymouth. The outfall originally discharged to Welch Creek until 1988 when it was relocated to the Roanoke River. In the 1980's it was recognized that dioxin, a carcinogen byproduct of the chlorine paper bleaching process, was accumulating in fish tissue in the receiving stream. The EPA mandated all states to include a dioxin limitation in NPDES permits for bleach kraft paper mills by mid 1993. In light of this, Weyerhaeuser initiated measures to drastically reduce dioxin concentrations in its effluent. In 1993, a dioxin limitation was added to the NPDES permit. Weyerhaeuser dioxin reduction efforts culminated in 1994 with a complete modernization of the paper mill in which chlorine is not used in the process.

Weyerhaeuser is required by the NPDES permit to provide extensive water quality and biological monitoring of the area of impact. The data indicates that dioxin levels in fish are gradually decreasing since the company started its dioxin reduction programs. However, the State fish consumption advisory remains in effect from Williamston to the mouth at Albemarle Sound for all species except for herring and shad. This section of the Roanoke River and Welch Creek will remain listed as *impaired* streams until such time the fish consumption advisory is completely lifted.

Nutbush Creek (Subbasin 06)

This stream is impacted by the Town of Henderson WWTP and urban run-off. The Town of Henderson WWTP effluent dominates the stream flow with an instream waste concentration of 97%. Benthic macroinvertebrate sampling conducted in August and October 1994 indicate that water quality has improved since the previous benthic macroinvertebrate sampling of 1988. However, the abundance and taxa richness values are still considered "fair."

NCDWQ is currently working with the Town of Henderson and compliance with the whole effluent toxicity test is expected in 1996. The Nutbush watershed has been prioritized for the investigation and implementation of non-point pollution management strategies. NCDWQ will conduct additional investigations prior to the next Roanoke River Basinwide Plan of 2001.

C. MANAGEMENT OF OXYGEN-CONSUMING WASTES FROM DISCHARGE FACILITIES

The Division of Water Quality has the responsibility of ensuring that the waste limits in NPDES discharge permits are established to protect dissolved oxygen (DO) standards in receiving waters. The standard for all waters in the Roanoke River basin, except for waters supplementally classified as swamp waters or trout waters, is 5.0 mg/l (daily average with instantaneous measurements not to fall below 4.0 mg/l). Swamp waters, which are prevalent in the lower portion of the basin, may have naturally lower levels of dissolved oxygen, and the acceptable dissolved oxygen level can vary from stream to stream. The dissolved oxygen standard for classified trout waters is 6.0 mg/l.

In the past, DO limits for all dischargers in the basin have been established on a case-by-case basis, but follow-up studies that have examined the cumulative effects of multiple discharges on receiving streams have found that the past approach may result in the overallocation of waste assimilative capacity of receiving waters. Under the basinwide approach, efforts are being made, as resources allow, to establish strategies called total maximum daily loads (TMDLs) which would apply to multiple discharges on streams or watershed areas within a river basin. In some cases, TMDLs include recommended permit limits designed to protect water quality standards and provide additional capacity for future expansions of new facilities. In others they are narrative or descriptive strategies for particular conditions.

Discharges to Low Flow Streams

Due to the preponderance of low flow streams across the state, the Division developed regulations for evaluating discharges to low flow streams. This policy requires that effluent limitations for new and expanded discharges of oxygen consuming waste be set at 5 mg/l BOD5, 2 mg/l NH3-N, and 6 mg/l DO, unless it is determined that these limitations will not protect water quality standards. Marlowe Creek in the Roanoke basin is an impaired stream which is effluent-dominated. The discharging facility (City of Roxboro wastewater treatment plant) is not affected by current low flow regulations unless it is expanded. DWQ staff will continue to work with the facility to improve wastewater treatment and water quality.

Discharges to Swamp Waters

Many of the streams in the Roanoke River Basin are classified as swamp waters. DWQ does not have a good tool to evaluate the ability of these waters to assimilate oxygen-consuming wastes as our desktop dissolved oxygen model assumes a steady-state, one-dimensional flow, and these conditions may not exist in swamp waters. In addition, data analyses from a previously studied system in the Lumber River Basin indicated that critical conditions in a swamp system are not limited to low flow conditions. Inadequate flow and water quality data prevent verification of the relationship between flow and dissolved oxygen in many of the tributaries classified as swamp waters.

Given the difficulty of determining assimilative capacity in these waters, DWQ has identified the need to develop a better tool to evaluate a swamp system's ability to assimilate waste flow. Since many swamp systems are very slow moving and naturally have low dissolved oxygen concentrations, the criteria by which impact is determined is currently being reevaluated. A work group has been formed in the Water Quality Section to determine wastewater impacts given various treatment capabilities and flow conditions in a swamp. Instream data above and below several facilities will be collected as part of the study. The focus of the study is to evaluate discharge impacts during various hydrologic regimes within the swamps in question. Emphasis will be placed on data collected during high, low and medium flows and during a falling hydrograph event when swamp backwaters drain to the mainstem carrying potentially lower dissolved oxygen concentrations.

Two classified swamp waters in the Roanoke are listed as impaired. These are Conoconnara Swamp (Subbasin 08) and the Cashie River (Subbasin 10). Management of these streams will benefit from the results of the studies.

Dissolved Oxygen Mainstem Models

In 1995 NCDWQ developed a field calibrated dissolved oxygen model (QUAL2E) for 74 stream miles of the mainstem of the Roanoke River, from the Roanoke Rapids dam to Hamilton. The QUAL2E model was used to determine the oxygen-consuming waste assimilative capacity of the lower Roanoke River. At existing permitted loads during low flow conditions, the minimum predicted dissolved oxygen is approximately 6 mg/l. NCDWQ will continue to use this model to allocate oxygen-consuming permit limitations in the Roanoke River mainstem from Roanoke Rapids to Hamilton.

D. NUTRIENTS

Control of two major plant nutrients, phosphorus and nitrogen, is necessary to limit the excessive growth of algae and other aquatic plants in lakes and some slow-moving streams in the Roanoke River basin. Sources of nutrients include animal operations, cropland, urban stormwater and wastewater treatment plants. Strategies for limiting nutrients have been recommended by DWQ for the following areas:

Roxboro Lake and Lake Roxboro (Subbasin 05)
These two lakes are water supply reservoirs near the Town of Roxboro. Lake Roxboro supports all of its uses, but Roxboro Lake is considered threatened because of algal bloom conditions observed in 1994. Sampling indicated the lakes are eutrophic. The watersheds for both lakes are comprised of agricultural, forest and pasture lands, and residential areas. Implementation of nonpoint source nutrient reduction best management practices will be needed in order to prevent further water quality degradation and loss of uses. The lakes will continue to be monitored and reevaluated prior to the next basin plan.

Nutbush Arm of Kerr Lake (Subbasin 06)
Conditions at the headwaters of the Nutbush Creek Arm have in the past been nearly hypereutrophic. During low flow conditions, Nutbush Creek is dominated by the effluent of the Henderson WWTP. A study conducted in 1988 by DWQ indicated that the Henderson WWTP was a major contributor of nutrients to Nutbush Creek.

Since the mid 1980's, DWQ has been working with the City of Henderson to resolve this problem. DWQ efforts included the implementation of a phosphorus limitation in Henderson's NPDES permit. The Henderson WWTP has undergone a number of upgrades, including phosphorus removal capabilities. A study in 1995 was conducted to ascertain water quality conditions after improvements and upgrades were installed at the wastewater treatment plant. The study still indicated elevated nutrients, algal bloom conditions, and violations of the water quality standard for dissolved gases. Consequently, the Nutbush Arm of Kerr Lake is considered threatened. Data collected by DWQ in 1994 ranked the lake as being mesotrophic. DWQ will continue to monitor the Nutbush Arm of Kerr Lake.

Lake Gaston (Subbasin 07)
Lake Gaston is located between Kerr Lake and Roanoke Rapids Lake. This body of water is impaired due to the infestation of exotic plants such as hydrilla (Hydrilla verticillata), Brazilian Elodea (Egeria densa) and Eurasian watermilfoil (Myriophyllum spicatum). These plants are estimated to cover about 3,100 acres, or 15% of the lake's surface. The NC Division of Water Resources has been applying herbicides to the plants in the lake since 1991. The herbicide treatments increased every year from 1991 to 1994. In 1995, the pesticides were cut back as grass carp were introduced to the lake to control the plants. Additional treatments of the plants are planned for 1996 but will take into account the effects of the grass carp. The need for nutrient controls to the lake should be examined prior to completion of the next basin plan.

Roanoke Rapids Reservoir (Subbasin 08)
Roanoke Rapids Reservoir is located immediately below Lake Gaston. This body of water is impaired due to the infestation of exotic weeds such as hydrilla (Hydrilla verticillata), Brazilian Elodea (Egeria densa), and Eurasian watermilfoil (Myriophyllum spicatum). The lake was rated mesotrophic in 1994 and nutrient values have remained low to moderate since 1983. North Carolina Power and the N.C. Division of Water Resources have been considering options for treatment of macrophytes in Roanoke Rapids Lake. The watershed is being targeted for NPS pollution controls.

E. RUNOFF FROM URBAN STORMWATER AND DEVELOPMENT

Water quality impairment from growth and development is becoming a concern in the Roanoke River Basin. Two streams are identified as being partially impaired at least in part as a result of urban runoff based on DWQ's most recent biological monitoring. These are Nutbush Creek which is adjacent to the City of Henderson and Marlowe Creek which is adjacent to Roxboro.

DWQ administers several programs aimed at minimizing water quality impacts from urban stormwater runoff. These include 1) NPDES stormwater permit requirements for municipalities greater than 100,000 in population 2) NPDES stormwater permit requirements for certain industrial activities and 3) programs for the control of development activities near High Quality Waters (HQW), Outstanding Resource Waters (ORW) and designated Water Supply (WS) watersheds.

Henderson and Roxboro are not required to develop stormwater programs but are encouraged to consider the several basic steps, listed below, that could be undertaken at relatively low cost to help control urban stormwater pollution.

- Mapping of municipal storm sewer systems and outfall points, and developing procedures to update this information.
- Evaluating existing land uses in the local government's jurisdictional area to determine where sources of stormwater pollution may exist. In addition, local government activities and programs could be evaluated to determine where existing activities address stormwater management in some way, or could be modified to do so.
- Developing educational programs to inform citizens of activities that may contribute pollutants to stormwater runoff (dumping oil, paint or chemicals down storm drains) and offering ways of carrying out such activities in an environmentally sound manner. Storm drain stenciling is a good example of a low cost educational tool.
- Developing programs to locate and remove illicit connections (illegal discharge of non-stormwater materials) to the storm sewer system. These often occur in the form of floor drains and similar connections. In practice, stormwater management programs represent an area where local governments can develop their own ideas and activities for controlling sources of pollution.
- Reviewing local ordinances pertaining to parking, curb and gutter and open space requirements. Many of these local ordinances could be modified to enhance water quality protection from urban stormwater runoff impacts. Maintaining riparian buffer strips along streams is an example.

DWQ's urban stormwater staff have recently completed a series of stormwater workshops across the state for the benefit of local governments and others on addressing urban stormwater pollution. DWQ can provide additional information to interested local governments or can provide references of other local governments in the state that are undertaking programs on their own.

F. FECAL COLIFORM BACTERIA

Fecal coliforms are bacteria typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of disease-causing bacteria and viruses. They enter surface waters from a number of sources including failing onsite wastewater systems, broken sewer lines, improperly treated discharges of domestic wastewater, pump station overflows, and runoff carrying livestock and wildlife wastes. Maintaining disease-free waters in the Roanoke is particularly important in light of extensive use of the waters and for recreation (swimming, boating, tubing) and water supplies.

There are several water bodies where fecal coliform standards have been exceeded in at least 25% of the samples taken by DWQ. These sampling sites are listed below followed by the percentage of samples above the state standard of 200/100 ml.

1) Dan River at NC Hwy 704 near Francisco (33.3%)
2) Mayo River at SR 1358 Near Price (33.3%)
3) Dan River at SR 2150 near Wentworth (43%)
4) Dan River at SR 1716 near Mayfield (40%)
5) Dan River at Hwy 62 at NC/VA line at Milton (28.6%)
6) Hyco Creek at US 158 near Leasburg (26.7%)
7) Marlowe Creek at SR 1322 near Woodsdale (43%)
8) Nutbush Creek at SR 1317 near Henderson (26.7%)

Therefore, the following general recommendations for addressing fecal coliform contamination in both fresh and estuarine waters are outlined:

- Proper maintenance of onsite waste disposal systems (such as septic tanks).
- Maintenance and repair of sanitary sewer lines by WWTP authorities.
- Elimination of direct unpermitted discharges of domestic sewage wastes (also known as "straight pipes") from homes and businesses to streams or stormwater systems.
- Proper management of livestock to keep wastes from reaching surface waters.
- Encouragement of local health departments and other appropriate State agencies to routinely monitor waters known to be used for body contact recreation (e.g., swimming and tubing). DWQ has classified 144 miles of streams for primary water contact.

G. RECLASSIFICATION OF HIGH RESOURCE VALUE WATERS

Waters considered to be biologically sensitive or of high resource value may be afforded protection through reclassification to HQW (high quality waters), ORW (outstanding resource waters) or WS (water supply), or they may be protected through more stringent NPDES permit conditions. Waters eligible for reclassification to HQW or ORW may include those designated as native trout waters, critical habitat for threatened or endangered species (as designated by the NC Wildlife Resources Commission), waters having Excellent water quality, or waters used for domestic water supply purposes and classified WS I or II.

Portions of the Cascade and Indian Creeks and their tributaries have been identified as potential candidates for reclassification to ORW. These streams will be evaluated for reclassification during the next basin schedule.

H. MANAGING FLOWS IN THE ROANOKE RIVER FOR WATER QUALITY PROTECTION

Variations in flow can greatly affect the water quality of a river system. Any attempts to protect water quality must take these variations into account. In addition, the operations of Kerr, Gaston and Roanoke Rapids Reservoirs are interconnected and managed by four independent entities under normal operations. The reservoirs are used for power generation and flood control. Flows downstream of them are highly regulated and their management can effect water quality and habitat in downstream areas.

Several potential occurrences have the capacity to alter the flow conditions in the basin, especially in the Roanoke River. For example, the pipeline proposed by the City of Virginia Beach may consume up to 60 MGD. Other local governments already are turning to the Roanoke River as a water supply source, and more will in the future. A study by the NC Division of Water Resources estimated that consumptive water use in the Roanoke Basin will increase approximately 240% from 1980 to 2010. In 2001, FERC will relicense the Gaston-Roanoke Rapids project. FERC will reevaluate the entire operation of that project and may impose a significantly different flow regime. The precise effects of these contingent actions cannot be reliably predicted. This reinforces the need to develop more fully models of the lower basin, and to plan for the most efficient use of this resource so as not to compromise water quality.

DWQ recognizes the need to establish and implement an appropriate flow regime. To date, DWQ has not studied this aspect of the Roanoke River Basin sufficiently to enable it to recommend a comprehensive flow regime. The United States Fish and Wildlife Service has proposed a year round flow regime based on the preimpoundment hydrograph. The Service suggests that such a regime is important to protect instream uses, such as fish spawning. DWQ hopes that the water quality modeling being undertaken as part of the relicensing of the Gaston and Roanoke Rapids hydroelectric projects will be used by the US Army Corps of Engineers to develop a water quality model that will allow DWQ and others to evaluate the merits of this and other suggested regimes, and promote an appropriate plan.

FUTURE INITIATIVES IN THE ROANOKE RIVER BASIN

LOWER ROANOKE INSTREAM FLOW STUDIES

The license granted by FERC for the Roanoke Rapids and Gaston Hydropower project on the Roanoke River expires on January 31, 2001. North Carolina Power owns and operates this hydropower project and intends to submit an application for a new FERC license by the beginning of 1999. The Department of Environment, Health, and Natural Resources will be involved in the development and review of the license application. DWQ is currently working with NC Power on the flow and water quality study plans to be addressed during the relicensing process.

DWQ has also attended a series of meetings with NC Power and the US Army Corps of Engineers (COE) in response to a major fish kill on the Roanoke River in late July and early August, 1995. A "Lower Roanoke River Environmental Betterment Plan" was developed by NC Power in response to these meetings (See section 7.2 of Chapter 7). The purpose of the proposed plan is to minimize the possibility of a recurrence of a fish kill similar to the one that happened in the summer of 1995. The proposed elements of the plan include initiating an agreement with the COE to mitigate the impact of lower Roanoke River hypoxic swamp water drainage into the mainstem of the river, the encouragement of a lower Roanoke River environmental monitoring and communications network, increasing minimum flow releases from Roanoke Rapids dam during critical summer conditions and the promotion of lower Roanoke River basin water quality modeling studies.

NONPOINT SOURCE CONTROL STRATEGIES AND PRIORITIES

- Establishment of nonpoint source basin teams in each basin. Each team will include representatives from agriculture, local governments, environmental groups, construction, mining, onsite wastewater disposal, forestry, solid waste, wetland, groundwater, the League of Municipalities and others. Teams will provide descriptions of NPS activities within each basin, conduct assessments of NPS controls in targeted watersheds, identify future monitoring sites, develop five-year action plans, and develop funding proposals to obtain federal nonpoint source funds for targeted watersheds.
- Promote wetlands protection. Future management strategies will be targeted at protecting and maintaining the water quality functions of wetlands and encouraging their use for nonpoint source pollution abatement. This will include the promotion of wetland acquisition and restoration by state, federal, and local government agencies and national, regional, and local land trusts.
- Interagency Water Quality Monitoring. DWQ has begun the process of coordinating with other natural resource agencies on the idea of interagency water quality monitoring across the state. There is a need for more widespread monitoring data in order to better assess water quality, identify trends, improve water quality modeling capabilities and assure an ample supply of high quality water for aquatic life support, water supply and recreation.

FURTHER EVALUATION OF SWAMP SYSTEMS

Many of the waterbodies in the eastern third of the State are classified as swamp waters. It is difficult to evaluate monitoring data in these systems to determine if a waterbody is impaired. For example, a swamp may have low dissolved oxygen concentrations, but these may be due to natural background concentrations rather than from impacts from point and nonpoint sources. DWQ will continue its efforts to evaluate these systems using chemical and biological data.

GENERAL NPDES PROGRAM INITIATIVES

In the next five years, efforts will be continued to:

- improve compliance with permitted limits;
- improve pretreatment of industrial wastes to municipal wastewater treatment plants so as to reduce the toxicity in effluent wastes;
- encourage pollution prevention at industrial facilities in order to reduce the need for pollution control;
- require dechlorination of chlorinated effluents or use of alternative disinfectants;
- require multiple treatment trains at wastewater facilities; and
- require plants to begin plans for enlargement well before they reach capacity.

Longer-term objectives will include refining overall management strategies after obtaining feedback on current management efforts during the next round of water quality monitoring. Long-term point source control efforts will stress reduction of wastes entering wastewater treatment plants, seeking more efficient and creative ways of recycling byproducts of the treatment process (including nonpotable reuse of treated wastewater), and keeping abreast of and recommending the most advanced wastewater treatment technologies.

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The purpose this Basinwide Water Quality Management Plan is to report to citizens, policy makers and the regulated community on

- the current status of surface water quality in the basin,
- major water quality concerns and issues,
- projected trends in development and water quality,
- the long-range water quality goals for the basin, and
- recommended point and nonpoint source management options.

This Plan presents strategies for management of point sources and nonpoint sources of pollution. Section 1.2 provides an overview of the plan format to assist in the use and understanding of the document. It is one of a series of basinwide water quality management plans that are being prepared by the Water Quality Section of the North Carolina Division of Environmental Management (DEM). Plans will be prepared for all seventeen of the state's major river basins over the next five years as shown in Figure 1.1. An introduction to the basinwide management approach and a statewide basinwide permitting schedule are presented in Section 1.3.

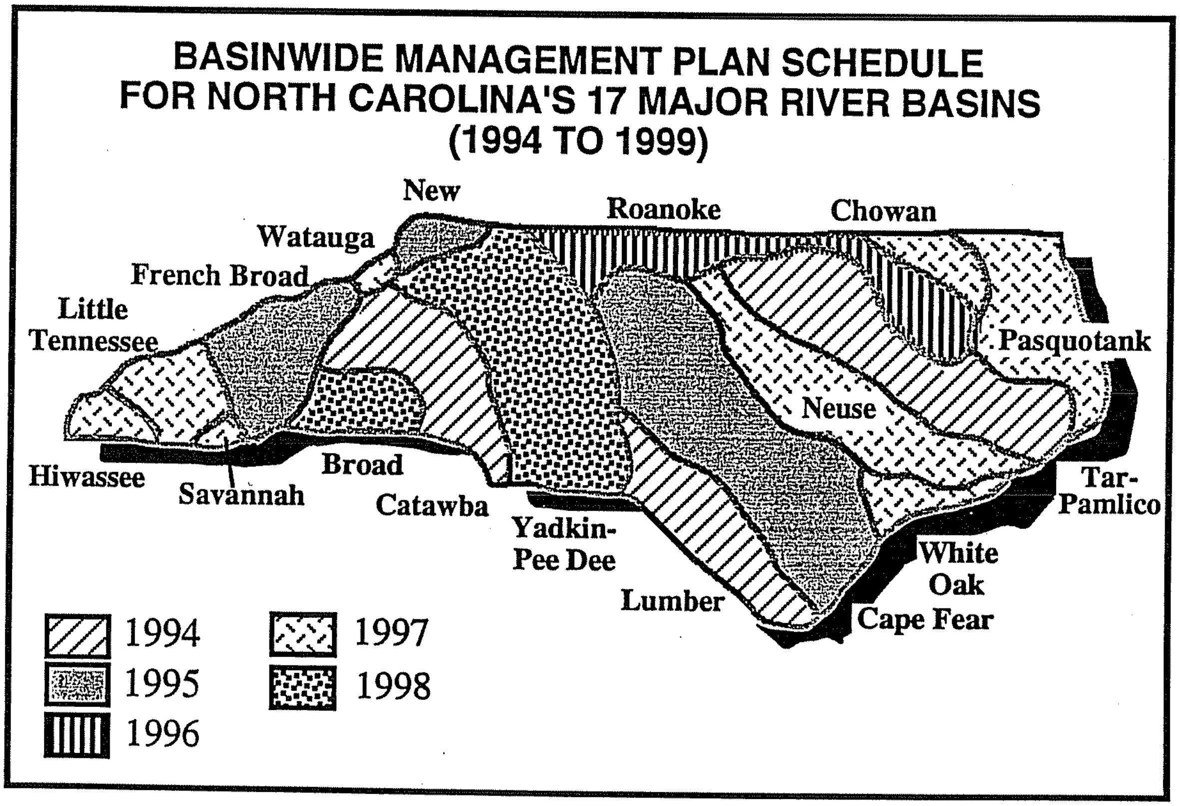


Figure 1.1 Basinwide Management Plan Schedule (1994 to 1998)

1.2 GUIDE TO USE OF THIS DOCUMENT

CHAPTER 1: Introduction - This chapter provides a non-technical description of the purpose of this plan, the basinwide water quality management approach and how this approach will be administered. The description of the basinwide management approach is based primarily on a 54-page document entitled *North Carolina's Basinwide Approach to Water Quality Management: Program Description - Final Report/August 1991* (Creager and Baker, 1991).

CHAPTER 2: General Basin Description - This chapter provides a general description of the basin. Some of the specific topics covered include:

- an overview of the major features such as location, rainfall, population, physiography, etc.
- hydrology of the basin and its subbasins
- a summary of land cover within the basin based on results of a 1982 and 1992 Nationwide Resources Inventory (NRI) conducted by the US Department of Agriculture Natural Resources Conservation Service.
- population growth trends and densities by subbasin using 1970, '80 and '90 census data.
- major water uses in the basin and DWQ's program of water quality classifications and standards.

CHAPTER 3: Causes and Sources of Water Pollution in the Basin - Chapter 3 discusses the probable causes and sources of surface water degradation in the basin. It describes both point and nonpoint sources of pollution as well as a number of important causes of water quality impacts including sediment, biochemical oxygen demand (BOD), toxic substances, nutrients, color, fecal coliform bacteria and others. It also discusses pollutant loading in the basin and generally discusses water quality problem areas.

CHAPTER 4: Water Quality Status in the Basin - Data generated by DWQ on water quality and biological communities are reviewed and interpreted in this chapter in order to assess current conditions and the status of surface waters within the basin. The chapter describes the various types of water quality monitoring conducted by DWQ, summarizes water quality in each of the subbasins in the basin and presents a summary of use support ratings for those surface waters that have been monitored or evaluated.

CHAPTER 5: Existing Point and Nonpoint Source Pollution Control Programs - Chapter 5 summarizes the existing point and nonpoint source control programs available to address water quality problems. These programs represent the management tools available for addressing the priority water quality concerns and issues that are identified in Chapter 6. Chapter 5 also describes the concept of Total Maximum Daily Loads (TMDLs). TMDLs represent management strategies aimed at controlling point and nonpoint source pollutants on various water bodies within the basin.

CHAPTER 6: Basinwide Goals, Major Water Quality Concerns and Recommended Management Strategies - Water quality issues identified in Chapters 2, 3 and 4 are evaluated and prioritized based on use-support ratings, degree of impairment, and the sensitivity of the aquatic resources being affected. Recommended management strategies, or TMDLs, are then presented that describe how the available water quality management tools and strategies described in Chapter 5 will be applied in the basin. This includes generalized wasteload allocations for dischargers (for nutrients, biochemical oxygen demand (BOD) and toxicity) and recommended programs and best management practices for controlling nonpoint sources.

CHAPTER 7: Future Initiatives - This chapter presents future initiatives necessary to evaluate and manage human impacts on the natural resources of the basin. Management strategies need to be developed for a number of areas identified within the basin. Future programmatic initiatives will consider further evaluation of swamp waters, use of discharger self-monitoring data, promotion of non-discharge alternatives, and improved data management and expanded use of geographic information (GIS) computer capabilities.

1.3 NORTH CAROLINA'S BASINWIDE MANAGEMENT APPROACH

Introduction - Basinwide water quality management is a watershed-based management approach being implemented by DWQ which features basinwide permitting, integrating existing point and nonpoint source control programs, and preparing basinwide management plan reports.

DWQ is applying this approach to each of the seventeen major river basins in the state as a means of better identifying water quality problems, developing appropriate management strategies, maintaining and protecting water quality and aquatic habitat, and assuring equitable distribution of waste assimilative capacity for dischargers. Other important benefits of the basinwide approach include improved efficiency, increased cost-effectiveness, better consistency and equitability, and improved public awareness and involvement in management of the state's surface waters.

After conducting public workshops to identify areas of concern and major issues, a basinwide management plan document is prepared for each basin. The plans are circulated for public review and are presented at public meetings in each river basin. The management plan for a given basin is completed and approved preceding the scheduled date for basinwide permit renewals in that basin. The plans are then to be evaluated, based on followup water quality monitoring, and updated at five year intervals thereafter.

DWQ began formulating the idea of basinwide management in the late 1980s, established a basin permitting schedule in 1990, began basinwide monitoring activities in 1990, and published a basinwide program description in August 1991. Basinwide management entails coordinating and integrating, by major river basin, DWQ's water quality program activities. These activities, which are discussed further in Section 1.4, include permitting, monitoring, modeling, nonpoint source assessments, and planning.

Water Quality Program Benefits - Several benefits of basinwide planning and management to North Carolina's Water quality program include: (1) *improved program efficiency,* (2) *increased effectiveness*, (3) better *consistency and equitability* and (4) *increased public awareness of the state's water quality protection programs*. First, by reducing the area of the state covered each year, monitoring, modeling, and permitting efforts can be focused. As a result, *efficiency increases* and more can be achieved for a given level of funding and resource allocation. Second, the basinwide approach is in consonance with basic ecological principles of watershed management, leading to *more effective* water quality assessment and management. Linkages between aquatic and terrestrial systems are addressed (e.g., contributions from nonpoint sources) and all inputs to aquatic systems, and potential interactive, synergistic and cumulative effects, are considered. Third, the basinwide plans will provide a focus for management decisions. By clearly defining the program's long-term goals and approaches, these plans will encourage *consistent* decision-making on permits and water quality improvement strategies. Consistency, together with greater attention to long-range planning, will promote a *more equitable* distribution of assimilative capacity, explicitly addressing the trade-offs among pollutant sources (point and nonpoint) and allowances for economic growth.

Basinwide management will also promote integrating 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 prevent overloading of the receiving waters and to allow for a reasonable margin of safety to ensure compliance with water quality standards.

Basinwide Planning Schedule - The following table presents the overall basin schedule for all 17 major river basins in the state. Included are the dates for permit reissuance and the dates by which management plans are to be completed for each basin.

Table 1.1 Basinwide Permitting and Planning Schedule for North Carolina's 17 Major River Basins (1993 through 1998).

Basin	Discharge Permits to be Issued	Target Date for Basin Plan Approval	Basin	Discharge Permits to be Issued	Target Date for Basin Plan Approval
Neuse	4/93	2/93 (approved)	**Roanoke**	**1/97**	**7/96**
			White Oak	6/97	1/97
Lumber	11/94	5/94 (approved)	Savannah	8/97	4/97
			Watauga	9/97	4/97
Tar-Pamlico	1/95	12/94 (approved)	Little Tennessee	10/97	5/97
Catawba	4/95	2/95 (approved)	Hiwassee	12/97	5/97
French Broad	8/95	5/95 (approved)			
New	11/95	7/95 (approved)	Chowan	1/98	8/97
			Pasquotank	1/98	8/97
Cape Fear	1/96	9/95 (approved)	Neuse (2nd cycle)	4/98	11/97
			Yadkin-Pee Dee	7/98	1/98
			Broad	11/98	6/98

The number of plans to be developed each year varies from one to six and is based on the total number of permits to be issued each year. For example, the Cape Fear basin, the state's largest, has about as many dischargers as all six of the small basins in 1997. This has been done in order to balance the permit processing workload from year to year. In years where more than one basin is scheduled to be evaluated, an effort has been made to group at least some of the basins geographically in order to minimize travel time and cost for field studies and public meetings.

Plans to be updated every five years - The earliest basin plans will likely not achieve all of the long-term objectives for basinwide management outlined above. However, subsequent updates of the plans, every 5 years, will incorporate additional data and new assessment tools (e.g., basinwide water quality modeling) and management strategies (e.g., for reducing nonpoint source contributions) as they become available.

Basinwide Plan Preparation, Review and Public Involvement - Preparation of an individual basinwide management plan is a five year process which is broken down into four phases described below.

Year	Activity
1 to 3	Water Quality Data Collection/Identification of Goals and Issues: Year 1 entails identifying sampling needs and canvassing for information. It also entails coordinating with other agencies, the academic community and local interest groups to begin establishing goals and objectives and identifying and prioritizing problems and issues. Biomonitoring, fish community and tissue analyses, special studies and other water quality sampling activities are conducted in Years 2 and 3 by DWQ's Environmental Sciences Branch (ESB). These studies provide

information for assessing water quality status and trends throughout the basin and provide data for computer modeling.

3 to 4 Data Assessment and Model Preparation: Modeling priorities are identified early in this phase and are refined through assessment of water quality data from the ESB. Data from special studies are then used by DWQ's Technical Support Branch (TSB) to prepare models for estimating potential impacts of waste loading from point and nonpoint sources using the TMDL approach. Preliminary water quality control strategies are developed, based on modeling, with input from local governments, the regulated community and citizens groups during this period.

4 Preparation of Draft Basinwide Plan: The draft plan, which is prepared by DWQ's Planning Branch, is due for completion by the end of year 4. It is based on support documents prepared by ESB (water quality data) and TSB (modeling data and recommended pollution control strategies). Preliminary findings are presented at informal meetings through the year with local governments and interested groups, and comments are incorporated into the draft.

5 Public Review and Approval of Plan: At the beginning of year 5, the draft plan, after approval of the Environmental Management Commission (EMC), is circulated for review, and public meetings are held. Revisions are made to the document, based on public comments, and the final document is submitted to the EMC for approval midway through year 5. Basinwide permitting begins at the end of year 5.

Each basinwide management plan includes a minimum of six chapters as presented on page 2. A seventh chapter has also been added to the plans that discusses future initiatives needed to address water quality concerns.

Implementation - The implementation of basinwide planning and management will occur in phases. Permitting activities and associated routine support activities (field sampling, modeling, wasteload allocation calculations, etc.) have already been rescheduled by major river basin. All National Pollutant Discharge Elimination System (NPDES) permit renewals within a basin occur within a prescribed time period after completion of the final basin plan, and will be repeated at five year intervals (Table 1.2).

Table 1.2 Subbasin NPDES Permit Schedule for the Roanoke River Basin

Subbasin No.	Month/Year	Subbasin No.	Month/Year
030201	January, 1997	**030206**	April, 1997
030202	January, 1997	**030207**	April, 1997
030203	Febraury, 1997	**030208**	May, 1997
030204	April, 1997	**030209**	May, 1997
030205	April, 1997	**030210**	May, 1997

Basinwide NPDES permitting in the Roanoke River basin will occur during time intervals between January, 1997 and May, 1997. Table 1.2 lists each subbasin and the month in which permitting will occur for that subbasin.

1.4 BASINWIDE RESPONSIBILITIES WITHIN THE DWQ WATER QUALITY SECTION

The Water Quality Section is the lead state agency for the regulation and protection of the state's surface waters. It is one of four sections located within the Division of Water Quality. The other sections are Groundwater, Construction Loans and Grants and the Laboratory.

The primary responsibilities of the Water Quality Section are to maintain or restore an aquatic environment of sufficient quality to protect the existing and best intended uses of North Carolina's surface waters and to ensure compliance with state and federal water quality standards. The Section receives both state and federal allocations and also receives funding through the collection of permit fees. Policy guidance is provided by the Environmental Management Commission. The Water Quality Section is comprised of over 200 staff members in the central and seven regional offices (Figure 1.2). The major areas of responsibility are water quality monitoring, permitting, planning, modeling (wasteload allocations) and compliance oversight.

The Central office is divided into four branches, with each branch being subdivided into two units. The Planning Branch is responsible for developing water quality standards and classifications, program planning and evaluation, and implementation of new water quality protection programs. The *Water Quality Planning and Assessment Unit* handles surface water reclassifications, development of water quality standards, and the coordination of the state's nonpoint source program. The *Basinwide Assessment Unit* administers implementation of the basinwide management program and includes technical staff to assist in modeling nonpoint pollution sources, developing use support ratings and improving the section's GIS capabilities. It also coordinates EPA water quality planning grants, state environmental policy act responsibilities and the implementation of the Comprehensive Conservation and Management Plan (CCMP) that resulted from the Albemarle-Pamlico Estuarine Study (APES).

The Operations Branch is responsible for permit compliance tracking, the pretreatment program, water supply watershed protection/local government technical support, and the operator training and certification program. The *Facility Assessment Unit* includes both the permit compliance and pretreatment programs. The *Water Quality and Technical Assistance Unit* includes the water supply watershed protection program and the operator certification and training program. The former program assists local governments in meeting the requirements of the water supply watershed protection program. The latter program rates the complexity of operation of wastewater treatment plants and provides formal training for operators commensurate with the plant operating needs.

The Technical Support Branch is responsible for processing of discharge and nondischarge permits as well for preparing TMDLs and wasteload allocations for dischargers. The *Instream Assessment Unit* provides primary computer modeling support and is responsible for coordinating development of TMDLs and individual NPDES wasteload allocations. The *Permits and Engineering Unit* handles reviews and processing of permit applications for both discharging and nondischarging wastewater treatment systems.

The Environmental Sciences Branch is responsible for water quality monitoring, toxicity testing, biological laboratory certifications and the wetlands 401 Water Quality Certification program. The branch is divided into the Ecosystems Analysis Unit and the Aquatic Survey and Toxicology Unit. Some of the major functions of the *Ecosystems Analysis Unit* include biological and chemical

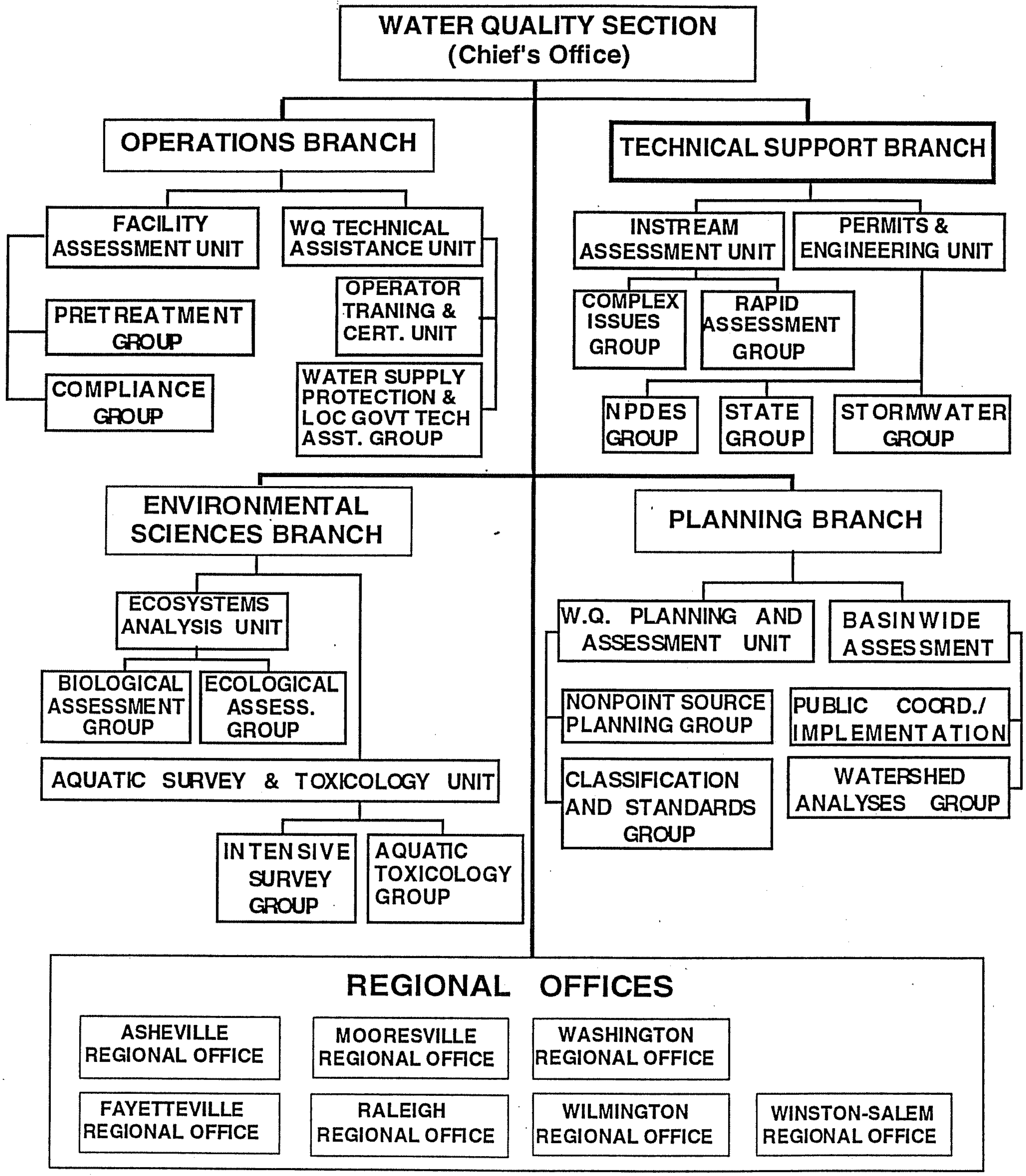


Figure 1.2 Organizational Structure of the DWQ Water Quality Section

water quality monitoring and evaluation, evaluating reclassification requests, algal analyses, benthic macroinvertebrate monitoring (biomonitoring), fish tissue and fish communities studies and wetlands assessment and certification. Major functions of the *Aquatic Survey and Toxicology Unit* include effluent toxicity testing, chemical toxicity evaluations, toxicity reduction evaluations (TRE), biological lab certification, biocide evaluations and related special studies, intensive surveys, special studies, dye studies, time-of-travel studies, long term biochemical and sediment oxygen demand, chemical water quality monitoring and lakes assessments.

The seven Regional Offices carry out activities such as wetland reviews, compliance evaluations, permit reviews and facility inspections for both discharging and nondischarging systems, ambient water quality monitoring, state environmental policy act reviews, stream reclassification reviews, pretreatment program support and operator training and certification assistance. In addition, they respond to water quality emergencies such as oil spills and fish kills, investigate complaints and provide information to the public.

Although the basic structure and major responsibilities within the Water Quality Section will remain unchanged, implementation of a basinwide approach to water quality management will require some modification of and additions to the tasks currently conducted by each branch and the regional offices. The goal of basinwide planning is to broaden the scope of management activities from a stream reach to the entire basin. Accomplishing this goal will require more complex water quality modeling, data interpretation, and database management within the water quality program. For example, more sophisticated methods of quantitatively estimating nonpoint source pollutant loads will need to be developed and applied. In addition, these quantitative estimates of nonpoint source loads will have to be integrated with information on point sources to determine the total loading to the system.

Planning for future growth and the possibility of incorporating "agency banking" (see Section 5.3) into the Water Quality Section's management objectives will require model projections of various potential scenarios to allocate the remaining assimilative capacity and fairly distribute control requirements. Finally, the link between water quality data and model projections for the multiple stream reaches within a basin, and the overlay of other relevant types of information, such as land use, will require expanded use of geographic information systems (GIS) with coordination and support from this state's Center for Geographic Information Analysis (CGIA).

1.5 STATE AND FEDERAL LEGISLATIVE AUTHORITIES FOR NORTH CAROLINA'S WATER QUALITY PROGRAM

Authorities for some of the programs and responsibilities carried out by the Water Quality Section are derived from a number of federal and state legislative mandates outlined below. The major federal authorities (Section 1.5.1) for the state's water quality program are found in sections of the Clean Water Act (CWA). State authorities listed in Section 1.5.2 are from state statutes.

1.5.1 Federal Authorities for NC's Water Quality Program

- **Section 301** - Prohibits the discharge of pollutants into surface waters unless permitted by EPA (see Section 402, below).
- **Section 303(c)** - States are responsible for reviewing, establishing and revising water quality standards for all surface waters.
- **Section 303(d)** - Each state shall identify those waters within its boundaries for which the effluent limits required by section 301(b)(1) A and B are not stringent enough to protect any water quality standards applicable to such waters.
- **Section 305(b)** - Each state is required to submit a biennial report to the EPA describing the status of surface waters in that state.

- **Section 319** - Each state is required to develop and implement a nonpoint source pollution management program.
- **Section 402** - Establishes the National Pollutant Discharge Elimination System (NPDES) permitting program. Allows for delegation of permitting authority to qualifying states (includes North Carolina).
- **Section 404/401** - Section 404 prohibits the discharge of fill materials into navigable waters and adjoining wetlands unless permitted by the US Army Corps of Engineers. Section 401 forbids any federal agency from issuing any license or permit, including a 404 permit, to conduct any activity which may result in a new discharge to the navigable waters, or the alteration of an existing discharge, unless the state has certified that the activity will comply with all state water quality or related standards. Thus, the applicant must receive a state Water Quality Certification prior to issuance of a 404 or other federal discharge-related permit.

1.5.2 State Authorities for NC's Water Quality Program

- **G.S. 143-214.1** - Directs and empowers the NC Environmental Management Commission (EMC) to develop a water quality standards and classifications program.
  G.S. 143-214.2 - Prohibits the discharge of wastes to surface waters of the state without a permit.
- **G.S. 143-214.5** - Provides for establishment of the state Water Supply Watershed Protection Program.
- **G.S. 143-214.7** - Directs the EMC to establish a Stormwater Runoff Program.
- **G.S. 143-215** - Authorizes and directs the EMC to establish effluent standards and limitations.
- **G.S. 143-215.1** - Outlines methods for control of sources of water pollution (NPDES and nondischarge permits, statutory notice requirements, public hearing requirements, appeals, etc.).
- **G.S. 143-215.1** - Empowers the EMC to issue *special orders* to any person whom it finds responsible for causing or contributing to any pollution of the waters of the state within the area for which standards have been established.
- **G.S. 143-215.3(a)** - Outlines additional powers of the EMC including provisions for adopting rules, charging permit fees, delegating authority, investigating fish kills and investigating violations of rules, standards or limitations adopted by the EMC.
- **G.S. 143-215.6A, 143-215.6B and 143-215.6C** - Includes enforcement provisions for violations of various rules, classifications, standards, limitations, provisions or management practices established pursuant to G.S. 143-214.1, 143-214.2, 143-214.5, 143-215, 143-215.1, 143-215.2. 6A describes enforcement procedures for civil penalties. 6B outlines enforcement procedures for criminal penalties. 6C outlines provisions for injunctive relief.
- **G.S. 143-215.75** - Outlines the state's Oil Pollution and Hazardous Substances Control Program.

REFERENCES CITED: CHAPTER 1

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

CHAPTER 2

GENERAL DESCRIPTION OF THE ROANOKE RIVER BASIN

2.1 ROANOKE RIVER BASIN OVERVIEW

The Roanoke River Basin begins in the Blue Ridge Mountains of Virginia and flows in a generally southeastern direction into the Albemarle Sound in North Carolina. Figure 2.1 provides a general view of the entire basin, including the portion that is in Virginia. Roughly 64% of the drainage area of the Roanoke is in Virginia. Figure 2.2 illustrates the location of the basin within the boundaries of North Carolina.

The North Carolina portion of the Roanoke Basin is composed of two major parts: the Dan River and its tributaries in the western section, upstream of Kerr Lake, and the Roanoke River as it enters North Carolina in the eastern section. The Roanoke River mainstem enters North Carolina through Kerr Lake and then flows into Lake Gaston and Roanoke Rapids Lake before regaining its riverine form. The North Carolina portion of the basin contains twelve lakes that have been monitored by the Division of Water Quality, all of which are man-made reservoirs.

There are 16 counties and 37 municipalities located in whole or in part in the basin. Based on 1990 census data, the population of the basin is 263,661 people. 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 78 persons per square mile versus a statewide average of 123 persons per square mile. The percent population growth over the past ten years (1980 - 1990) was 15% versus a statewide average of 12.7%

Over half of the land in the river basin is forested. Statistics provided by the US Department of Agriculture, Natural Resources Conservation Service indicate that during the last decade there has been an increase in the amount of developed land and a decrease in the amount of cultivated cropland.

2.2 BASIN HYDROLOGY

The Roanoke River originates in the Blue Ridge Mountains of Virginia and flows east/southeast through the Piedmont and Coastal Plain to the Albemarle Sound in North Carolina. The entire watershed is approximately 9,666 square miles in size, 3,600 of which are in North Carolina. Part of the upper portion of the basin in the Dan River area is designated as a North Carolina State Water Trail by the NC Division of Parks and Recreation. The lower Roanoke River is important habitat for anadromous fish, including striped bass, and is bounded by vast forested wetland areas.

The watershed is divided into 5 major hydrologic areas (*8-digit hydrologic units*) by the U.S. Water Resources Council and the U.S. Geologic Survey (USGS). 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 River and tributaries. These major hydrologic areas are further subdivided by DWQ for management purposes into 10 subbasins denoted by 6-digit numbers (03-02-01 to 03-02-10) as shown in figures 2.3, 2.4a and 2.4b. Table 2.1 shows the breakdown of USGS hydrologic units and DWQ's corresponding subbasins.

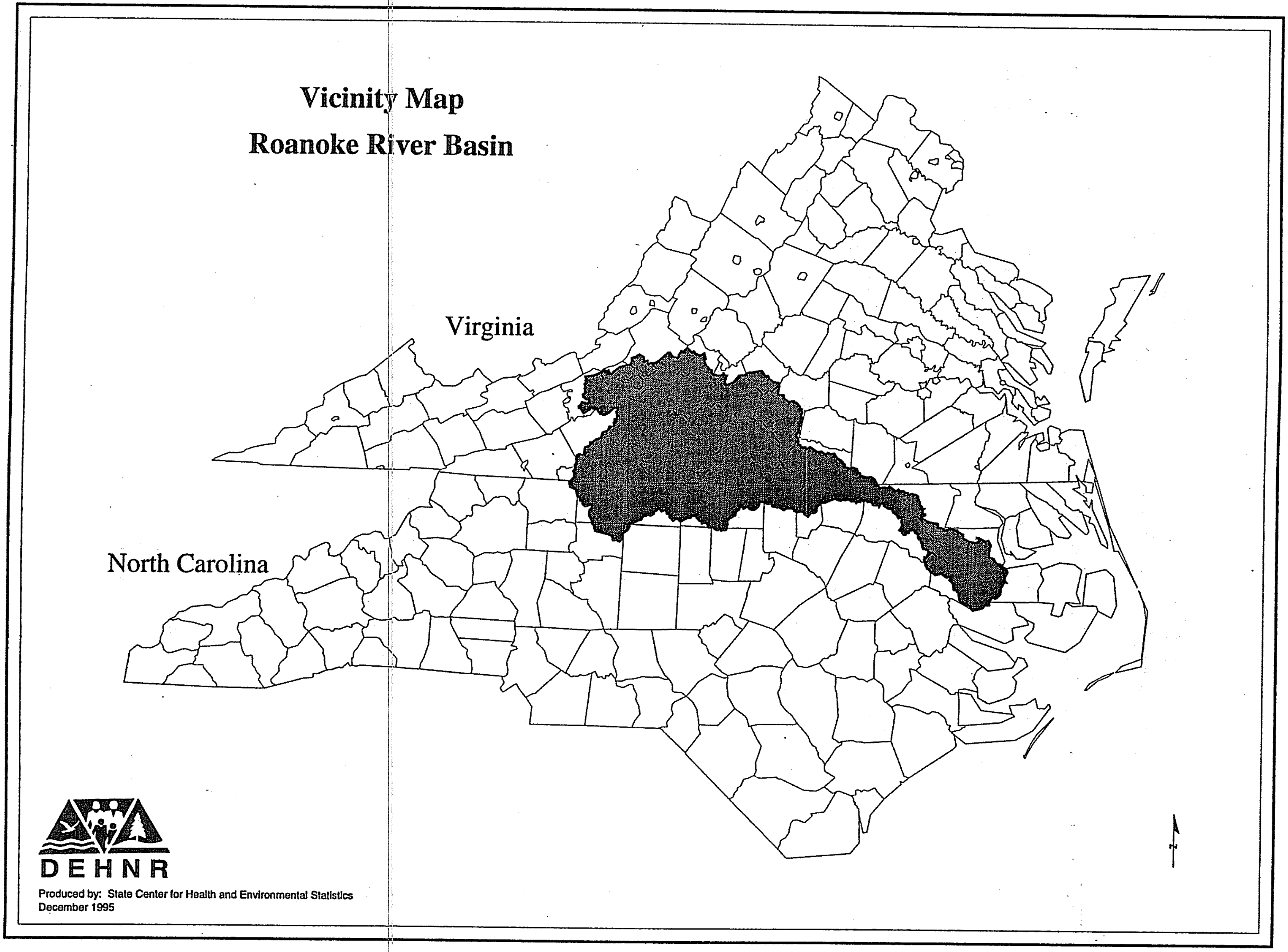
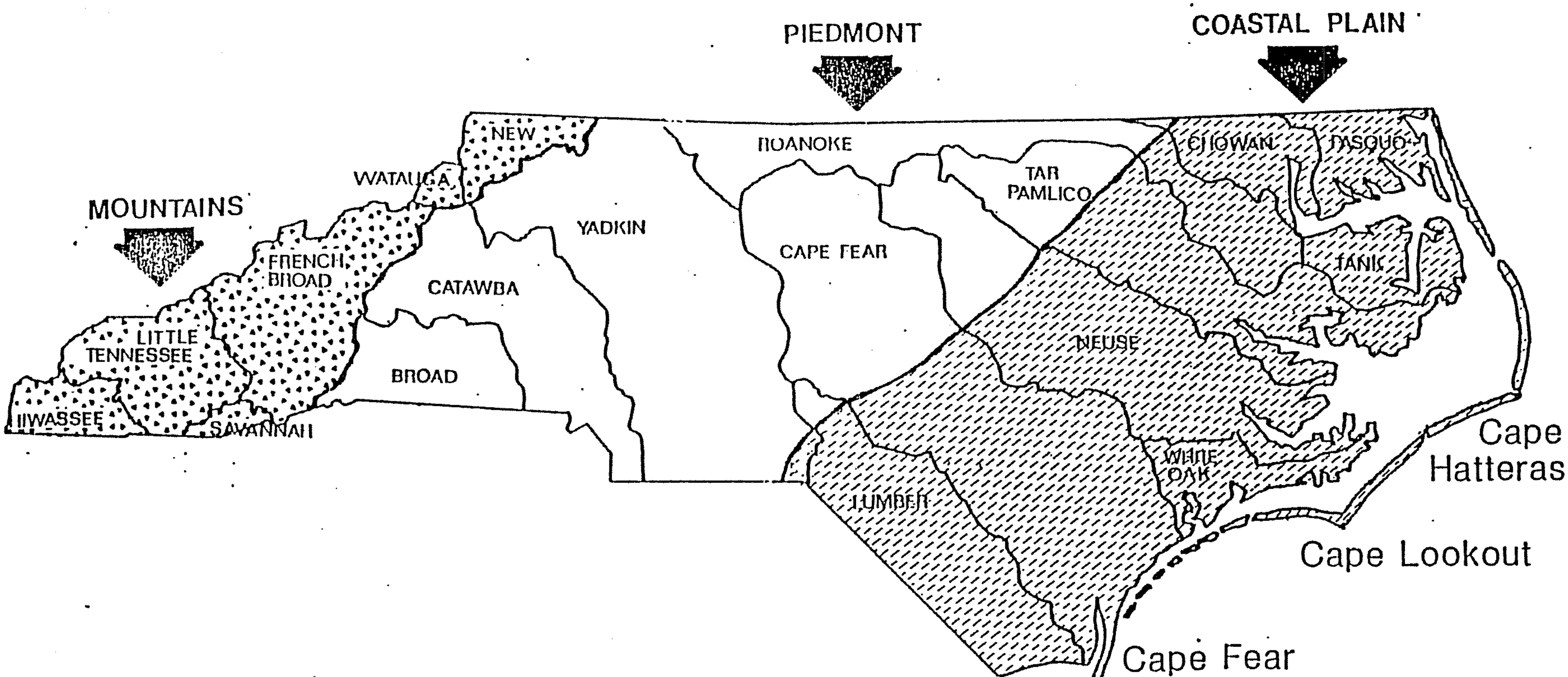


Figure 2.1 The Roanoke River Basin in North Carolina and Virginia



River Basins And Physiographic Zones Of North Carolina

Figure 2.2 Physiographic Regions and Major River Basins in North Carolina

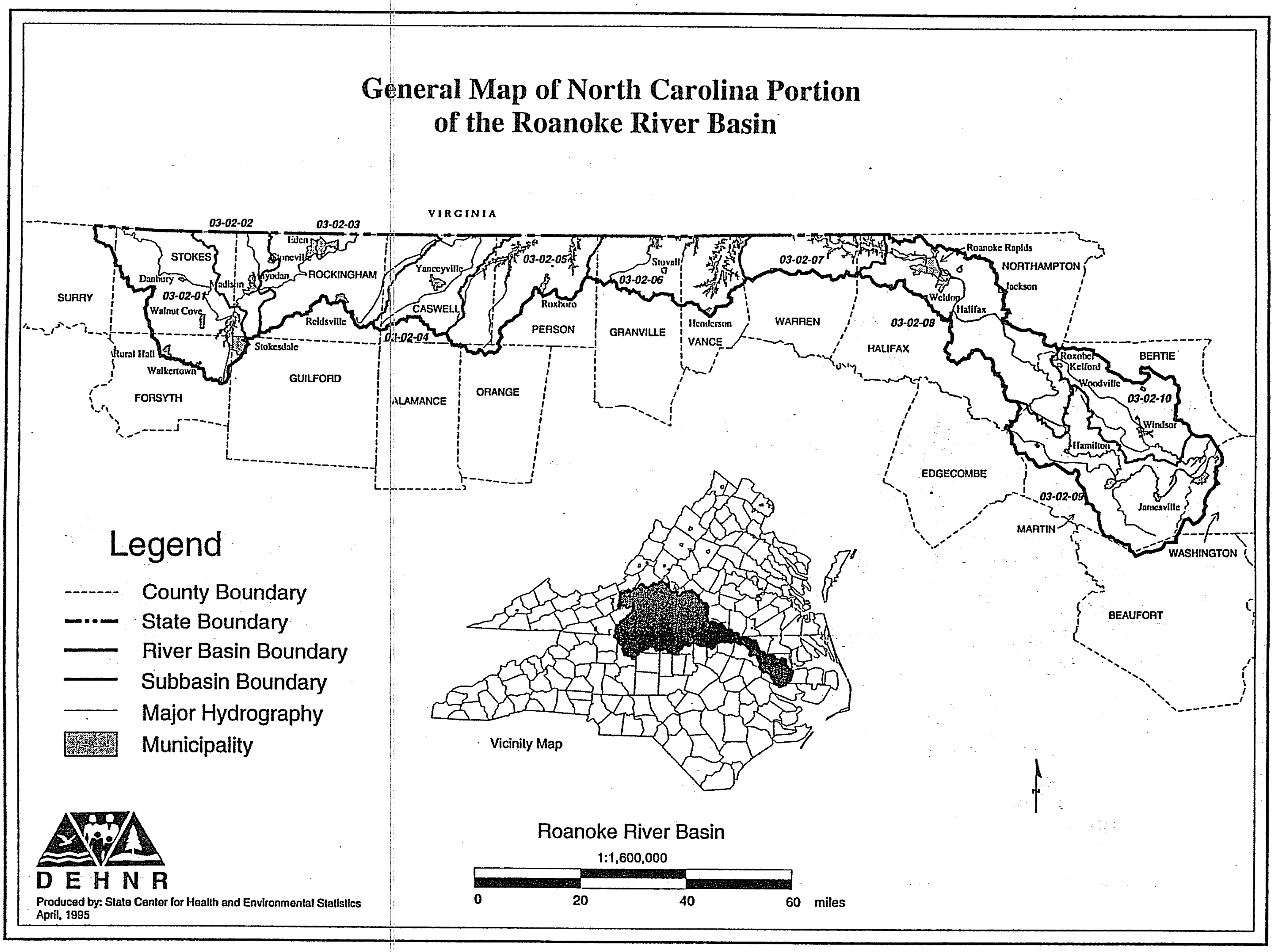


Figure 2.3 General Map of the Roanoke River Basin in North Carolina

General Map of the Western Roanoke River Basin

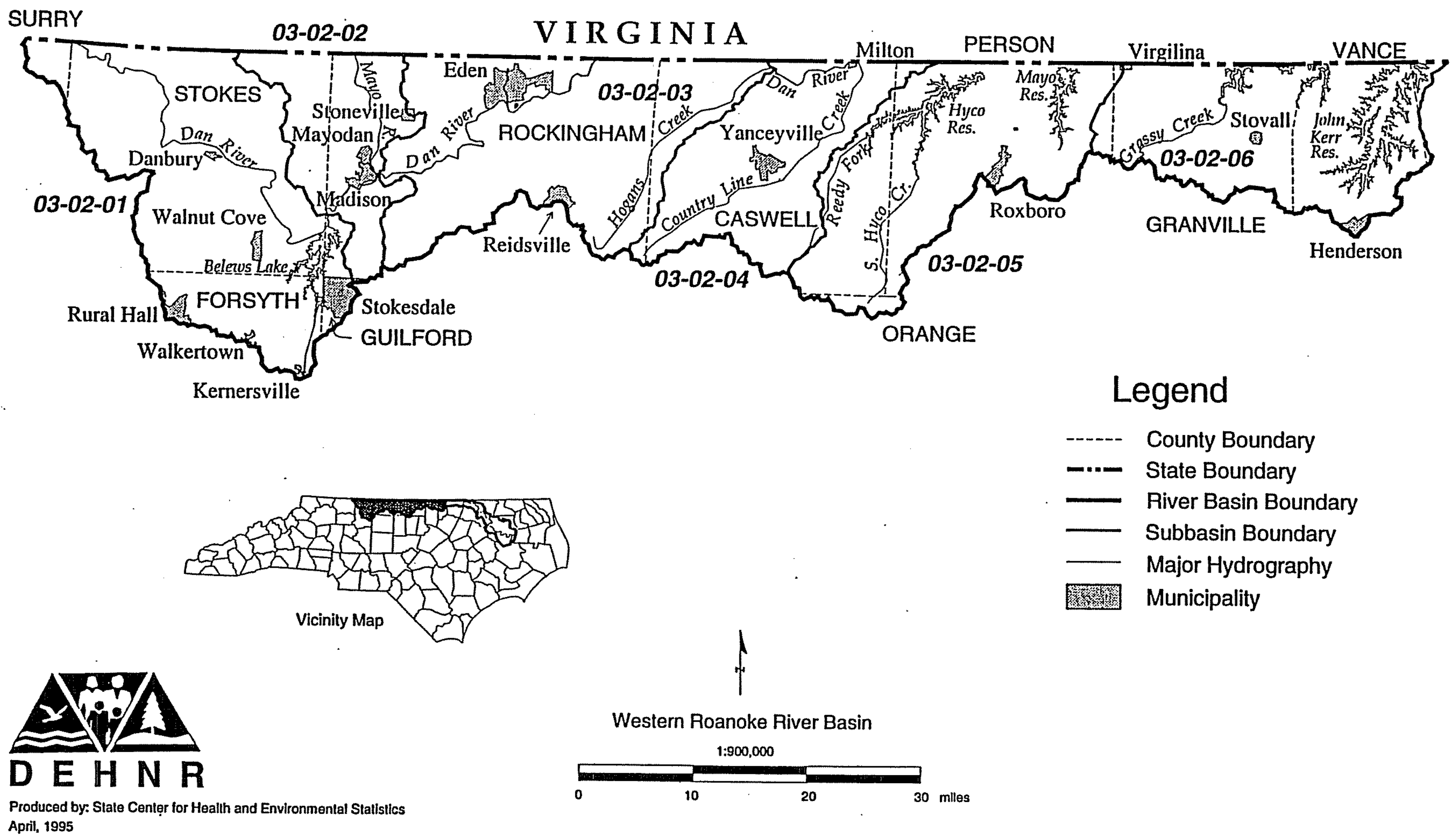


Figure 2.4a Western Roanoke River Basin

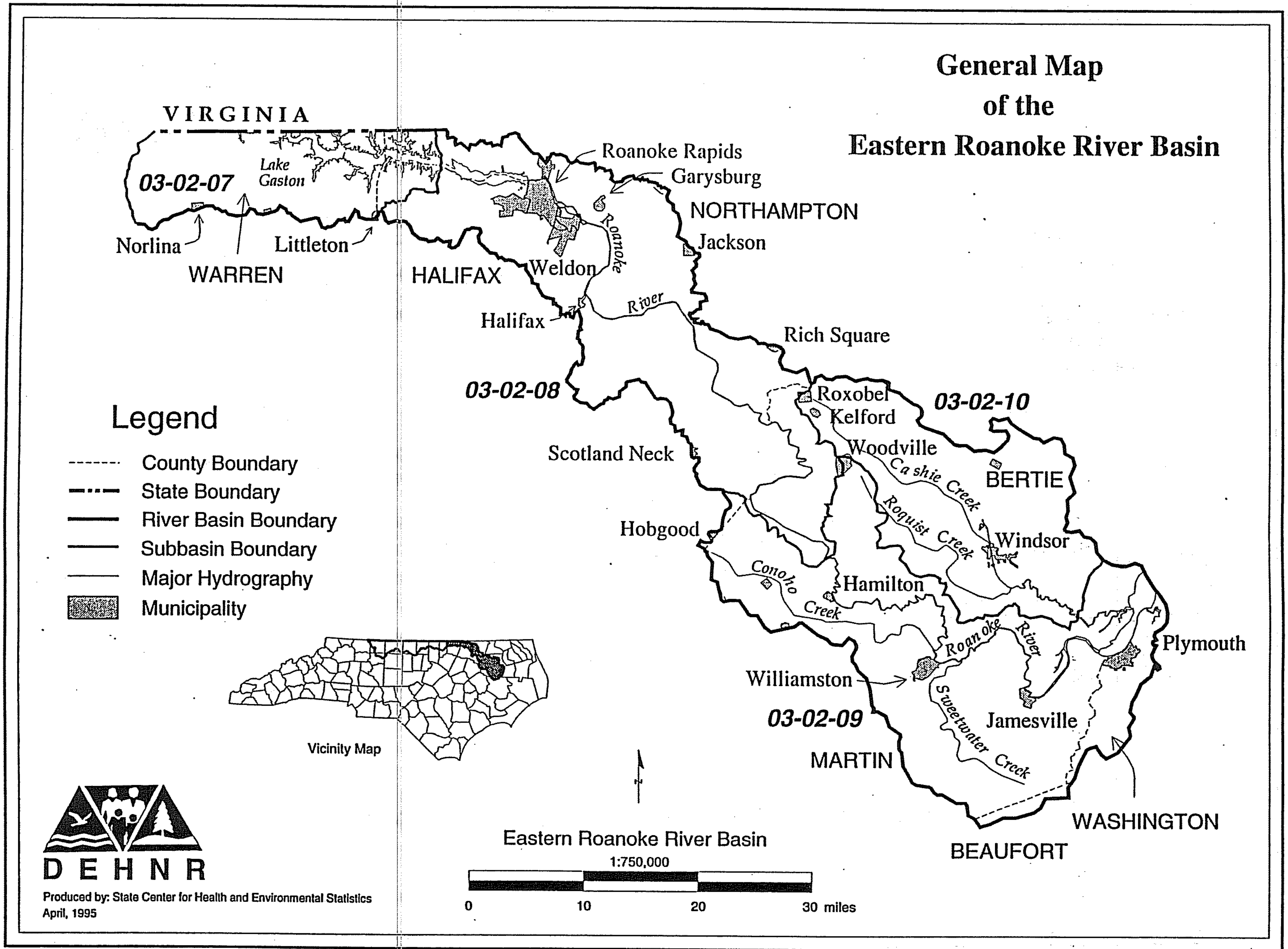


Figure 2.4b Eastern Roanoke River Basin

Table 2.1. Hydrologic Divisions in the Roanoke River Basin

Watershed Name and Major Tributaries	USGS 8-digit Hydrologic Units	DWQ Subbasin 6-digit codes Figure 2.3
Dan River (NC Portion)	**03010103**	**030201 to 03**
Dan River and Town Fork Creek	"	01
Dan River and Mayo River	"	02
Dan River, Wolf Creek, Hogans Creek	"	03
Country Line Creek and Hyco Reservoir	**03010104**	**030204 to 05**
Country Line Creek, Moon Creek	"	04
North and South Hyco Creeks and Hyco Reservoir	"	05
Kerr Reservoir and tributaries	**03010102**	**030206**
Lake Gaston and Smith Creek	**03010106**	**030207**
Roanoke River and tributaries	**03010107**	**030208 to 10**
Roanoke Rapids Lake and Roanoke River	"	08
Lower Roanoke River, Conoho Creek	"	09
Cashie River	"	10

There are six major lakes in the North Carolina portion of the Roanoke River Basin. These are Belews, Hyco, Mayo, Kerr, Gaston and Roanoke Rapids. These man-made reservoirs serve a variety of purposes including electric power generation, public water supply, recreation, and flood control. Flow from Kerr Reservoir, Lake Gaston and Roanoke Rapids Lake influences water quality in the lower Roanoke River. These three reservoirs are managed by Virginia Power/North Carolina Power and the U.S. Army Corps of Engineers for electrical energy production and flood control. Physical attributes of these lakes are provided in Table 2.2.

Table 2.2. Physical attributes of Kerr Reservoir, Lake Gaston and Roanoke Rapids Lake

Reservoir	Elevation at full power pool (ft.)	Surface area at full power pool (acres)	Volume at full power pool[1] (acre-ft.)	Hydro-power drawdown (ft.)	Flood storage volume (acre-ft.)	Retention Time (days)[2]
Kerr	300	48,900	1,472,000	7	1,278,000	93
Gaston	200	203,000	450,000	1	63,000	29
Roanoke Rapids	132	46,000	77,140	3-5	0	5

1 Excludes flood storage volume.
2 Based on full power pool volume and annual mean flow of 7,951 cfs as measured at Roanoke Rapids gauge for water years 1964-1993.

Kerr Reservoir was established in 1950 and flood control is its primary function. Because of its use for flood control, it has a larger flood storage capacity (1,278,000 acre-ft.) than Lake Gaston or Roanoke Rapids.

Lake Gaston was constructed between 1960 and 1962. Its function is energy production and it is owned and operated by Virginia/North Carolina Power. The water level fluctuation is generally within one foot when the reservoir is being operated for energy production. Lake Gaston has an additional three feet of storage for flood control which translates to an additional storage of 63,000 acre-feet.

Roanoke Rapids Lake was constructed between 1953 and 1955. Energy production is its sole function and it is owned and operated by Virginia/North Carolina Power. This reservoir has no flood storage capacity. It is linked directly with Lake Gaston. Because of the differences in hydraulic and storage capacities between the two reservoirs, drawdown may range between 3-5 feet per day during operations at Roanoke Rapids Lake.

Three factors influence how water is discharged among the reservoirs and the portion of the river below Roanoke Rapids Lake. These include reservoir operations during dry, normal and flood periods; energy demand; and reservoir operations during striped bass spawning season. Aside from the actual flow rate in the lower Roanoke, the timing of flow release also can have a significant impact on water quality. For example, during July of 1995, the Corps of Engineers had been operating Kerr Reservoir in flood control mode at ranges from about 19,000 cfs (cubic feet per second) to 25,000 cfs for about thirty days, after which flows were reduced overnight to about 4,000 cfs at the Roanoke Rapids dam. A major fish kill in the Roanoke followed that event, and it is believed to have been caused by drainage of hypoxic swamp water into the river mainstem following inundation of the flood plain during the high flow release period.

Water allocation among the reservoirs for energy production varies depending on the quantity of water available and the demand for energy. At least one unit at Roanoke Rapids is always operated to maintain the required minimum flow which varies from 1,000 cfs to 2,000 cfs depending on the month of the year. During weekends when Gaston is not usually operated, the Roanoke Rapids Lake storage capacity is used to maintain minimum flow. Maintaining a 2,000 cfs flow rate during a weekend will result in a drawdown of Roanoke Rapids Lake of about 2.5 feet.

The lower Roanoke River (below Roanoke Rapids) and its tributaries support an important recreational and commercial fishery. Anadromous fish using these waters include striped bass, blueback herring, Atlantic sturgeon, alewife, hickory shad and American shad. A portion of this area is important for striped bass spawning. Spawning begins in April and ends by mid-June. In the 1980's a decline in the number of spawning striped bass was noted. This was followed by a decline in the commercial harvest of this species.

These declines have been attributed to overfishing, altered flow and water quality by various researchers. One management strategy used to attempt to recover the striped bass fishery has been to alter river flow during the spawning season. Moderately high flows are maintained during the spring to attract adult fish to the spawning grounds. In addition, stable moderate flows may be necessary to ensure proper and successful delivery of larval fish to Albemarle Sound. The current flow regime is provided in Table 2.3

Table 2.3. Flow regime during striped bass spawning season.

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

The North Carolina Wildlife Resources Commission has been conducting electrofishing on the striped bass spawning grounds near Weldon, N.C. since 1991. These studies have shown that there has been a trend of increasing catch rates since 1991. Also, the mean catch rates of female striped bass have increased annually. These results and estimates of egg abundance during 1991-1993 indicate that striped bass stocks are rebuilding (1995 DMF). Although a number of striped bass were killed in the summer of 1995 fish kills, striped bass populations are still anticipated to grow and recover (Gibson, 1995).

Currently Virginia Power/North Carolina Power is in the process of relicensing the Gaston and Roanoke Rapids hydroelectric facilities with the Federal Energy Regulatory Commission (FERC). The current license expires on January 31, 2001. Part of the relicensing process includes an assessment of how current and future project operations will affect environmental resources.

There are many factors that promote the need for management of water among the reservoirs and in the lower Roanoke River. Although flood control, energy production and the maintenance of flows for striped bass have been discussed briefly, other factors may influence management strategies. These include the importance of maintaining or augmenting flows, maintenance of water quality standards, and the need to provide appropriate flows for the maintenance of the lower Roanoke, fisheries, wetland communities and other natural resources.

A variety of aquatic systems are represented in the Roanoke basin as the terrain changes from the upper piedmont to the coastal plain. One of the most significant of these systems is a stretch of wetlands along the lower Roanoke River. This area is considered to be the largest intact and least disturbed bottomland hardwood forest in the mid-Atlantic region. Table 2.4 presents a breakdown of the significant natural wetland communities in the Roanoke River Basin.

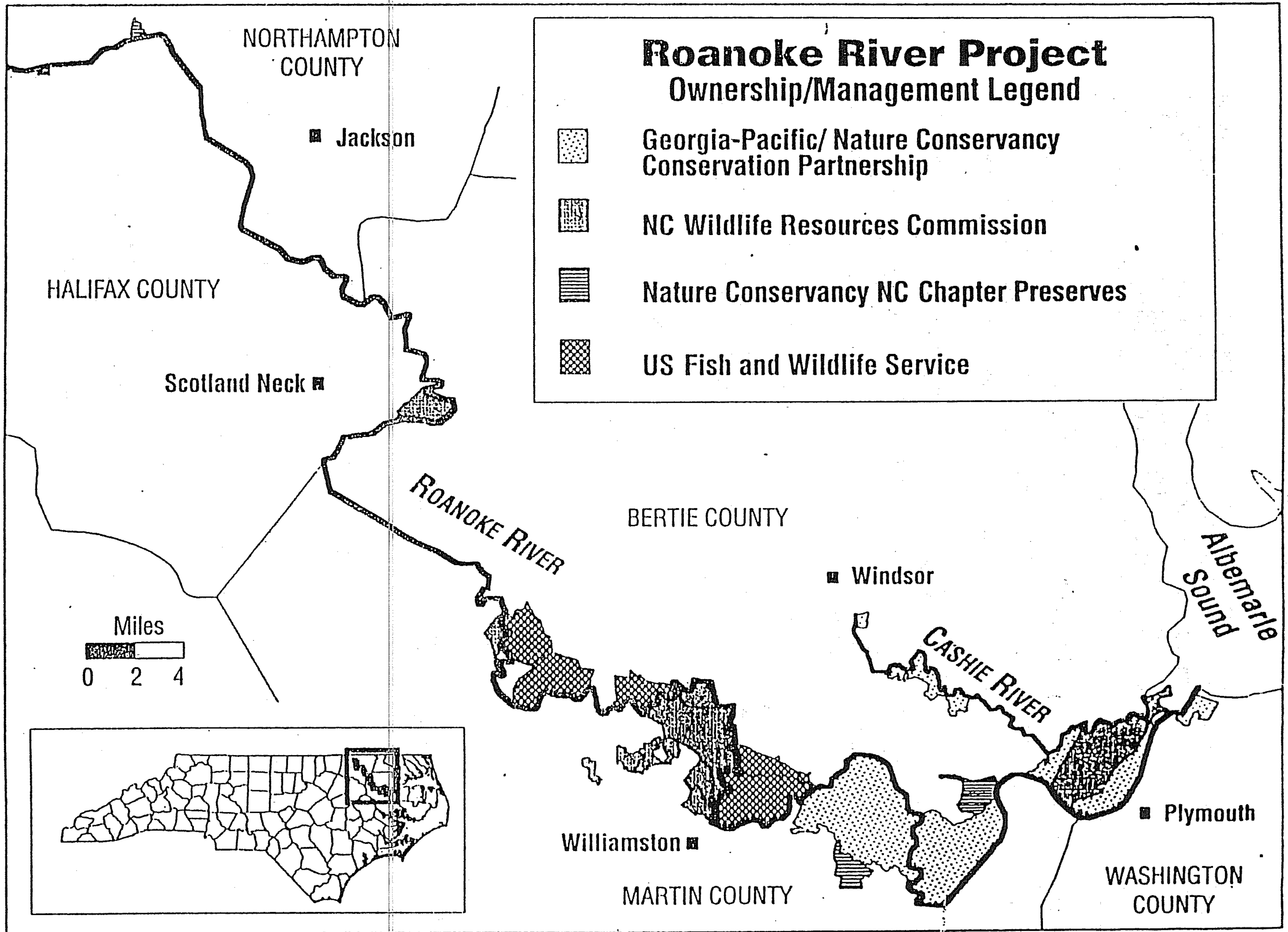
Table 2.4. Significant Natural Wetland Communities in the Roanoke River Basin

Site	Wetland Community Present	Acres
Roanoke River/NC 11 Alluvial Flats	Bottomland hardwood forests	1850
Roanoke River Delta Islands	Cypress-gum swamp forests	9000
Broad Creek Neck	Cypress-gum swamp forests	8000
Conine Island	Cypress-gum swamp forests	3748
Broadneck Swamp	Cypress-gum swamp forests	2200
Brodneck Ridge	Cypress-gum swamp forests; Bottomland hardwood forests	2000
Roquist Creek/Cashie River Swamp 1436	Cypress-tupelo swamp forest	2400

These sites are taken from the Regional Inventory for Critical Natural Areas, Wetland Ecosystems, and Endangered Species Habitats of the Albemarle-Pamlico Region: Phase 1 (APES 1990). The acres listed include associated upland communities.

The broad, forested floodplain along the lower Roanoke contains approximately 150,000 acres of bottomland hardwood and swamp forest communities. The floodplain forested wetlands perform valuable water quality functions including water, nutrient and sediment retention and nutrient transformation.

The lower portion of the floodplain adjacent to the Albemarle Sound contains several natural wetland communities of state and global significance, including a "globally endangered" Atlantic white cedar forest and approximately 20,000 acres of "roadless" cypress-gum swamp, the largest in the Carolinas (APES, 1993). Company Swamp, which is located in the southwest portion of Bertie County along the Roanoke River, contains the most extensive, climax cypress-gum swamp



This map was created by The Nature Conservancy NC Chapter's Geographical Information System.

Figure 2.5. Roanoke River Wetlands Protected through the Roanoke River Project

in a backwater in North Carolina. Broad Neck Creek located in the southeastern portion of Bertie County contains probably the largest expanse of contiguous cypress-water tupelo swamp forest in North Carolina. The U.S. Fish and Wildlife Service currently manages 12,500 acres in the Roanoke River National Wildlife Refuge, and The Nature Conservancy owns or manages 22,290 acres in the river basin. The floodplain of the Roanoke River is part of the Nature Conservancy's new ecosystem protection program aimed at maintaining entire functioning, healthy ecosystems that support both natural and human communities. Figure 2.5 illustrates the major players in this Roanoke River Project and where they either own or manage land.

2.3 LOCAL GOVERNMENT AND PLANNING JURISDICTIONS

The basin encompasses all or part of the following 16 counties and 37 municipalities presented in Table 2.5. Also included in the table are abbreviations for the Lead Regional Organizations (Councils of Government) and Districts of the North Carolina League of Municipalities.

2.4 LAND COVER, POPULATION AND GROWTH TRENDS

2.4.1 General Land Cover

Land cover information in this section is derived from two sources. The first is the US Department of Agriculture (USDA), Natural Resources Conservation Service's (NRCS) National Resources Inventory (NRI) of 1992 and 1982 (USDA, 1994). The NRI is a multi-resource national inventory based on soils and other resource data collected at scientifically selected random sample sites. According to the NRCS 1992 NRI Instructions booklet, the 1982 NRI was the most comprehensive study of our nation's natural resources ever conducted. It is considered accurate to the 8-digit hydrologic unit scale established by the US Geological Survey (NRCS, 1993). A 1992 update of this data was recently released. In addition, several state agencies including the NC Department of Transportation and the Department of Environment, Health and Natural Resources are working with the state's Center for Geographic Information and Analysis (CGIA) to develop statewide land cover information based on recent satellite imagery. However, until these other land coverages become available, the 1992 NRI data is the most recent comprehensive data for the basin as a whole.

Table 2.6 summarizes acreages and percentage of land cover from the 1992 NRI for the basin as a whole and for the major watershed areas within the basin. Land cover types identified by the NRI as occurring in the Roanoke River Basin include cultivated cropland, uncultivated cropland, pastureland, forest land, urban - large and small built-up lands, rural transportation, small water areas and census waters. Each type is described in Table 2.7.

Land cover in the basin, as presented in Table 2.6, is dominated by forest land which covers approximately 61% of the land area. Agriculture (including cultivated and uncultivated cropland and pastureland) covers approximately 25% of the area. The most dramatic changes exhibited between 1982 and 1992 were in the categories of uncultivated cropland and urban/built-up with increases of 60% and 54% respectively. Other notable changes include a 17% decrease in the amount of cultivated cropland and an 11% increase in the 'other' category.

The sedon land cover source is derived from interpretation of 1987 Landsat satellite data that were made available in a report by the NC Center for Geographic Information and Analysis (CGIA) (1991). The report was funded through the Albemarle-Pamlico Estuarine Study. This coverage is available for the part of the basin located downstream from Roanoke Rapids Dam. The land cover data for this portion of the basin are summarized in Table 2.8. They were used as the basis for calculating nutrient loading in the lower Roanoke Basin as presented in Section 3.2.2 in Chapter 3.

Table 2.5. Local Governments and Local Planning Units within the Roanoke River Basin

County	[1]% of county in basin	Region	League District	Municipality
Beaufort	trace	Q	II	
Bertie	70%	Q	I	Askewville Kelford Roxobel Windsor Woodville
Caswell	90%	G	VI	Milton Yanceyville
Forsyth	10%	I	IX	Kernersville Rural Hall Walterton
Granville	35%	K	VI	Stovall
Guilford	2%	G	IX	Stokesdale
Halifax	40%	L	V	Littleton Roanoke Rapids Scotland Neck Weldon
Martin	90%	Q	I	Hamilton Hassell Jamesville Oak City Williamston
Northampton	35%	L	V	Garysburg Gaston Jackson Rich Square
Person	60%	K	VI	Roxboro
Rockingham	85%	G	IX	Eden Madison Mayodan Reidsville Stoneville
Stokes	90%	I	IX	Danbury Walnut Cove
Surry	5%	I	X	
Vance	55%	K	VI	Middleburg
Warren	40%	K	V	Macon Norlina
Washington	5%	R	I	Plymouth

[1]Percents are approximate and rounded to the nearest five percent

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

Eight land cover categories are included. Each is briefly described in the chart accompanying Table 2.6. The four hydrologic units listed in Table 2.8 are subdivisions of the major watersheds listed in Table 2.6 as Roanoke Rapids and the Lower Roanoke. The first hydrologic unit in Table 2.8, identified as 301010601, makes up a small portion of that watershed identified in Table 2.6 as Roanoke Rapids. The remaining three hydrologic units in Table 2.8 cover approximately the same area as the watershed identified in Table 2.6 as Lower Roanoke.

When comparing the data for the last three hydrologic units in Table 2.8 with the Lower Roanoke watershed in Table 2.6, the data in the two tables are reasonably consistent for agricultural and forested lands although there is a large discrepancy in the urban land category. The other categories are not directly comparable between the two tables. For agriculture, the total agricultural area for the Lower Roanoke in Table 2.6 is 235,500 acres. This is 12% less than the 263,750 acres for agriculture in Table 2.8. The total forested acreage in Table 2.6, which includes the large bottomland hardwoods wetlands in the lower basin, is 530,000 acres. This figure is 8.6% higher than the total of the forest and wetlands categories in Table 2.8. The total urban/built-up area in Table 2.6 is 25,400 acres compared just 3,240 acres in Table 2.8.

For the most part, differences between the two tables are based on some variation in the definitions of the categories and on the procedures used in developing the data. In the urban category, where there is a large divergence in the acreages, the CGIA data in Table 2.8 identified just those urban areas with an impervious surface area of 25% or more. By contrast, the urban and builtup lands in Table 2.6 were more broadly defined and included such entitities as golf courses, cemetaries and playgrounds. It is also of note for Table 2.8 that urban areas with large tree canopies were often interpreted as forest in the satellite-based CGIA data because the trees obscured the view of the underlying development.

2.4.2 Population and Growth Trends in the Basin

The Roanoke River Basin has an estimated population of 263,661 people based on 1990 census data. Table 2.9 presents census data for 1970, 1980, and 1990 for each of the subbasins. It also includes land areas and population densities (persons/square mile) by subbasin based on the land area (excludes open water) for each subbasin. The size and number of densely populated areas are small but do occur around municipalities such as Eden, Roanoke Rapids, Williamston and Plymouth. The subbasin encompassing Williamston and Plymouth is the most dense with 146 persons/square mile computed to a basinwide average of 78 persons/square mile. In general, the density of people in the Roanoke basin is low when compared to other basins such as the Cape Fear which in some places has more than 1600 people/square mile. That portion of the Roanoke basin that is north of the Winston-Salem/Greensboro/High Point area has experienced the most population growth in the last 20 years. Overall, the population in the basin has grown 15% between 1970 and 1990, gaining 16% between 1970 and 1980 and losing 1% in the decade following that. Figure 2.6 shows the percent growth by subbasin between 1970 and 1990. Figures 2.7a and 2.7b describe 1990 population densities by census block group for the western and eastern Roanoke River Basin, respectively.

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, an estimate has to be made on the percentage of the population that is located in the subbasin. This is done by simply determining the percentage of the

Comparison of 1982 and 1992 Land Cover Data from the 1982 and 1992 National Resources Inventories (USDA - Natural Resources Conservation Service, Raleigh)

Estimated Acreage by Broad Land Use for the Roanoke River Basin - 1992 NRI

LAND COVER	Mid. Roanoke 03010102 Acres (1000s)	%	Upper Dan 03010103 Acres (1000s)	%	Lower Dan 03010104 Acres (1000s)	%	Roan. Rapids 03010106 Acres (1000s)	%	Lower Roanoke 03010107 Acres (1000s)	%	TOTAL ACRES (1000s)	% of TOTAL
Cult. Crop	27.8	15.6	83.3	14.6	66.0	13.6	24.6	15.6	220.6	25.7	422.3	18.7
Uncult. Crop	0.0	0.0	34.5	6.0	7.9	1.6	0.0	0.0	0.0	0.0	42.4	1.9
Pasture	13.8	7.7	37.8	6.6	36.7	7.5	0.0	0.0	14.9	1.7	103.2	4.6
Forest	89.5	50.1	332.6	58.1	330.1	67.9	88.9	56.5	537.1	62.6	1378.2	61.2
Urban/Built-up	9.9	5.5	46.0	8.0	14.2	2.9	16.8	10.7	25.4	3.0	112.3	5.0
Other	37.6	21.1	38.0	6.6	31.6	6.5	27.1	17.2	60.3	7.0	194.6	8.6
Totals	178.6	100.0	572.2	100.0	486.5	100.0	157.4	100.0	858.3	100.0	2253.0	100.0
% of Basin		7.9		25.4		21.6		7.0		38.1	2253.0	100.0
SUBBASINS	030206		01 - 03		04 - 05		030207		08 - 10			

Estimated Acreage by Broad Land Use for the Roanoke River Basin - 1982 NRI

LAND COVER	Mid. Roanoke 03010102 Acres (1000s)	%	Upper Dan 03010103 Acres (1000s)	%	Lower Dan 03010104 Acres (1000s)	%	Roan. Rapids 03010106 Acres (1000s)	%	Lower Roanoke 03010107 Acres (1000s)	%	TOTAL ACRES (1000s)	% of TOTAL
Cult. Crop	34.4	19.3	112.5	19.7	84.9	17.5	38.6	24.5	225.6	26.3	496.0	22.0
Uncult. Crop	0.0	0.0	22.0	3.8	4.4	0.9	0.0	0.0	0.0	0.0	26.4	1.2
Pasture	10.3	5.8	36.7	6.4	29.5	6.1	2.5	1.6	32.2	3.8	111.2	4.9
Forest	93.3	52.2	335.3	58.6	327.1	67.2	83.8	53.2	532.2	62.0	1371.7	60.9
Urban/Built-up	7.3	4.1	30.6	5.3	6.6	1.4	12.0	7.6	16.6	1.9	73.1	3.2
Other	33.3	18.6	35.1	6.1	34.0	7.0	20.5	13.0	51.7	6.0	174.6	7.7
Totals	178.6	100.0	572.2	100.0	486.5	100.0	157.4	100.0	858.3	100.0	2253.0	100.0
% of Basin		7.9		25.4		21.6		7.0		38.1		100.0
SUBBASINS	30206		01 - 03		04 - 05		030207		08 - 10			

Table 2.6 Summary of Land Cover for Major Watersheds in the Roanoke River Basin

Table 2.7 Description of Land Cover Types (1992 NRI - USDA NRCS)

Land Cover Type (No.)	Land Cover Description
1) Cultivated Cropland	Land used for the production of adapted crops for harvest, including row crops, small-grain crops, hay crops, nursery crops, orchard crops, and other specialty crops. The land may be used continuously for these crops or they may be grown in rotation with grasses and legumes.
2) Uncultivated Cropland	Summer fallow, aquaculture in crop rotation, or other cropland not planted (may include cropland in USDA set-aside or similar short-term program).
3) Pastureland	Land used primarily for production of introduced or native forage plants for livestock grazing. This category includes land that has a vegetative cover of grasses, legumes, and /or forbs, regardless of whether or not it is being grazed by livestock.
4) Forest Land	Land at least 10 percent stocked 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 and not currently developed for non-forest use. Ten percent stocked, when viewed from a vertical direction, is a canopy cover of leaves and branches of 25 percent or greater. The minimum area for classification of forest land is 1 acre, and the area must be at least 1,000 feet wide.
5) Urban and Built-up Land	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. Highways, railroads, and other transportation facilities are considered part of this category if surrounded by other urban and built-up areas. Tracts of less than 10 acres that do not meet this category's definitions (e.g., small parks or water bodies) but are completely surrounded by urban and built-up lands are placed in this category.
6) Other	<u>Rural Transportation</u>: 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). Includes the following three categories <u>Small Water Areas:</u> Water bodies less than 40 acres in size and streams less than one-half mile wide. <u>Census Water</u>: Large water bodies consisting of lakes and estuaries greater than 40 acres and rivers greater than one-half mile in width. <u>Minor Land:</u> Lands not in one of the other categories.

Table 2.8 Land Cover in the Lower Roanoke River Basin (Below Roanoke Rapids Lake Dam) based on Interpretation of 1987 Landsat Satellite Coverage (NC Center for Geographic Information and Analysis, 1991)

Hydrologic Unit	Agriculture (Acres)	Forest (Acres)	Urban (Acres)	Wetland (Acres)	Water (Acres)	Scrub (Acres)	Barren (Acres)	Shadow (Acres)	Total (Acres)	Total Percent
301010601	1,865	2,949	165	424	635	3	0	57	6,098	1%
301010701	112,353	107,293	1,148	45,110	3,746	7,537	0	1,222	278,409	34%
301010702	100,292	82,482	1,771	125,659	6,208	30,346	215	512	347,485	42%
301010703	51,105	89,443	321	40,763	656	14,192	0	184	196,664	24%
Total	265,615 32%	282,167 34%	3,405 0%	211,956 26%	11,245 1%	52,078 6%	215 0%	1,975 0%	828,656	1

Land Cover Type (No.)	Land Cover Description
1) Agriculture (6, 12)	Agriculture, Bare Soil, Grass and Disturbed Land
2) Urban (3, 4, 5)	Greater than 25% paved surfaces
3) Forest (8, 10, 11)	Pine, Hardwood and Mixed Upland Forest
4) Wetlands (9, 14 -19)	Bottomland Hardwoods, Riverine Swamp, Evergreen Hardwood/Conifer, Atlantic White Cedar, Low Pocosin, High Marsh, Low Marsh
5) Scrub (7)	Low Density Vegetation
6) Water (2)	Lakes, Reservoirs, Ponds, Estuaries, Sounds
7) Barren	Sand
8) Shadow	Areas in shadows or appearing to be in shadows and where actual cover types are indiscernible.

Table 2.9 Roanoke Subbasin Population (1970, 1980, 1990) and Land Area Summaries

	POPULATION (Number of Persons)			POPULATION DENSITY (Persons/Square Mile)			LAND AND WATER AREAS			
							Total Land and Water Area		Water Area	Land Area
SUBBASIN	1970	1980	1990	1970	1980	1990	(Acres)	(Sq. Miles)	(Sq. Miles)	(Sq. Miles)
03-02-01	29,829	47,011	45,777	66	104	102	291,098	455	7	448
03-02-02	18,910	20,957	19,588	60	67	62	210,402	329	18	311
03-02-03	11,103	11,980	11,695	49	50	46	152,551	238	237	1
03-02-04	26,709	27,971	27,208	49	51	50	352,881	551	13	538
03-02-05	6,747	10,175	9,903	32	33	32	196,544	307	300	7
03-02-06	20,311	22,904	21,604	62	70	66	215,739	337	12	325
03-02-07	6,676	6,681	8,338	38	38	47	124,298	194	20	174
03-02-08	41,640	42,627	43,392	83	85	86	319,585	512	13	499
03-02-09	48,718	58,768	58,886	120	145	146	259,428	405	403	2
03-02-10	14,982	15,859	17,300	91	97	105	104,726	163	0	163
TOTALS	228,625	264,933	263,661	67	78	78	2,235,718	3,493	93	3,400

Note: Population, land area and water area were derived from 1970, 1980 and 1990 census data.

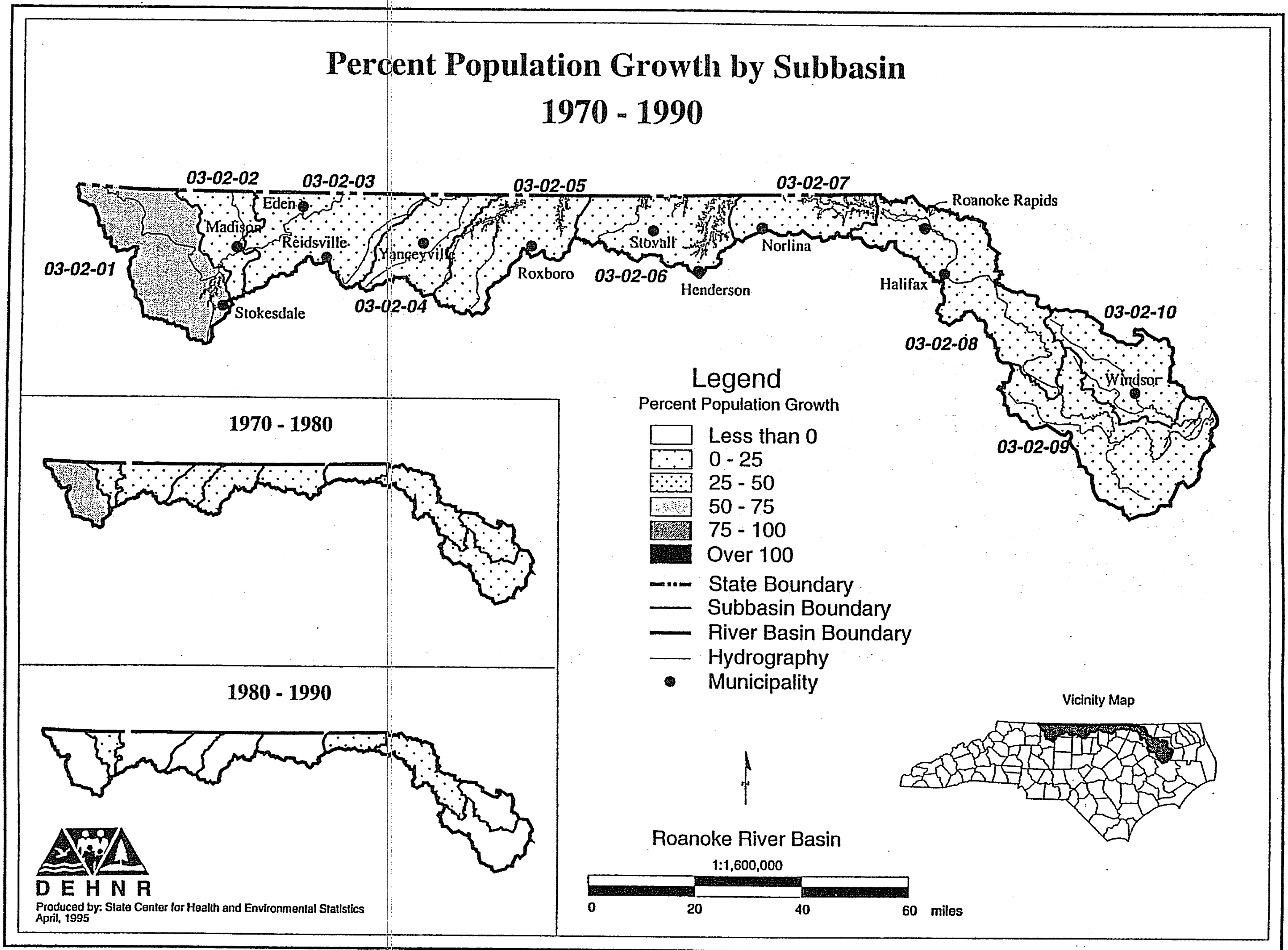


Figure 2.6 Percent Population Growth by Subbasin: 1970 - 1990

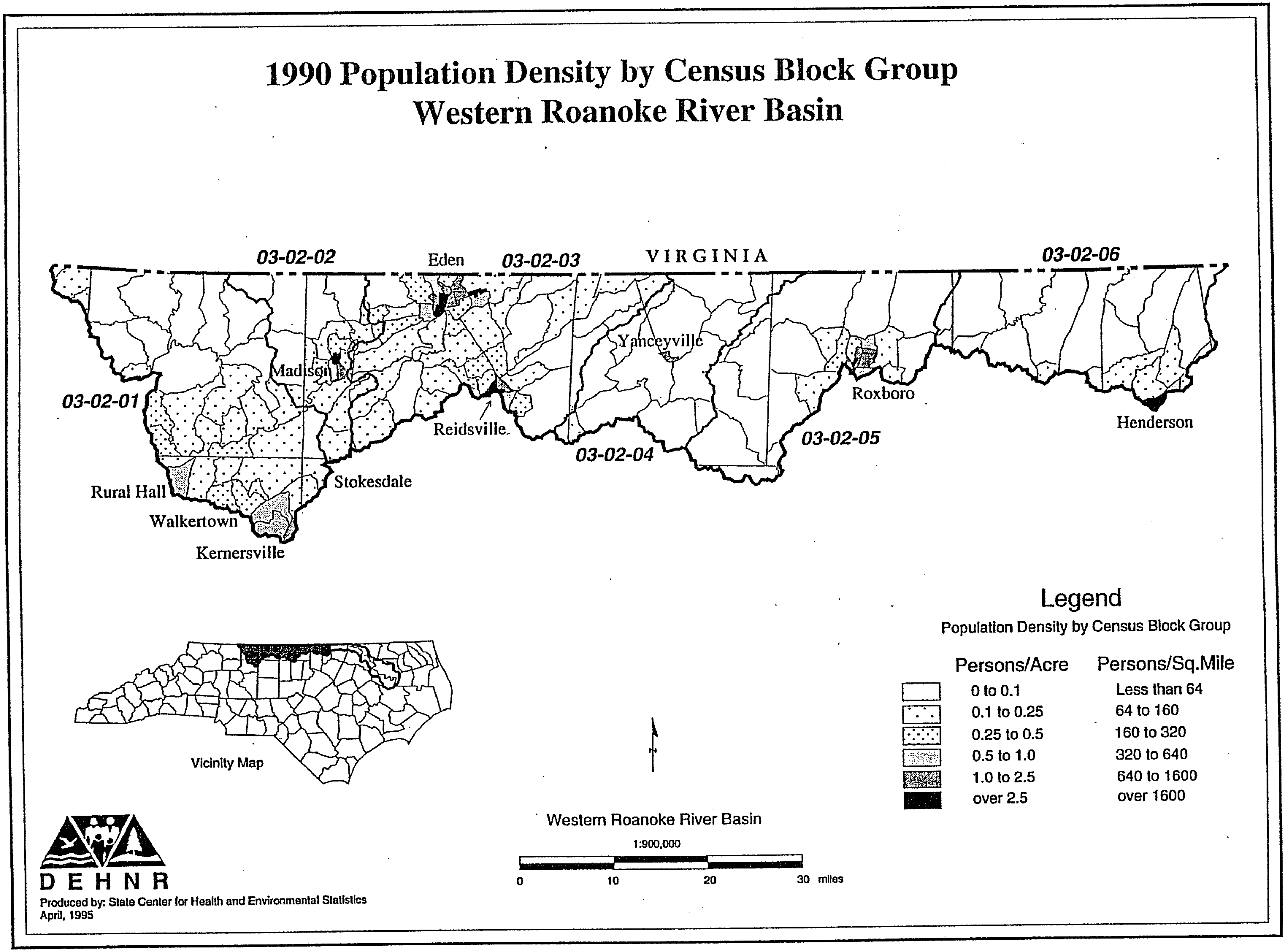


Figure 2.7a 1990 Population Density by Census Block Group: Western Roanoke River Basin

Table 2.10. Numbers of Certified and Registered Animal Operations in the Roanoke River Basin

TYPE OF	COUNTIES													
OPERATION	BERTIE	CASWELL	FORSYTH	GRANV	HALIFAX	MARTIN	NORTHA	PERSON	ROCKING.	STOKES	VANCE	WARREN	WASHING.	TOTALS
CATTLE														
Certified Ops		0	0	0	0	0	0	0	0	0	0	3	0	3
Registered Ops		4	4	10	16	4	10	3	14	30	1	3	1	100
Animals		655	451	1,390	6,379	780	461	360	1,694	4,184	60	2,590	356	19,360
Acres		975	960	2,040	8,821	485	1,747	1,000	3,970	3,906	90	4,180	160	28,334
SHEEP														
Certified Ops										0				0
Registered Ops										1				1
Animals														
Acres														
POULTRY														
Certified Ops					0		0						0	
Registered Ops					1		6						1	8
Animals					50,000		304,900						34,000	388,900
Acres					7,000		1,143						28	8,171
HORSES														
Certified Ops									0					0
Registered Ops									2					2
Animals									207					207
Acres									369					369
SWINE														
Certified Ops	2	0	0	0	0	0	7	0	1	0	0	8	3	21
Registered Ops	31	2	1	5	28	38	50	17	3	2	1	13	31	178
Animals	27,251	2,300	10	4,890	57,805	22,466	98,646	9,746	3,372	4,927	3,800	24,580	116,335	376,128
Acres	1,565	840	100	255	5,498	2,742	4,755	2,619	473	104	45	1,810	17,974	38,780
TOTALS														
Certified Ops	2	0	0	0	0	0	7	0	1	0	0	11	3	24
Registered Ops	31	6	5	15	45	42	66	20	19	33	2	16	33	333
Animals	27,251	2,955	461	6,280	114,184	23,246	404,007	10,106	5,273	9,111	3,860	27,170	150,691	784,595
Acres	1,565	1,815	1,060	2,295	21,319	3,227	7,645	3,619	4,812	4,010	135	5,990	18,162	75,654

Certified Operations = Facilities with an approved waste management plan. These fall into one of three categories: 1) new operations (those established since 2/93); 2) facilities that have expanded since 2/93; and 3) existing facilities that have obtained an approved waste managment plan prior to the 12/97 deadline.

Registered Operations = Operations existing as of 2/1/93 that exceeded the minimum threshold size* and were required to submit a registration priot to 12/31/93. These must become certified 12/97.

Animals = the number of animals that the facility was designed to handle (design capacity).

Acres = The number of acres used to apply waste from a lagoon (application acres).

* Threshold size = 100 cattle (beef and/or dairy); 250 swine; 1,000 sheep; 30,000 birds (poultry); 75 horses.

Table 2.11. Threatened and Endangered Freshwater Mussels and Fishes in the Roanoke River Basin (Source: NC Wildlife Resources Commission and the NC Natural Heritage Program)

Common Name	Scientific Name	Subbasins where found	Listing Status: State	Federal
Mussels:				
Green Floater	(Lasmigona subviridus)	06, 08, 10	E	(E)
Roanoke Slabshell	(Elliptio roanokensis)	08, 10	T	
Triangle Floater	(Alasmidonta undulata)	08, 10	T	
Fish:				
Cutlips Minnow	(Exoglossum maxillingua)	01-04	E	
Rustyside Sucker	(Thoburnia hamiltoni)	01-04	E	
Shortnose sturgeon	(Acipenser brevirostrum)	10	E	E

Listing abbreviations: E = Endangered, T = Threatened, (E) = Candidate for Federal Listing

In addition to the list in Table 2.11, there are two freshwater mollusks identified as species of special concern in North Carolina: the Eastern Pondmussel (Ligumia nasuta) and the Tidewater Mucket (Lampsilis ochracea). Species of 'special concern' have limited numbers and vulnerable populations and are in need of monitoring.

In the Dan River drainage portion of the Roanoke basin, there are several fish species that are either of special concern or significantly rare. These are the Spotted Margined Madtom (Noturus insignis), the Bigeye Jumprock (Moxostoma ariommum), the Roanoke Hogsucker (Hypentelium roanokense), and the Riverweed Darter (Etheostoma podostemone).

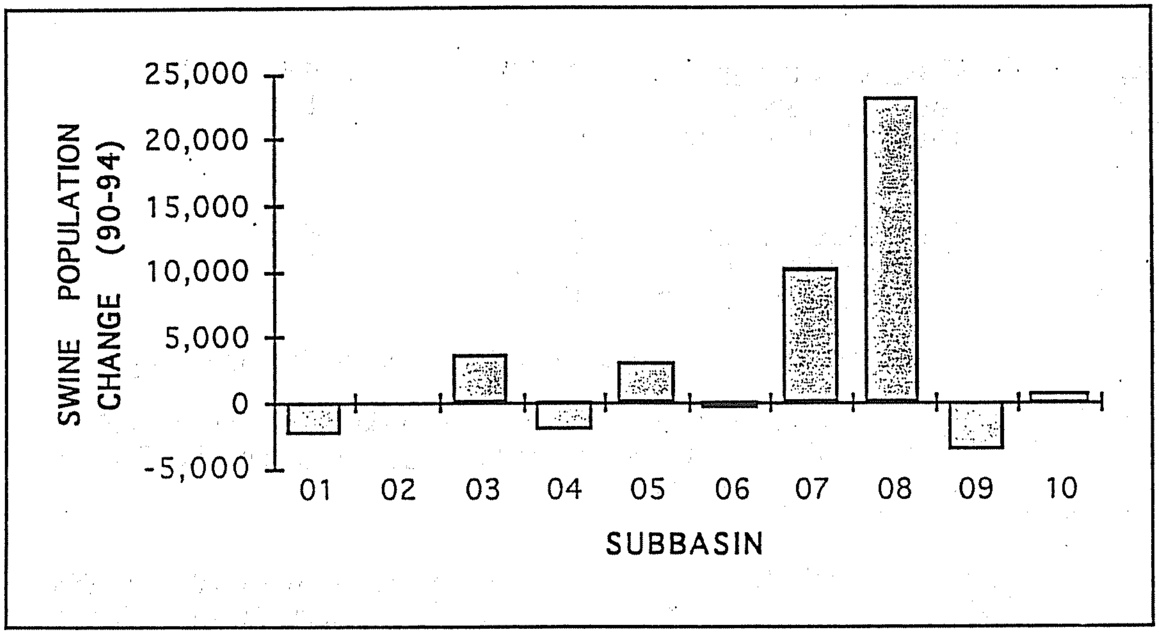
2.7 SURFACE WATER CLASSIFICATIONS AND STANDARDS

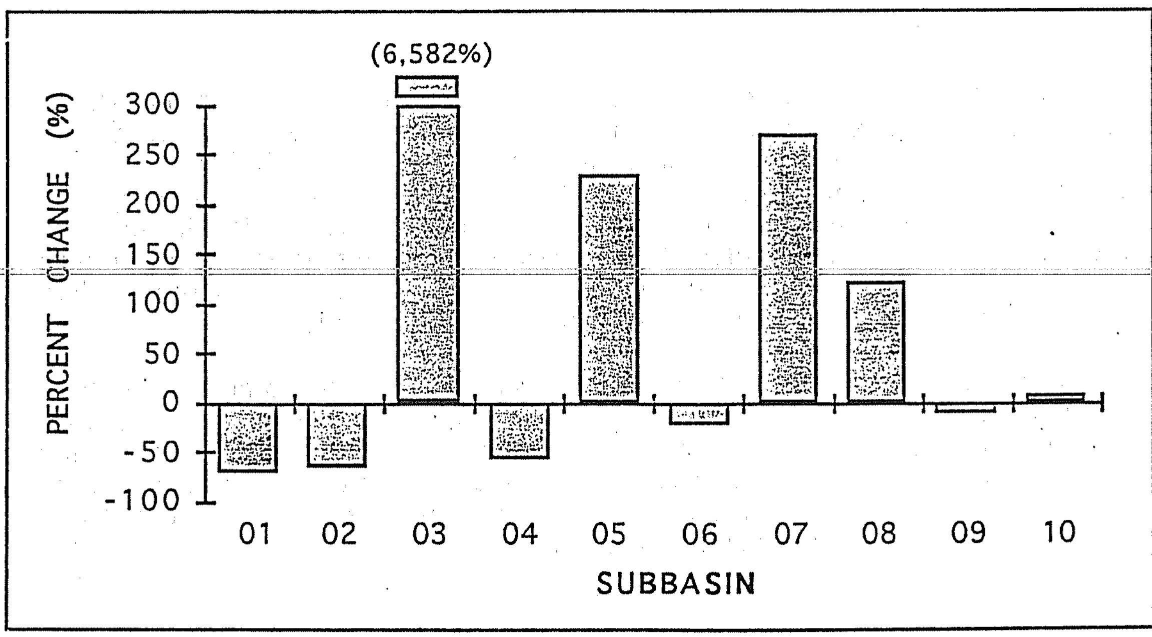
2.7.1 Program Overview

North Carolina has established a water quality classification and standards program pursuant to G.S. 143-214.1. Classifications and standards are developed pursuant to 15A NCAC 2B.0100 - Procedures for Assignment of Water Quality Standards. Waters were classified for their "best usage" in North Carolina beginning in the early 1950's, with classification and water quality standards for all the state's river basins adopted by 1963. The effort to accomplish this included identification of water bodies (which included all named water bodies on USGS 7.5 minute topographic maps), studies of river basins to document sources of pollution and appropriate best uses, and formal adoption of standards/classifications following public hearings.

The Water Quality Standards program in North Carolina has evolved over time and has been modified to be 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. Classifications and standards have been broadly interpreted to provide protection of uses from both point and nonpoint source pollution.

Figure 2.8 Bar Chart Showing Increases in Swine Numbers by Subbasin in the Roanoke River Basin from 1990 to 1994





2.7.2 Statewide Classifications and Water Quality Standards

All surface waters in the state are assigned a primary water classification, and they may also be assigned one or more supplemental classifications (Table 2.12). As noted above, classifications are assigned to protect uses of the waters such as swimming, aquatic life propagation or water supplies. For each classification, there is a set of water quality standards that must be met in order to protect the uses. Appendix I provides a more detailed summary of the state's primary and supplemental classifications including, for each classification, the best usage, water quality standards, stormwater controls and other protection requirements as appropriate. This information is derived from 15A NCAC 2B .0200 - Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina.

Table 2.12 Primary and Supplemental Classifications Applicable to the Roanoke River Basin

PRIMARY FRESHWATER CLASSIFICATIONS

Class	Best Uses
C	Aquatic life propagation/protection and secondary recreation
B	Primary recreation and class C uses
WS	Water Supply watershed and class C uses. There are five WS classes, I through 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. A CA , or Critical Area, 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: freshwaters protected for natural trout propagation and the survival of stocked trout
FWS	Future Water Supply: waters that have been requested by a local government and adopted by the Environmental Management Commission as a future water supply source

The WS (water supply) classifications outline protective management strategies aimed at controlling point and nonpoint source pollution. These strategies are summarized in Appendix I. The requirements for WS waters vary significantly from WS-I to WS-V. The WS-I classification carries the most stringent requirements for dischargers and surrounding land use activities while WS-V carries the least.

2.7.3 Surface Water Classifications in the Roanoke River Basin

The waters of the Roanoke River Basin have a variety of surface water quality classifications applied to them. The majority of the waters are classified as C or B. In the Dan River drainage portion of the basin, some waters carry the supplemental trout classification. Further downstream as the Roanoke River approaches the Albemarle Sound, some waters are supplementally classified as swamp. There are no classified High Quality Waters or Outstanding Resource Waters in the basin. There are a few areas however that are classified as WS-II water supplies, which are by definition considered High Quality Waters.

There are twelve water supply watersheds in the Roanoke River Basin. All but one of these are either WS-II or WS-IV water supplies. The largest category with respect to land area is Class WS-

IV. Acreages for land area covered by the watersheds by water supply classification are: WS-II = 73,957 acres; WS-III = 5,613 acres; and WS-IV = 235,698 acres. Figures 2.9a and 2.9b show the water supply watersheds in the Roanoke River Basin.

A complete listing of classifications for all surface waters in the basin can be found in a DWQ publication entitled "Classifications and Water Quality Standards Assigned to the Waters of the Roanoke River Basin". This has been reprinted in Appendix 1. Pending reclassifications are discussed in Chapter 6.

2.8 WATER USE IN THE ROANOKE RIVER BASIN

Maintaining an adequate supply of clean water will be critical to future economic growth and maintaining a healthy and productive environment. Information in this section was provided by the NC Division of Water Resources (1994).

Water use evaluations consider total water withdrawals and whether these withdrawals are consumptive or non-consumptive. Total withdrawals are the amount of water pumped or diverted from streams or pumped from wells in the basin. Consumptive uses are those that cause water to be lost to the basin through evaporation, interbasin transfer, or incorporation into industrial products. Non-consumptive uses are those in which water is returned to streams after use in the form of treated wastewater and is therefore available for reuse downstream.

Unless otherwise noted, the consumptive use figures in this section include the entire basin (both the North Carolina and Virginia portions) and include both surface water and groundwater.

2.8.1 1989 Consumptive Water Use Estimates

The most complete and accurate database available is for the year 1989. This data includes monthly averages of water consumption by type of water use. Analysis of these data illustrates who the major consumptive users in the basin are and shows how the degree of use fluctuates over the year.

There are four major types of water use identified in the Roanoke River Basin. These are public water supply, self-supplied industry, irrigation and thermal power. The category of self-supplied industry is made up of industries that have their own intake structure (as opposed to receiving water from a public water source).

Figure 2.10 illustrates how the amount of use in the basin fluctuates during the year. It is important to note that the highest use occurs during the summer months when instream flows are lowest. This condition puts stress on aquatic ecosystems and water quality.

By far the largest category for consumptive use in the basin is thermal power generation which comprises 48 percent of the basin's total use with an annual average consumption of 43 million gallons per day (MGD). This is followed by crop irrigation which accounts for 23 percent of the consumptive use with an annual average of 17 MGD. Most of this irrigation is occurring in the lower Roanoke basin to support production of cotton and tobacco. Self-supplied industry represents 19 percent (or 17 MGD) of the basin's consumptive use. And the smallest category of users is that of public water supply which used 9 MGD (or 9 percent of the total) in 1989.

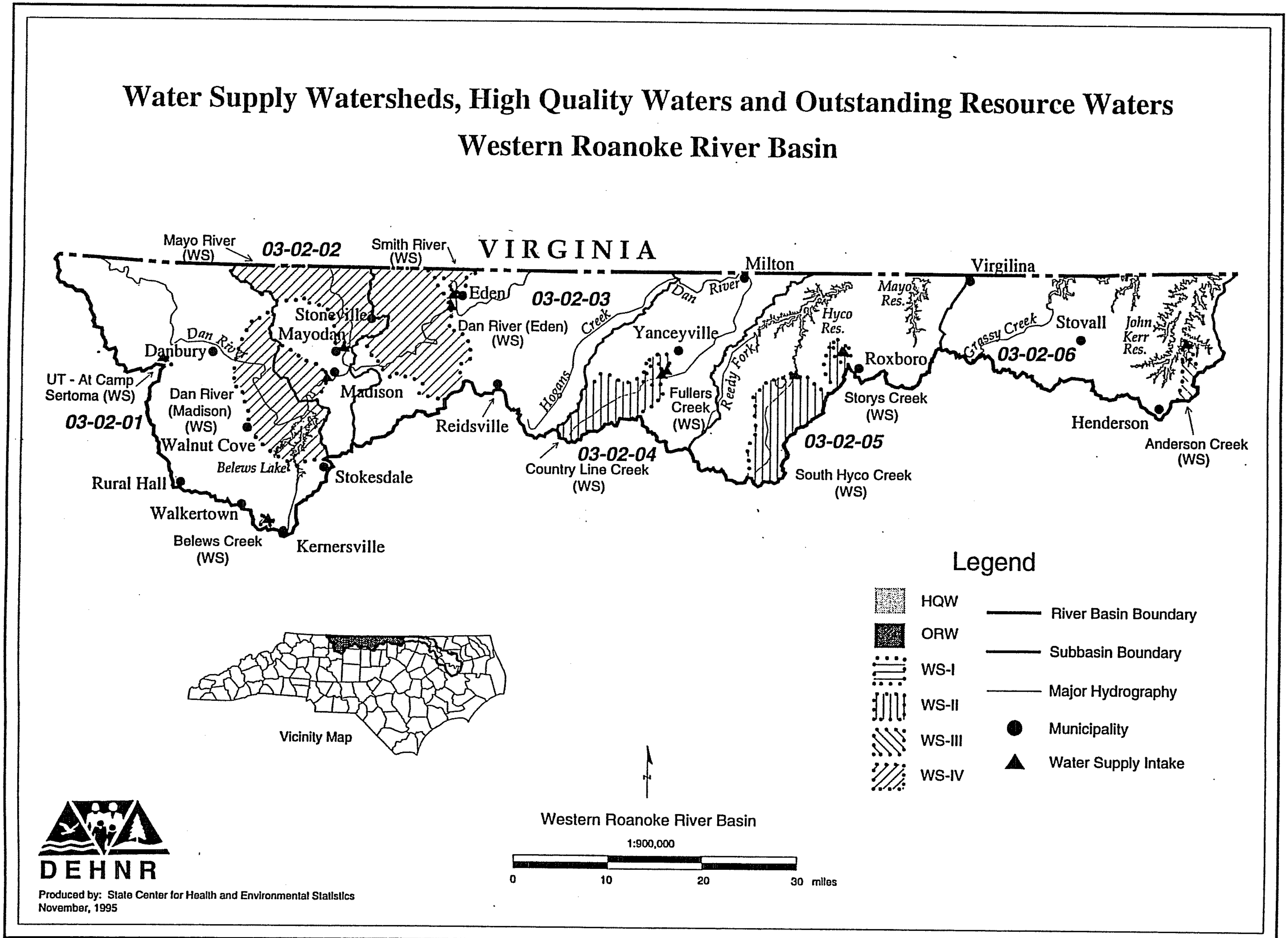


Figure 2.9a Water Supply Watersheds in the Western Roanoke River Basin

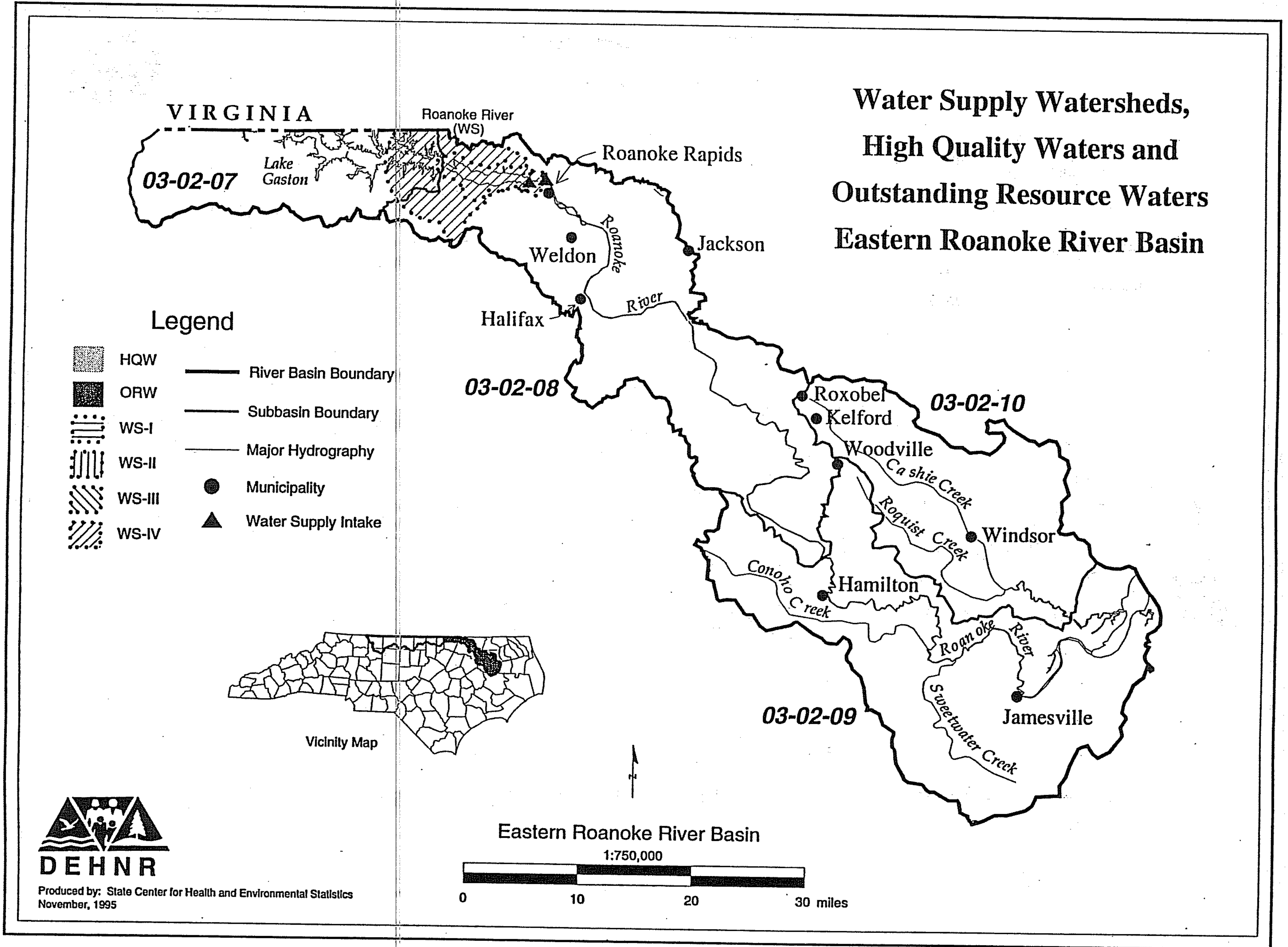
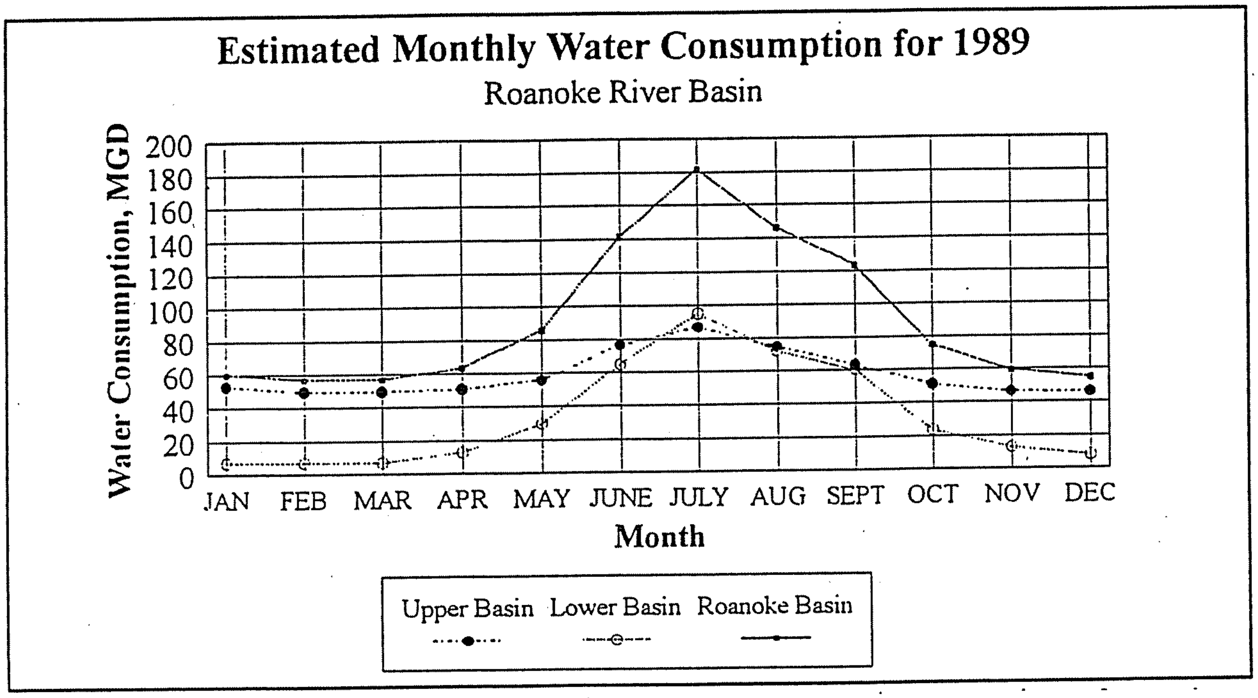


Figure 2.9b Water Supply Watersheds in the Eastern Roanoke River Basin

Figure 2.10 Monthly Water Consumption in the Roanoke River Basin
(Source: Division of Water Resources, 1994)



2.8.2 Projected Consumptive Use in the Roanoke River Basin

The Roanoke River Basin is expected to see a 240 percent increase in annual average consumptive use of water between the years of 1980 and 2010. More importantly, peak usage in the year 2010 is expected to be 500 percent greater than average daily consumption in 1980. Figure 2.12 shows projections by type of use. The largest increase is projected to be attributed to the potential additional new public water supply projects, the bulk of which is from the City of Virginia Beach's proposed 60 MGD withdrawal from Lake Gaston (this subject will be discussed in more detail in the following section). The remainder of the projected increase has been estimated based on interest shown by other municipalities (including Rocky Mount and Halifax County in North Carolina and Mecklenburg County in Virginia) for future surface water withdrawals from the Roanoke River Basin.

Self-supplied industries and irrigation are expected to contribute to moderate increases in use, while steady increases are anticipated for thermal power generation.

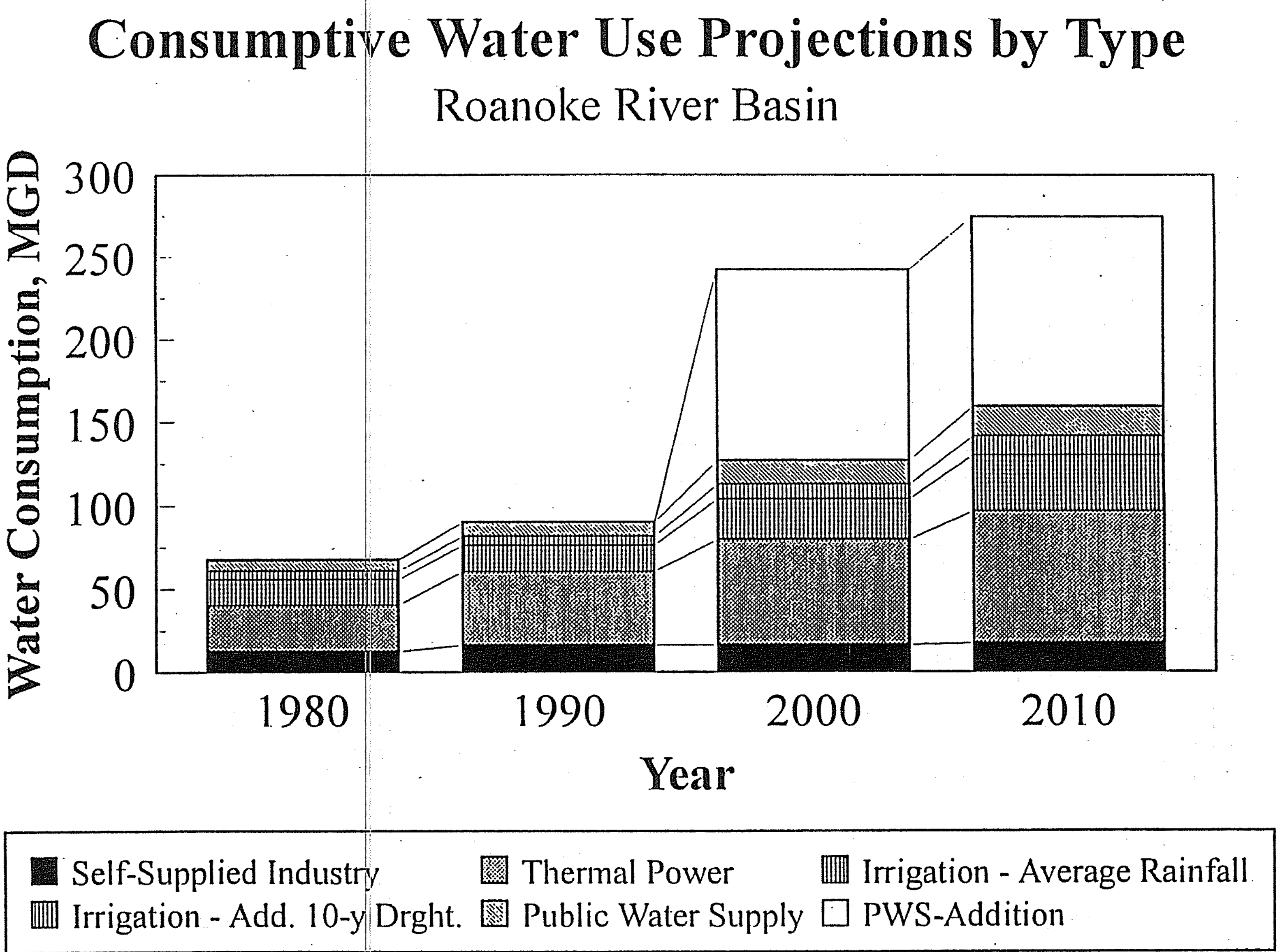


Figure 2.12 Consumptive Water Use Projections by Type

2.8.3 Proposed Water Withdrawal from Lake Gaston

Two municipalities in the State of Virginia (Virginia Beach and Chesapeake) want to utilize Lake Gaston as a water supply source. Water would be pumped from the lake, travel through a pipeline 76 miles in length and be discharged into Lake Prince from which the water would be withdrawn and treated for distribution (Figure 2.13 provides an illustration of the project). Unlike other municipal water withdrawals, the Lake Gaston pipeline would create an interbasin transfer. The project would not return any wastewater to the Roanoke River basin; instead, it would discharge wastewater into the Atlantic Ocean.

This proposal was formally presented in 1984 when the Corps of Engineers issued a permit to the City of Virginia Beach to withdraw 60 MGD from the lake. Since then, there has been a raging legal debate over this withdrawal which continues to this day. In order to withdraw the water, approval of the Federal Energy Regulatory Commission (FERC) is required because the lake is part of a licensed power generation project.

North Carolina has been strongly opposed to this project on environmental, economic and legal grounds (including the failure of the applicants to obtain a certification from the State of North Carolina under § 401 of the Clean Water Act). It has strenuously disputed the need for this water in Southeast Virginia and pointed to the availability of many alternative water supplies for that region. Notwithstanding North Carolina's objections, FERC issued an amended license approving the pipeline in July, 1995. That decision is now on appeal to the United States Court of Appeals. Other legal challenges are also pending.

As noted above, the FERC license for the entire project is scheduled to expire in January of 2001. Therefore, even if the pipeline is built, it can be reconsidered during the relicensing process, which is just underway.

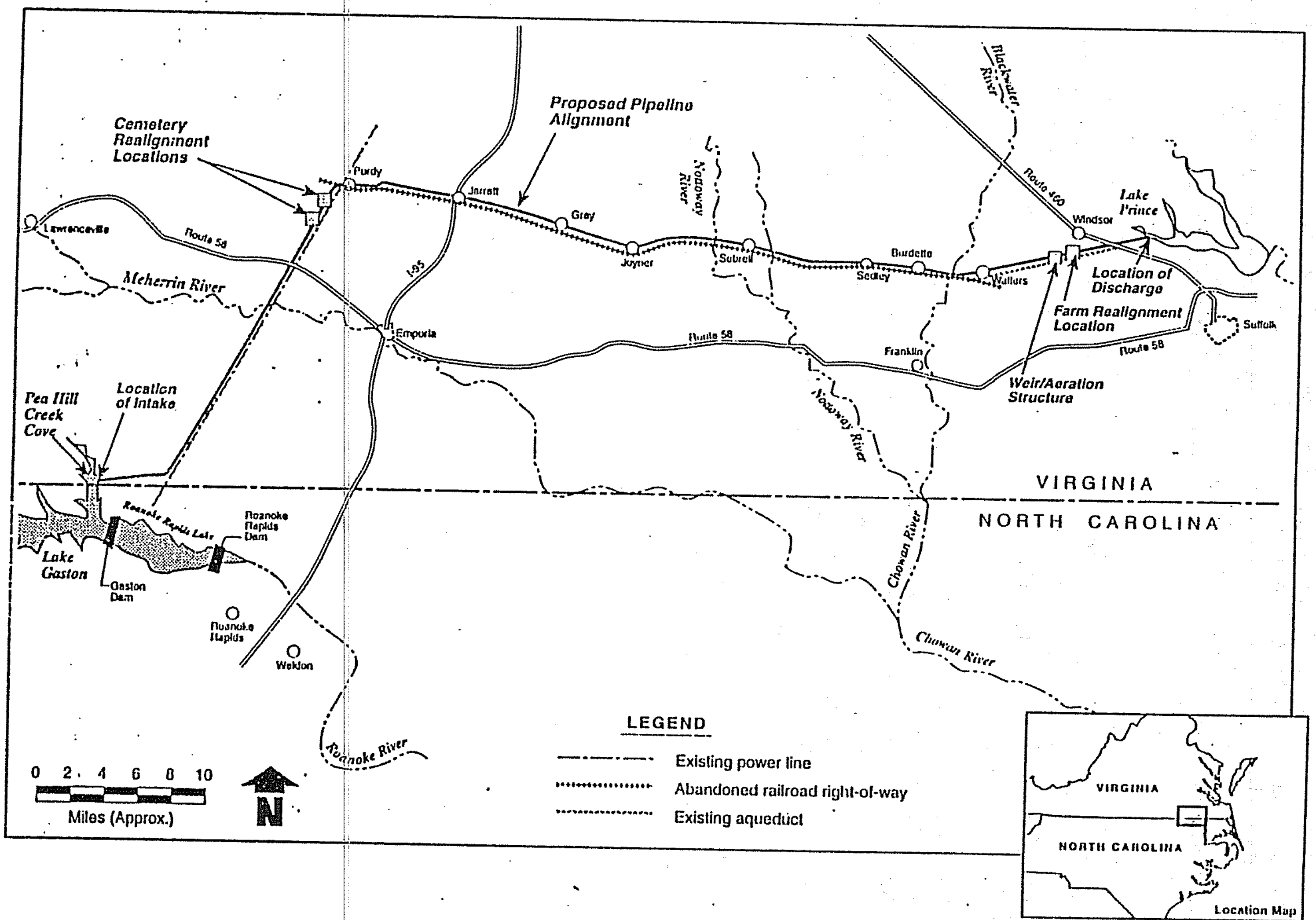


Figure 2.13 Principle Project Feature of the Proposed Water Withdrawal from Lake Gaston (Source: FERC, 1995)

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CHAPTER 3

CAUSES AND SOURCES OF WATER POLLUTION IN THE ROANOKE RIVER BASIN

3.1 INTRODUCTION

Water pollution is caused by a number of substances including sediment, nutrients, bacteria, oxygen-demanding wastes, metals, color and toxic substances. *Sources* of these pollution-causing substances are divided into broad categories called *point* sources and *nonpoint* sources. Point sources are typically piped discharges from wastewater treatment plants and large urban and industrial stormwater systems. Nonpoint sources can include stormwater runoff from small urban areas (population less than 100,000), forestry, mining, agricultural lands and others. **Section 3.2** identifies and describes the major causes of pollution in the Roanoke basin. **Sections 3.3** and **3.4** describe point and nonpoint source pollution in the basin.

3.2 CAUSES OF POLLUTION

The term *causes* of pollution refers to the substances which enter surface waters from point and nonpoint pollution sources and result in water quality degradation. The major causes of pollution discussed throughout the basin plan include biochemical oxygen demand (BOD), sediment, nutrients, toxicants (such as heavy metals, chlorine, pH and ammonia) and fecal coliform bacteria. Each of the following descriptions indicates whether the cause is point or nonpoint source-related (or both).

3.2.1 Oxygen-Consuming Wastes

Oxygen-consuming wastes are substances such as decomposing organic matter or chemicals which reduce dissolved oxygen in the water column through chemical reactions or biological activity. Raw domestic wastewater contains high concentrations of oxygen-consuming wastes that need to be removed from the wastewater before it can be discharged into a waterway. Maintaining a sufficient level of dissolved oxygen in the water is critical to most forms of aquatic life.

The concentration of dissolved oxygen (DO) in a water body is one indicator of the general health of an aquatic ecosystem. The United States Environmental Protection Agency (EPA) states that 3.0 milligrams per liter (mg/l) is the threshold dissolved oxygen concentration needed for many species' survival (EPA, 1986). North Carolina has adopted a water quality standard of 5.0 mg/l (daily average with minimum instantaneous measurements not permissible below 4.0 mg/l) in order to protect the majority of its waters. Higher concentrations are needed to promote propagation and growth of a diversity of aquatic life in North Carolina's surface waters. Exceptions to this standard exist for waters supplementally classified as *trout waters* and those supplementally classified as *swamp*. Trout waters have a dissolved oxygen standard of 6.0 mg/l due to the higher sensitivity of trout to low dissolved oxygen levels. Swamp waters often have naturally low levels of dissolved oxygen, and aquatic life typically found in these waters are adapted to the lower dissolved oxygen levels. Sluggish swamp waters in the Coastal Plain portion of the state may have natural dissolved oxygen levels of 3.0 to 4.0 mg/l or less at times. Therefore, the dissolved oxygen standard for swamp waters may be less than 5.0 mg/l if that lower level is judged to be the result of natural conditions. Many of the freshwater streams in the Coastal Plain portion of the basin are supplementally classified by the state as swamp waters (see section 2.7 for further discussion on standards and classifications).

Dissolved oxygen concentrations are affected by a number of factors. Higher dissolved oxygen is produced by turbulent actions which mix air and water such as waves, rapids and water falls. In addition, lower water temperature generally allows for retention of higher dissolved oxygen concentrations. Therefore, the cool swift-flowing streams of the mountains are generally high in dissolved oxygen. Low dissolved oxygen levels tend to occur more often in warm, slow-moving waters that receive a high input of effluent from wastewater treatment plants during low flow conditions. In general, the lowest dissolved oxygen concentrations occur during the warmest summer months and particularly during low flow periods. Water depth is also a factor. In deep slow-moving waters, such as reservoirs or estuaries, dissolved oxygen concentrations may be very high near the surface due to wind action and plant (algae) photosynthesis, but may be entirely depleted (anoxic) at the bottom.

Causes of dissolved oxygen depletion can include wastewater treatment plant effluent and the decomposition of organic matter such as leaves, dead plants and animals, and organic waste matter that may be washed or discharged into the water. Sewage from human and household wastes is high in organic waste matter, and bacterial decomposition can rapidly deplete dissolved oxygen levels unless these wastes are adequately treated at a wastewater treatment plant to remove much of the organic component. In addition, some chemicals may react with and bind up dissolved oxygen.

A large portion of the organic material discharged into the water from a wastewater treatment plant is readily decomposed as the oxygen-consuming decay process may begin to occur within a matter of hours. As this decay process occurs in a moving water column, the area of greatest impact may be several miles below the point of discharge. This area can often be identified by a marked reduction in instream dissolved oxygen concentrations and is commonly referred to as the *sag zone*. Frequently, dissolved oxygen concentrations will gradually rise downstream of the sag zone as the amount of readily decomposed organic matter is reduced. However, a significant portion of the organic matter in wastewater treatment plant effluent may take days to decompose.

Biochemical oxygen demand, or BOD, is a technical term that describes the overall demand on dissolved oxygen from the various oxygen-depleting processes presented above. A commonly used measure of BOD is called BOD_5 where the "5" stands for the amount oxygen demand exerted over five days. BOD_5 is a standard waste limit in most discharge permits. A limit of 30 mg/l of BOD_5 is the highest concentration allowed by federal and state regulations for municipal and domestic wastewater treatment plants. Limits less than 30 mg/l and sometimes as low as 5 mg/l are becoming more common in order to protect dissolved oxygen standards in the receiving waters.

Oxygen-Consuming Wastes in the Roanoke River Basin

The protection of dissolved oxygen through management of the discharge of oxygen-consuming wastes into waters of the Roanoke River basin continues to be a high priority. Efforts to limit the discharge of these wastes from NPDES discharge facilities have been largely successful over the past two decades. Several factors have contributed to improvements in water quality related to reductions in oxygen-consuming wastes. These include 1) more stringent point source pollution control requirements mandated by the federal Clean Water Act, 2) management actions implemented through the state's NPDES program and 3) major efforts by municipalities, industries and others, in the form of wastewater treatment plant upgrades and improved plant operation, to meet these requirements for water quality protection.

Using historical data, a rough estimate can be made of changes in wastewater flows and contributions of oxygen-consuming wastes over time. Table 3.1 presents approximated amounts of wastewater flow and BOD_5 for wastewater facilities in the Roanoke River basin in 1986 and 1995. During that time period there was a 7% increase in flow and a 27% decrease in the amount of BOD_5 being discharged.

Table 3.1. Wastewater flows and BOD5 contributions for the Roanoke River Basin in 1986 and 1995.

	1986	1995
Total Flow (MGD)	76	81
BOD5 (pounds/day)	16,600	12,200

In general, while water quality standards for dissolved oxygen are being met throughout most of the North Carolina portion of the basin, there are some areas of concern (the Cashie River), and some characteristics of the basin such as the highly regulated flows and swamp waters that warrant close observation as evidenced by low episodes of dissolved oxygen in the summer of 1995. Monitoring of these conditions in conjunction with the management of contributions of BOD are both important in maintaining appropriate dissolved oxygen levels for the protection of aquatic life. Recommended strategies for addressing BOD are presented in Section 6.3 of Chapter 6.

3.2.2 Nutrients

The term *nutrients* in this document refers to the substances phosphorus and nitrogen, two common components of plant fertilizers. Nutrients in surface waters come from both point and nonpoint sources. Nutrients in an aquatic system are necessary to support primary productivity by algae and other aquatic plants. Algae, also referred to as *phytoplankton*, are a basic component of the aquatic food web upon which fish and other aquatic organisms depend. However, through human activities such as wastewater discharges and agriculture, nutrients are often added to waterbodies at an excessive rate. An overabundance of nutrients under favorable conditions can stimulate the occurrence of algal blooms and excessive plant growth in quiet waters such as ponds, lakes, reservoirs and estuaries. Algae blooms, through respiration and decomposition, deplete the water column of dissolved oxygen and can contribute to serious water quality problems. Nutrient overenrichment and the resultant problems with low DO is called *eutrophication.* The blooms are also aesthetically undesirable, impair recreational use and enjoyment of the affected waters, impede commercial fishing and pose difficulties in water treatment at water supply reservoirs.

Runoff from agricultural lands and forests and discharges from wastewater treatment plants are the main sources of nutrients in the basin. Nutrients in nonpoint source runoff come mostly from fertilizer and animal wastes. Nutrients in point source discharges are from human wastes, food residues and some cleaning agents. A statewide phosphorus detergent ban implemented in 1988 significantly reduced the amount of phosphorus reaching and being discharged into surface waters from wastewater treatment plants.

DO depletion from nutrient overenrichment and algal blooms fluctuates seasonally and with the time of day. Oxygen is produced by algae and other plants in the presence of sunlight through a process called *photosynthesis*. At nighttime, however, photosynthesis and DO production slow and DO is consumed by plants through the process of *respiration.* During the summer months, this daily cycle of daytime oxygen production and nighttime depletion often results in supersaturation of the surface water by oxygen during the afternoon hours on bright, sunny days, and low DO concentrations during the late night and early morning hours. In addition, decaying algae may settle to the bottom of the water body and create a *sediment oxygen demand* (SOD) which may lower DO concentrations in the bottom waters of lakes, reservoirs, and estuaries.

At this time, North Carolina has no instream standards for total phosphorus (TP) and total nitrogen (TN). Limits on the amount of phosphorus that may be discharged into surface waters are presented in Chapter 6. In addition, the State has a standard of 40 ug/l (micrograms per liter or parts per billion) for chlorophyll a. Chlorophyll a is a chemical constituent of algae (it gives it its green color). A chlorophyll a reading above the 40 ug/l standard is indicative of excessive algal growth and portends bloom conditions.

Nutrient Loading in the Roanoke Basin

A nutrient loading model has been developed for the Roanoke River Basin. This model is a nutrient budget, the simplest type of loading model. This nutrient budget was developed by Research Triangle Institute (RTI) as part of an Albemarle Pamlico (A/P) Estuarine Study Program in 1991 for the Roanoke River Basin below Roanoke Rapids Lake Dam (Dodd and McMahon, 1992). Nutrient budgets identify the amount of nutrient loading from each pollutant source within a given watershed. Nonpoint source loading was estimated through the use of *export coefficients* for different land cover types. Export coefficients refer to the amount of a substance, such as sediment or nutrients, that might be expected to be transported from the land by stormwater to nearby surface waters. Export coefficients, which are based on research studies, are expressed in terms of the amount of loading per unit area per year (e.g. lbs/acre/year or kg/hectare/year). The amount of loading of a specific type of substance will vary with the type of land use; different land uses and cover types have different export coefficients. Therefore, in a nutrient budget analysis, an estimate is made of the land area in each type of land use, and export coefficients from literature are used to estimate nonpoint source loading from each land use type. Flow and nutrient concentration from point sources are used to determine point source nutrient loading.

It should be noted that export coefficients give rough estimates of loading and there may be much error in the estimates. Therefore, care should be exercised when using them. Export coefficients do not allow one to estimate delivered load to a given site in the basin as they do not account for fate and transport of the nutrients. However, they can be useful to managers by giving them one method to prioritize areas in a basin for management. For example, a subbasin with high areal load may be prioritized if other characteristics of the subbasin are similar to other subbasins.

RTI used actual discharger data from 1989 and 1990 to estimate the point source loading to the basin. For use in this basin plan, the nutrient loading was updated to include discharge data from 1994.

In the RTI study, land use data were obtained from a 1987-1988 LANDSAT land cover classification survey (see Chapter 2), and export coefficients were estimated from a literature search of numerous studies. A range of export coefficients (high, median and low) was identified in the literature for each land cover type. For the purpose of the RTI work, the median, or "most likely", value for each land cover type was used to estimate the total loading. These values and the number of studies on which they are based are presented in Table 3.2, on the next page.

Table 3.2. Export Coefficient Literature Review

	Agriculture lb/ac-yr	Agriculture kg/ha-yr	Forest/Wetland lb/ac-yr	Forest/Wetland kg/ha-yr	Developed lb/ac-yr	Developed kg/ha-yr	Atmospheric lb/ac-yr	Atmospheric kg/ha-yr
Total Phosphorus								
Low (25%)	0.49	(0.55)	0.08	(0.09)	0.40	(0.45)	0.22	(0.25)
Median	**0.88**	**(0.99)**	**0.12**	**(0.13)**	**0.95**	**(1.06)**	**0.58**	**(0.65)**
High (7%)	1.81	(2.03)	0.19	(0.21)	1.34	(1.50)	0.62	(0.69)
Total Nitrogen								
Low (25%)	4.46	(5.00)	0.62	(0.69)	4.46	(5.00)	7.76	(8.7)
Median	**8.74**	**(9.80)**	**2.08**	**(2.33)**	**6.71**	**(7.50)**	**11.06**	**(12.4)**
High (7%)	12.75	(14.3)	3.39	(3.80)	8.67	(9.72)	21.41	(24.0)
Number of Studies	**77**		**36**		**78**		**6**	

Tables 3.3 and 3.4 summarize the relative contributions of total nitrogen (TN) and total phosphorus (TP) loadings to the Roanoke River from point and non-point sources below Roanoke Rapids Lake Dam by hydrologic unit. These hydrologic units nest within DWQ's subbasins (see Table 2.1). The tables in this section indicate that agriculture and point sources are the dominant sources of nutrients below the Roanoke Rapids Lake Dam.

Tables 3.3 and 3.4 must be interpreted with care. Since no land use data were available for the majority of the basin, the percent loadings assigned to each category could be dramatically different from the loading that occurs within the entire basin. In order to compare the load in the rest of the basin to the export coefficients, DWQ estimated the nutrient load coming out of the dam using the Army Corps of Engineer's FLUX model. FLUX estimates the annual load of nutrients at a given point within a basin based on continuous flow and nutrient grab data collected at the site. Therefore, it is measuring delivered load, but does not indicate the source of the nutrients. For further information on the FLUX model, the reader is referred to the user's manual (Walker, 1987). DWQ used flow and water quality data collected on the Roanoke River at Highway 48 for use in the analysis.

Table 3.3. Contributions of Total Nitrogen to the Roanoke River below Roanoke Rapids Dam

Hydrologic Unit	Agriculture (kg/yr)	Forest (kg/yr)	Urban (kg/yr)	Wetland (kg/yr)	Water (kg/yr)	Scrub (kg/yr)	Other (kg/yr)	Point Source (kg/yr)	Totals (kg/yr)	Totals Percent
301010601	7,400	2,780	500	390	2,080	0	50	227,870	241,070	9%
301010701	445,600	101,170	3,480	41,990	10,850	7,110	1,150	208,820	820,170	31%
301010702	397,800	77,780	5,380	116,960	16,020	28,620	690	590,190	1,233,440	47%
301010703	202,700	84,340	970	37,940	1,760	13,380	170	3,550	344,810	13%
	1,053,500	266,070	10,330	197,280	30,710	49,110	2,060	1,030,430	2,639,490	
	40%	10%	0%	7%	1%	2%	0%	39%		100%

Table 3.4 Contributions of Total Phosphorus to the Roanoke River below Roanoke Rapids Dam

Hydrologic Unit	Agriculture (kg/yr)	Forest (kg/yr)	Urban (kg/yr)	Wetland (kg/yr)	Water (kg/yr)	Scrub (kg/yr)	Other (kg/yr)	Point Source (kg/yr)	Totals (kg/yr)	Totals Percent
301010601	750	160	70	20	170	0	0	13,890	15,060	5%
301010701	45,010	5,650	490	2,370	990	400	60	54,220	109,190	34%
301010702	40,180	4,340	760	6,610	1,630	1,600	40	111,970	167,130	52%
301010703	20,480	4,710	140	2,140	170	750	10	420	28,820	9%
Totals	106,420	14,860	1,460	11,140	2,960	2,750	110	180,500	320,200	
	33%	5%	0%	3%	1%	1%	0%	56%		100%

Since FLUX estimates delivered load and the export coefficients estimate source load, the results are not directly comparable. They are summarized here only to illustrate the importance of nutrient load from the basin above Roanoke Rapids Lake Dam. Figures 3.1 and 3.2 summarize the relative contributions of total nitrogen (TN) and total phosphorus (TP) loadings to the Roanoke River from point sources, non-point sources, and the area above Roanoke Rapids Lake Dam. These figures indicate that point source discharges below Roanoke Rapids contribute 13% of the TN and 36% of the TP to the basin. Agriculture below the dam is the main nonpoint source contributor of TN (14%) and TP (22%) in the basin. However, various sources above Roanoke Rapids Dam provide the majority of the nitrogen (67%) to the basin and 35% of the total phosphorus to the basin.

3.2.3 Toxic Substances

Regulation 15A NCAC 2B. 0202(36) defines a toxicant as "any substance or combination of substances ... which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, has the potential to cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions or suppression in reproduction or growth) or physical deformities in such organisms or their offspring or other adverse health effects". Toxic substances frequently encountered in water quality management include *chlorine*, *ammonia*, *organics* (hydrocarbons, pesticides, herbicides), and *heavy metals*. These materials are toxic to different organisms in varying amounts, and the effects may be evident immediately or may only be manifested after long-term exposure or accumulation in living tissue.

North Carolina has adopted standards and *action levels* for several toxic substances. These are contained in 15A NCAC 2B .0200. Usually, limits are not assigned for parameters which have action levels, such as copper, unless monitoring indicates that the parameter may be causing toxicity or federal guidelines exist for a given discharger for an action level substance. This process of determining action levels exists because these toxic substances are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics and/or associated waste characteristics. Water quality-based limits may also be assigned to a given NPDES permit if data indicate that a substance is present for which there is a federal criterion but no water quality standard.

Whole effluent toxicity (WET) testing is required on a quarterly basis for major dischargers and any discharger releasing complex (industrial) wastewater. There are 34 such dischargers in the Roanoke River Basin. A complete listing of these facilities is included in Appendix II. This test

Figure 3.1 Estimated Sources of Nitrogen Below Roanoke Rapids Dam

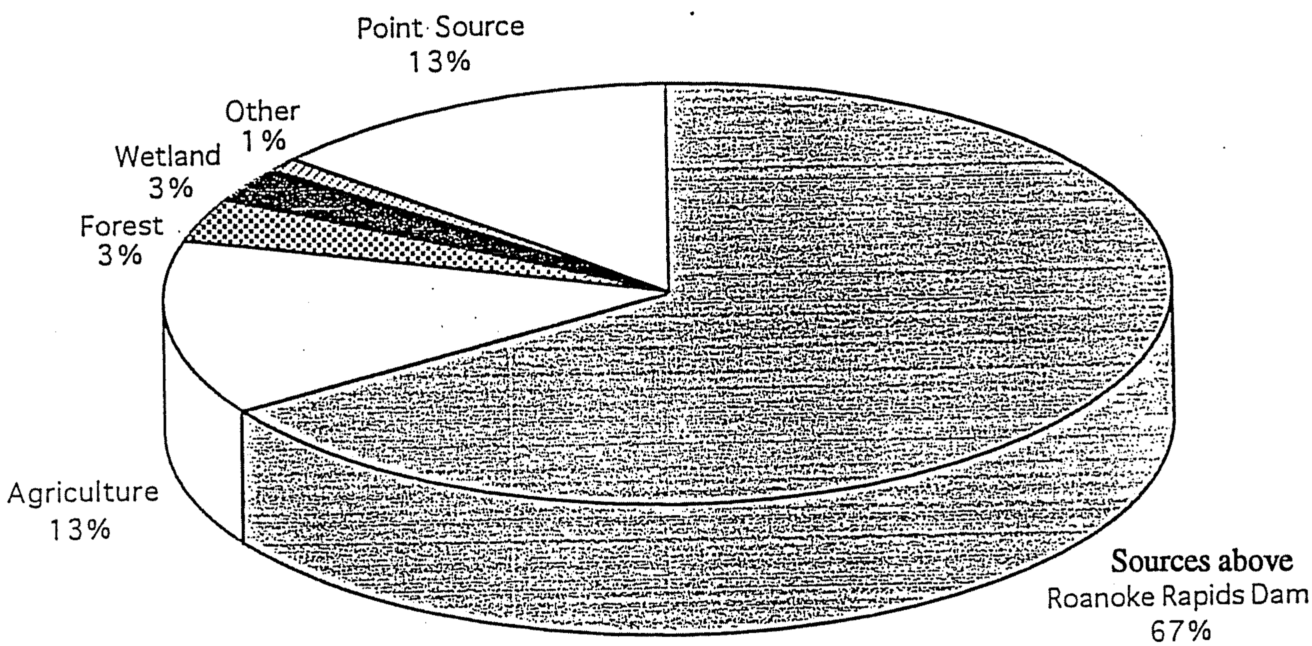
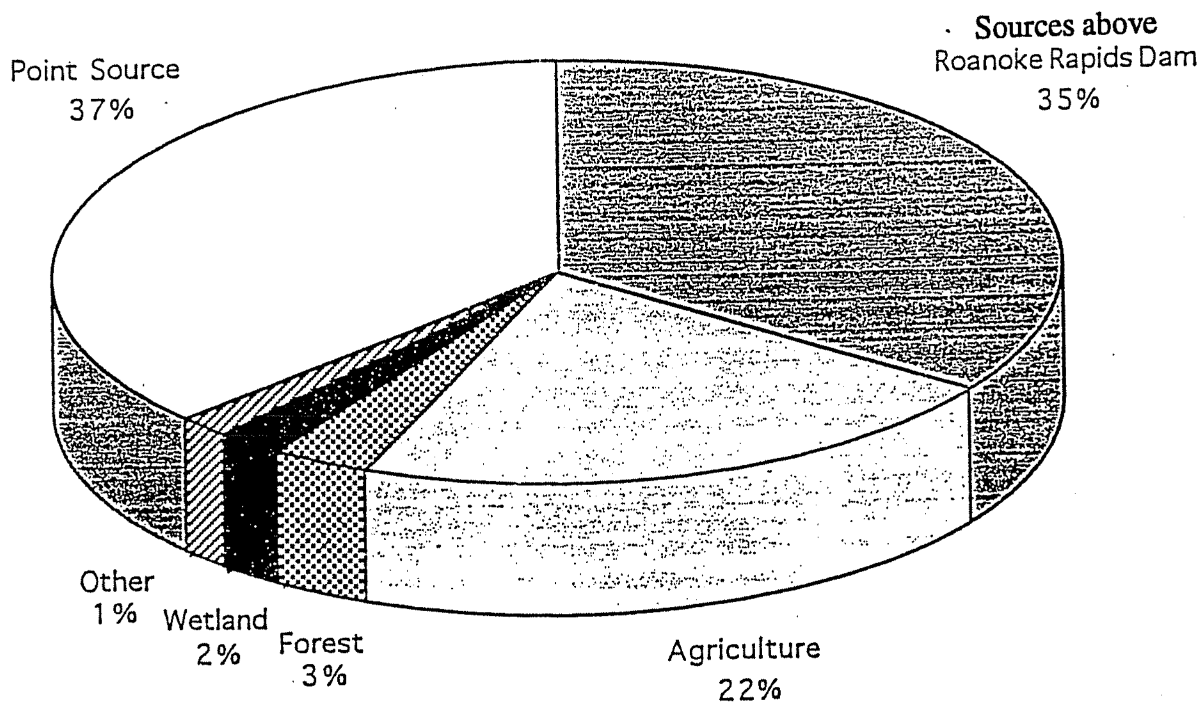


Figure 3.2 Estimated Sources of Phosphorus below Roanoke Rapids Dam



shows whether the effluent from a treatment plant is toxic, but it does not identify the specific cause of toxicity. If the effluent is found to be toxic, further testing is done to determine the specific cause. This follow-up testing is called a *toxicity reduction evaluation* (TRE). WET testing is discussed in Sections 4.2.4 and 5.2.5 of Chapters 4 and 5, respectively. Strategies to address toxicity problems associated with dischargers are presented in Section 6.5 of Chapter 6.

Metals

Municipal and industrial dischargers along with urban runoff, and possibly atmospheric deposition, are the main sources of metals contamination in surface water. North Carolina has stream standards for many heavy metals, but the most common ones in municipal permits are cadmium, chromium, nickel, lead, mercury, silver and zinc. Each of these is monitored at the 21 ambient monitoring stations in the basin along with aluminum and arsenic. Point source discharges of metals are controlled through the NPDES permit process. Mass balance models (Appendix III) are employed to determine appropriate limits. Municipalities with significant industrial users discharging wastes to their treatment facilities limit the heavy metals coming to them from their industries through their *pretreatment program* (Table 3.5 lists facilities in the Roanoke basin with a pretreatment program). Source reduction and wastewater recycling at WWTPs also reduces the amount of metals being discharged to a stream. Nonpoint sources of pollution are controlled through best management practices.

Table 3.5. NPDES Facilities in the Roanoke River Basin with Pretreatment Programs

Subbasin	Facility Name	NPDES or ND #	WWTP SIUs	Region
030202	Mayodan	NC0021873	4	Winston-Salem
030202	Stoneville	NC0028011	3	Winston-Salem
030203	Eden (Dry Cr.)	NC0025151	0	Winston-Salem
030203	Eden (Mebane Bridge)	NC0025071	4	Winston-Salem
030204	Yanceyville	NC0040011	1	Winston-Salem
030205	Roxboro	NC0021024	5	Raleigh
030206	Henderson	NC0020559	5	Raleigh
030208	Roanoke Rapids	NC0024201	4	Raleigh
030208	Weldon	NC0025721	1	Raleigh
030209	Williamston	NC0020044	2	Washington

NPDES or ND# = facility's discharge permit number
WWTP = wastewater treatment plant
SIUs - significant industrial users

In the Roanoke River basin, there are two lakes that are partially supporting their uses due to fish consumption advisories related to elevated levels of selenium. Belews and Hyco Lakes were contaminated with selenium by runoff from coal ash ponds. Corrective measures to prevent further runoff into the lakes have been employed and monitoring of selenium levels continues.

Chlorine

Chlorine is commonly used as a disinfectant at NPDES discharge facilities which have a domestic (i.e., human) component. These discharges are a major source of chlorine in the State's surface waters. Chlorine dissipates fairly rapidly once it enters the water, but it can have significant toxic effects on sensitive aquatic life such as trout and mussels. North Carolina has adopted a freshwater standard for trout waters of 17 ug/l (micrograms per liter). For all other waters an action level of 17 ug/l is applied to protect against chronic toxicity. It is recommended that new and expanding discharges with domestic waste provide dechlorination or alternate disinfection of wastewater. A total residual chlorine limit is assigned based on the freshwater action level of 17 ug/l or a maximum concentration of 28 ug/l for protection against acute effects in the mixing zone. In 1993, letters were sent to existing facilities with chlorine monitoring requirements. These letters encouraged permittees to examine their effluent chlorine levels and noted that limits may be implemented in the future. At this time, the State is only requiring chlorine limits at existing treatment facilities where the discharge is into supplementally classified as trout waters. If a chlorine standard is developed for NC, chlorine limits may be assigned to all dischargers in the state that have chlorine in their effluent.

Ammonia (NH_3)

Point source dischargers are one of the major sources of ammonia. In addition, decaying organisms which may come from nonpoint source runoff and bacterial decomposition of animal waste products also contribute to the level of ammonia in a waterbody. At this time, there is no numeric standard for ammonia in North Carolina. However, DWQ has agreed to address ammonia toxicity through an interim set of instream criteria of 1.0 mg/l in the summer (April - October) and 1.8 mg/l in the winter (November - March). These interim criteria are under review, and the State may adopt a standard in the future.

3.2.4 Sedimentation

Sedimentation and erosion is the most widespread cause of nonpoint source pollution in the state. It impacts streams in several ways. Eroded sediment may gradually fill lakes and navigable waters and may increase drinking water treatment cost. Sediment may clog the gills of fish, eliminate the available habitat of organisms which serve as food for fish, or even completely cover shellfish beds. Sediment also serves as a carrier for other pollutants including nutrients (especially phosphorus), toxic metals and pesticides. Most sediment-related impacts are associated with nonpoint source pollution generated by ground-disturbing activities such as building and road construction and farming.

North Carolina does not have a numeric water quality standard for suspended solids, however all discharges must meet federal effluent guideline values at a minimum (e.g. 30 mg/l for domestic discharges). Also, most point source BOD limitations usually require treatment to a degree that removes sediments to a level below federal guidelines requirements. Discharges to high quality waters (HQW) must meet a total suspended solids (TSS) limit of 10 mg/l for trout waters and primary nursery areas and 20 mg/l for all other HQWs. In addition, the state has adopted a numerical instream turbidity standard for point and nonpoint source pollution. Nonpoint sources are considered to be in compliance with the standard if approved best management practices (BMPs) have been implemented.

Statistics compiled by the US Department of Agriculture, Natural Resources Conservation Service indicate a statewide decline in erosion from 1982 to 1992 (USDA, NRCS, 1992) as shown in Table 3.6.

Table 3.6. Overall Erosion Trends in North Carolina

	1982	1987	1992
Area (1,000 acres)	33,708.2	33,708.2	33,708.2
Gross Erosion (1,000 tons/yr)	46,039.5	43,264.6	36,512.9
Erosion Rate (Tons/Yr/Ac)	1.4	1.3	1.1

The NRCS statistics also indicate a statewide reduction per acre on cropland erosion using the Universal Soil Loss Equation (Table 3.7).

Table 3.7. USLE Erosion on Cultivated Cropland in North Carolina

	1982	1987	1992
Cropland Area (1,000 acres)	6,318.7	5,956.8	5,538
Gross Erosion (1,000 tons/yr)	40,921.4	37,475.3	30,908.3
Erosion Rate (Tons/Yr/Ac)	6.5	6.3	5.6

While there is an overall 10-year downtrend statewide in the erosion rate on agricultural lands, the erosion rate/acre and the 10-year trends vary by region as shown in Table 3.7. The greatest improvement in erosion control is seen in the Southern Piedmont and Sand Hills with a small uptrend in the tidewater area and a significant increase in the mountains.

Table 3.8. North Carolina Erosion on Major Land Resource Areas (MLRA) in Tons/acre/yr

	1982	1987	1992
Blue Ridge Mountains	12.7	20.8	18.3
Southern Piedmont	12.3	12.0	10.5
Carolina and Georgia Sand Hills	6.0	5.6	5.1
Southern Coastal Plain	3.9	3.9	4.0
Atlantic Coast Flatwoods	3.2	3.1	3.2
Tidewater Area	1.4	1.5	1.6

Sedimentation in the Roanoke River Basin

There are approximately 38 miles of streams in the Ronaoke River Basin impacted due to sedimentation. This number is based on evaluated information which includes areas where best professional judgement was used to determine a cause for impact. Table 4.23 of Chapter 4 presents more detailed monitored information and indicates that 14.3 miles of streams are only partially supporting their uses at least partly due to problems from sedimentation. The affected streams are Marlowe Creek and Smith Creek in subbasins 030205 and 030207 respectively. Section 6.6 of Chapter 6 discusses strategies for improving sediment control.

3.2.5 Fecal Coliform Bacteria

Fecal coliform bacteria are typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of pathogenic, or disease-causing, bacteria and viruses. They enter surface waters from improperly treated discharges of domestic wastewater and from nonpoint source runoff. Common nonpoint sources of fecal coliform bacteria include leaking or failing septic systems, leaking sewer lines or pump station overflows, runoff from livestock operations and wildlife.

Fecal coliform bacteria are used as indicators of waterborne pathogenic organisms (which cause such diseases as typhoid fever, dysentery, and cholera) because they are easier and less costly to detect than the actual pathogens. Fecal coliform water quality standards have been established in order to ensure safe use of waters for water supplies, recreation and shellfish harvesting. The current State standard for fecal coliform bacteria is 200 MF/100 ml for all waters except SA waters. MF is an abbreviation for the Membrane Filter procedure for determining fecal coliform concentrations. This procedure entails pouring a 100 ml water sample through a membrane filter. The filter is then placed on a cultured medium and incubated for a specified period of time. The number of colonies of bacteria that grow on the medium is then compared to the standard of 200 colonies per 100 ml. Fecal coliform bacteria in treatment plant effluent are controlled through disinfection methods including chlorination (sometimes followed by dechlorination), ozonation or ultraviolet light radiation.

Fecal Coliform Bacteria in the Roanoke River Basin

Ambient monitoring data for the last five years indicates that there are areas in the Dan River drainage portion of the Roanoke basin (especially at a sampling station at Wentworth) that have elevated concentrations of fecal coliform bacteria. In the Roanoke River area, concentrations are generally lower. This information is presented in more detail in Chapter 4. Management strategies for addressing fecal coliform bacteria are presented in Section 6.9 of Chapter 6.

3.2.6 Color

Color in wastewater is generally associated with industrial wastewater or with municipal plants that receive certain industrial wastes, especially from textile manufacturers, that use dyes to color their fabrics, and from pulp and paper mills. For colored wastes, 15A NCAC 2B .0211(b)3(F) states that the point sources shall discharge only such amounts as will not render the waters injurious to public health, secondary recreation, or aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses. NPDES permit requirements regarding color are included on a case-by-case basis since no numeric standard exists for color, and because a discharger may have high color values but no visual impact instream due to dilution or the particular color of the effluent. No waters in the basin have been identified as use-impaired due to color.

3.3 POINT SOURCES OF POLLUTION

3.3.1 Defining *Point* Sources

Point sources refers to discharges that enter surface waters through a pipe, ditch or other well-defined points of discharge. The term most commonly refers to discharges associated with wastewater treatment plant facilities. These include *municipal* (city and county) and *industrial* wastewater treatment plants as well as small *domestic* discharging treatment systems that may serve schools, commercial offices, residential subdivisions and individual homes. In addition, discharges from *stormwater systems* at industrial sites are now considered point source discharges and are being regulated under new urban stormwater runoff regulations being required by the U.S. Environmental Protection Agency (EPA). The urban stormwater runoff program is discussed in more detail in Chapter 5 and Section 6.8 in Chapter 6. The primary water quality pollutants associated with point source pollution are oxygen-demanding wastes, nutrients, color and toxic substances including chlorine, ammonia and metals. In the Roanoke River Basin, there are an estimated 73 miles of freshwater streams impacted due to point sources.

Point source discharges are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the National Pollutant Discharge Elimination System (NPDES) program delegated to North Carolina from EPA. The amount or loading of specific pollutants that may be allowed to be discharged into surface waters are defined in the NPDES permit and are called *effluent limits*. Under the NPDES permitting program, each NPDES discharger is assigned either *major* or *minor* status. Major facilities are large with greater flows. For municipalities, all dischargers with a flow of greater than 1 million gallons per day (MGD) are classified as major. Most point source discharges, other than urban and industrial stormwater discharges, are continuous and do not occur only during storm events as do nonpoint sources. They generally have the most impact on a stream during low flow conditions when the percentage of stream flow composed of treated effluent is greatest. Permit limits are generally set to protect the stream during low flow conditions. The standard low flow used for determining point source impacts is called the *7Q10*. This is the lowest flow which occurs over seven consecutive days and which has an average recurrence of once in ten years.

Information is collected on NPDES permitted discharges in several ways. The major method of collection is facility self-monitoring data which are submitted monthly to the DWQ by each individual permittee. NPDES facilities are required to monitor for all pollutants for which they have limits as well as other pollutants which may be present in their wastewater. All domestic wastewater dischargers are required to monitor flow, dissolved oxygen, temperature, fecal coliform, BOD, ammonia, and chlorine (if they use it as a disinfectant). In addition, facilities with industrial sources may have to monitor for chemical specific toxicants and/or whole effluent toxicity (see Section 3.2.3); and all dischargers with design flows greater than 50,000 gallons per day (GPD) monitor for total phosphorus and total nitrogen. Minimum NPDES monitoring requirements are provided in 15A NCAC 2B .0500.

Other methods of collecting point source information include effluent sampling by DWQ during inspections and special studies. The regional offices may collect data at a given facility if they believe there may be an operational problem or as a routine compliance check. In addition, DWQ may collect effluent data during intensive surveys of segments of streams, and extensive discharger data have been collected during onsite toxicity tests.

3.3.2 Point Source Discharges in the Roanoke River Basin

In the Roanoke River Basin, there are 366 permitted NPDES dischargers. Table 3.9 summarizes the number of dischargers and their total permitted and actual flows for each subbasin and by broad categories of dischargers including majors, minors, domestic, municipal, industrial (process and nonprocess) and stormwater. A distribution map of the discharge facilities is shown in Figures 3.3 a and b (upper and lower basin). These figures are followed by Table 3.10 which provides a list of the major discharges in the basin with numbers that correspond to locations on the maps.

Of the total 316 dischargers, 19 are municipalities and 38 are industries. Seventeen (17) of the total number are major facilities and 58 of the total have 100% domestic wastewater. The total permitted flow for all facilities is 184 million gallons per day (MGD) with the actual measured flows being 797 MGD. The reason that the average actual flow is higher than the permitted flow is because some industrial discharges, such as those for cooling water, stormwater or nonprocess wastewater, do not have a total flow limit specified in their permit although they monitor and report total flow anyway. Meaningful comparisons between permitted and actual flows can be seen in the municipal and domestic wastewater categories, the actual flows are 53% and 52% of their respective permitted flows.

Table 3.9 Summary of Major/Minor Dischargers and Permitted and Actual Flows by Subbasin in the Roanoke River Basin

FACILITY CATEGORIES	SUBBASIN 01	02	03	04	05	06	07	08	09	10	TOTALS
Total Facilities	80	34	128	4	30	16	3	36	22	13	**366**
Facils. w/o Stmwtr & Gen. Permits	29	8	26	3	7	4	1	11	9	4	**102**
Total Permitted Flow (MGD)	1.02	2.32	19.88	0.27	26.03	4.16	0.01	41.06	87.50	1.30	**183.55**
# of Facilities Reporting	23	7	21	3	8	5	1	11	9	3	**91**
Total Avg. Flow (MGD)	624.44	0.86	80.10	0.22	7.23	3.62	0.00	27.46	52.18	0.48	**796.59**
*Major Discharges	1	1	4	0	3	1	0	3	3	1	**17**
Total Permitted Flow (MGD)	5	1.25	19.2	0	26.02	4.14	0	37	86	1.15	**179.755**
# of Facilities Reporting	1	1	4	0	3	1	0	3	3	1	**17**
Total Avg. Flow (MGD)	744.00	1.16	74.80	0.00	83.80	2.58	0.00	23.10	73.30	0.40	**1,003.14**
*Minor Discharges	28	7	22	3	4	3	1	8	6	3	**85**
Total Permitted Flow (MGD)	1.15	1.07	0.92	0.27	0.01	0.02	0.01	4.12	1.50	0.15	**9.22**
# of Facilities Reporting	22	6	16	3	4	3	1	8	6	2	**71**
Total Avg. Flow (MGD)	0.50	83.90	0.32	0.22	0.50	0.20	0.00	2.80	0.90	1.30	**90.64**
100% Domestic Wastewater	23	2	15	1	2	2	1	3	0	1	**50**
Total Permitted Flow (MGD)	0.80	0.03	0.17	0.02	0.01	0.02	0.01	0.09	0.00	0.00	**1.15**
# of Facilities Reporting	18	2	11	1	2	2	1	3	0	1	**41**
Total Avg. Flow (MGD)	0.24	0.01	0.05	0.01	0.01	0.01	0.00	0.07	0.00	0.00	**0.41**
Municipal Facilities	1	3	2	1	1	1	0	4	4	2	**19**
Total Permitted Flow (MGD)	0.19	2.28	14.00	0.25	5.00	4.14	0.00	9.17	3.03	1.30	**39.35**
# of Facilities Reporting	1	3	2	1	1	1	0	4	4	2	**19**
Total Avg. Flow (MGD)	0.21	0.82	5.68	0.18	3.10	2.50	0.00	6.38	1.59	0.48	**20.95**
Major Process Industrial	1	0	3	0	2	0	0	1	2	0	**9**
Total Permitted Flow (MGD)		0	5.7	0	21.02	0	0	28	84	0	**138.715**
# of Facilities Reporting	1	0	3	0	2	0	0	1	2	0	**9**
Total Avg. Flow (MGD)	624.00	0.00	74.00	0.00	3.90	0.00	0.00	17.80	50.27	0.00	**769.97**
Minor Process Industrial	5	1	6	1	1	0	0	3	1	0	**18**
Total Permitted Flow (MGD)	0.16	0.03	0.25	0.00	0.00	0.00	0.00	3.80	0.45	0.00	**4.69**
# of Facilities Reporting	5	1	4	1	1	0	0	3	1	0	**16**
Total Avg. Flow (MGD)	0.09	0.01	0.02	0.01	0.36	0.00	0.00	2.60	0.20	0.00	**3.29**
Nonprocess Industrial	3	1	2	0	1	2	0	0	2	0	**11**
Total Permitted Flow (MGD)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
# of Facilities Reporting	0	1	1	0	1	2	0	0	1	0	**6**
Total Avg. Flow (MGD)	0.00	0.01	0.23	0.00	0.15	1.05	0.00	0.00	0.02	0.00	**1.46**
Stormwater Facilities	13	17	28	1	8	8	3	22	11	5	**116**
Total Avg. Flow (MGD)	0	0	0	0	0	0	0	0	0	0	**0**

* Number of facilities without stormwater and general permits

Figure 3.3a Map of NPDES Discharges in the Upper Roanoke River Basin

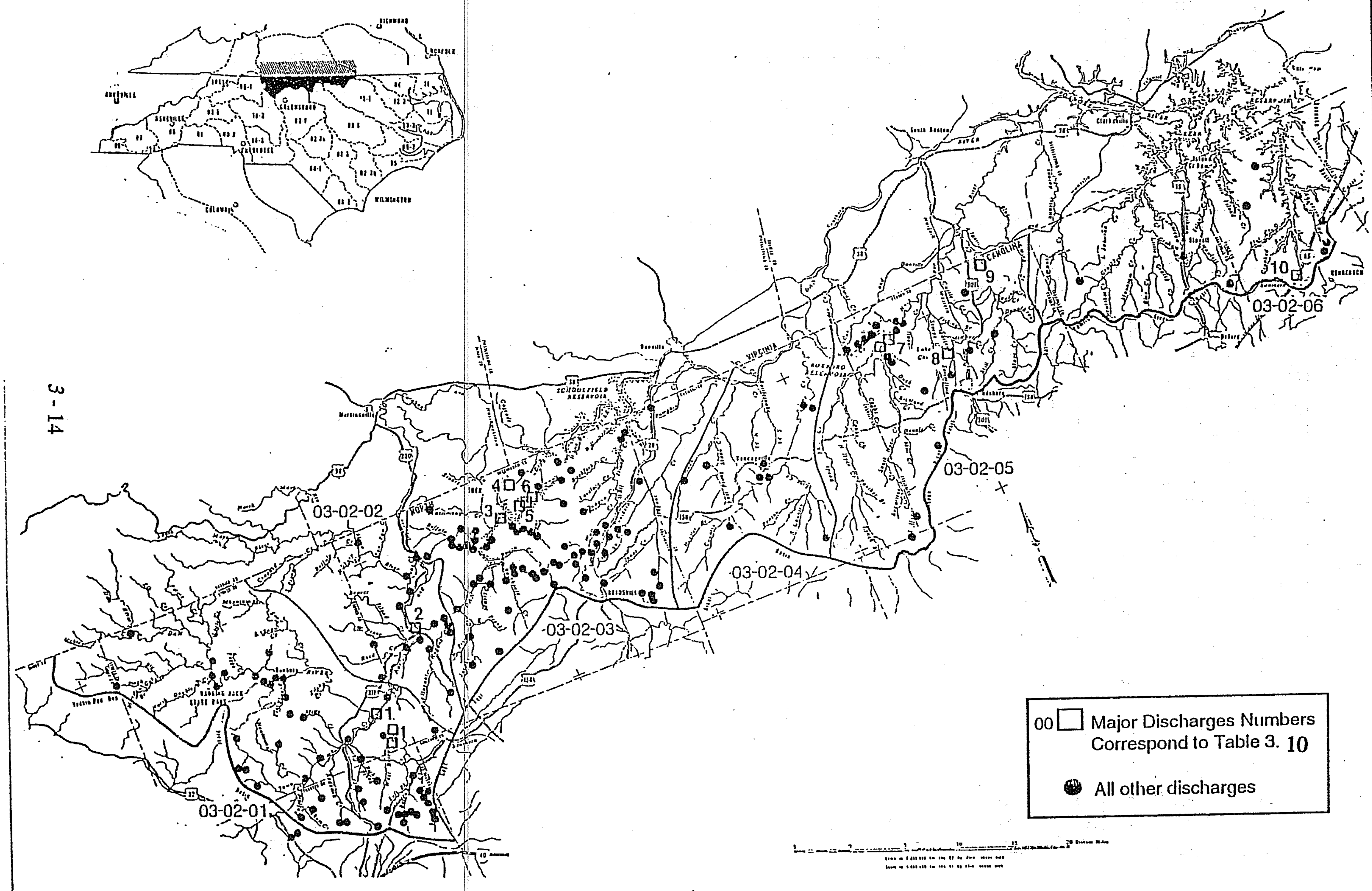


Figure 3.3b Map of NPDES Discharges in the Lower Roanoke River Basin

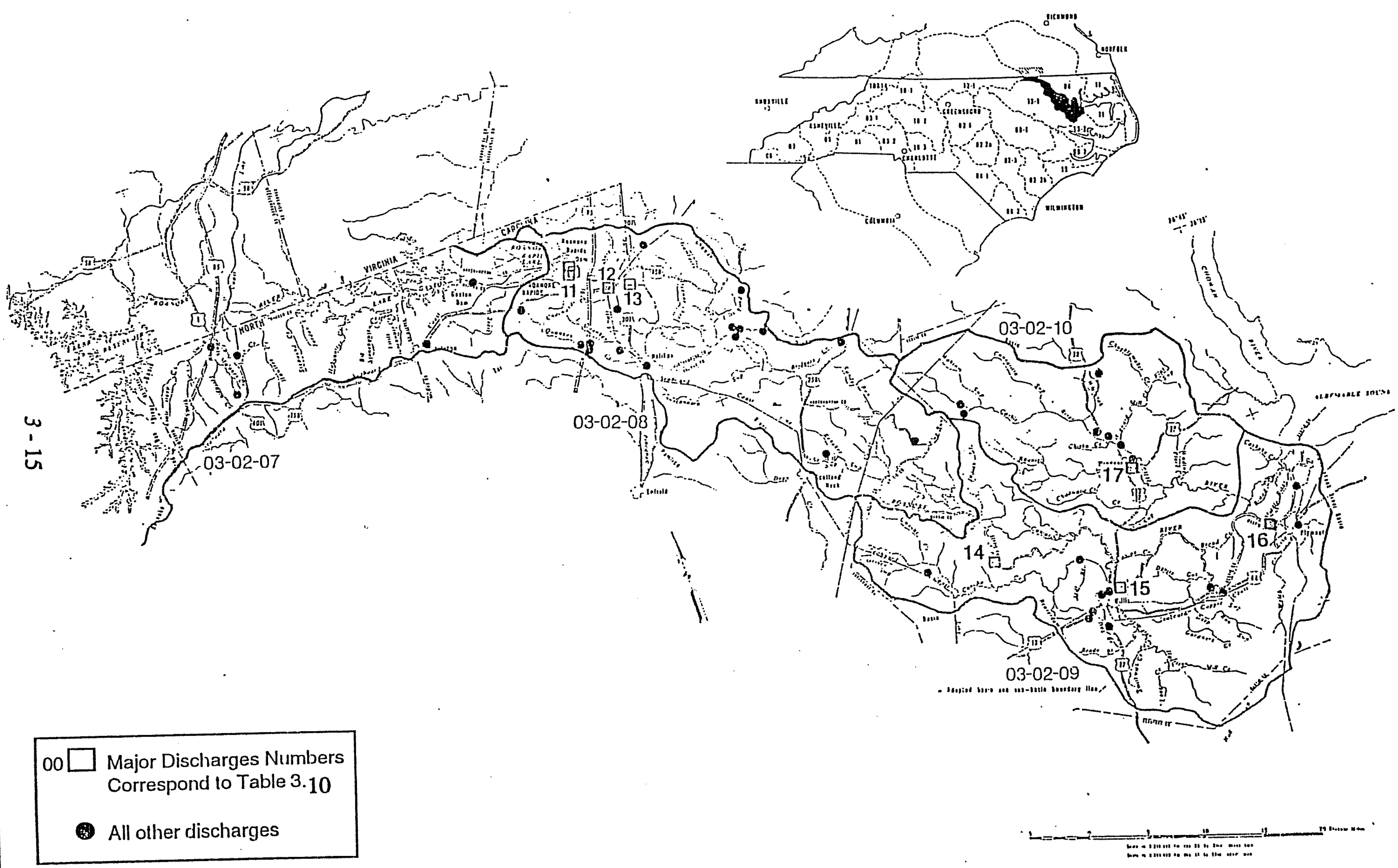


Table 3.10 Major NPDES Discharges in the Roanoke River Basin

Map#	Name	NPDES No.	Subbasin	Type	Design Flow
1	Duke Power/ Belews Cr. Steam Stn.	NC0024406	030201	NON	5.0 MGD
2	Mayodan WWTP	NC0021873	030202	MUN	1.25 MGD
3	Eden/Mebane Bridge WWTP	NC0025071	030203	MUN	13.5 MGD
4	Miller Brewing Co.	NC0029980	030203	NON	5.2 MGD
5	Duke Power/ Dan R. Steam Stn.	NC0003468	030203	NON	monitor
6	Fieldcrest Cannon/ New Street WWTP	NC0001643	030203	NON	0.5 MGD
7	CP&L/Roxboro Steam Elec. Plant (2 pipes)	NC0003425	030205	NON	0.015 MGD
8	Roxboro WWTP	NC0021024	030205	MUN	5.0 MGD
9	CP&L/Mayo Steam Electric Plant	NC0038377	030205	NON	21.0 MGD
10	Henderson/Nutbush Creek WWTP	NC0020559	030206	MUN	4.14 MGD
11	Champion International (4 pipes)	NC0000752	030208	NON	28.0 MGD
12	Roaonoke Rapids Sanitary Dist. WWTP	NC0024201	030208	MUN	8.34 MGD
13	Weldon WWTP	NC0025721	030208	MUN	0.6 MGD
14	Alamac Knit Fabrics	NC0001961	030209	NON	1.5 MGD
15	Williamston WWTP	NC0020044	030209	MUN	2.0 MGD
16	Weyerhaeuser Co. Plymouth Plant (3 pipes)	NC0000680	030209	NON	82.5 MGD
17	Windsor WWTP	NC0026751	030210	MUN	1.15 MGD

MUN = Municipal Facilities
NON = Facilities that are not municipal (Non-municipal Facilities)

3.4 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) refers to runoff that enters surface waters through stormwater or snow melt. There are many types of land use activities that can serve as sources of nonpoint source pollution including land development, construction, crop production, animal feeding lots, failing septic systems, landfills, roads and parking lots. As noted above, stormwater from large urban areas (>100,000 people) and from certain industrial sites is technically considered a point source since NPDES permits are required for piped discharges of stormwater from these areas. However, a discussion of urban runoff will be included in this section.

Sediment and nutrients are major pollution-causing substances associated with nonpoint source pollution. Others include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or removed from the atmosphere and carried into surface waters. Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur at random intervals depending on rainfall events. Below is a brief description of major areas of nonpoint sources of concern in the Roanoke Basin.

3.4.1 Agriculture

There are a number of activities associated with agriculture that may impact water quality if not done properly. Land clearing and plowing render soils susceptible to erosion which in turn can cause stream sedimentation. Contour plowing, terracing and grassed waterways are several common methods used by most farmers to minimize soil loss. Maintaining a vegetated buffer between fields and streams is another excellent means of minimizing soil loss to streams although this practice is not always utilized because it may necessitate taking some land out of production. While sedimentation is the most widespread cause of stream impact resulting from agricultural activities, it should be noted that statewide agricultural soil loss rates had dropped from 1982 to 1992 based on statistics compiled by the USDA Natural Resources Conservation Service (Section 3.2.4).

Improper application of pesticides and fertilizers (including chemical fertilizers, manure and spray application of lagoon wastewater) can result in these substances being washed from fields. Field buffers would again minimize this potential problem. Improperly designed storage or disposal sites can also be a problem. Construction of drainage ditches on poorly drained soils enhances the movement of stormwater into surface waters, and channelization of natural streams destroys habitat values. In addition, use of small streams for irrigation can dewater the streams and cause localized impacts.

Concentrated animal operations can be a significant source of nutrients, biochemical oxygen demand and fecal coliform bacteria if wastes are not properly managed (see Section 5.3.1 of Chapter 5 for discussion of animal waste rules). Impacts can result from over-application of wastes to fields, from leaking lagoons and from unpermitted flows of lagoon liquids to surface waters from improper waste lagoon management. Also there are potential concerns associated with nitrate-nitrogen movement through the soil from poorly constructed lagoons and from wastes applied to the soil surface.

The bar chart in Figure 3.4 presents a comparison between the amount of nutrients generated through manure and the amount of nutrients needed for crop and forage production for each county in the Roanoke River basin. A percentage greater than 100 means that there are more nutrients generated in the manure than can be used by the crops and forage grown in that county. Plant recoverable manure nutrients are those that remain from the time the animal voids the manure till the time it is transported to the field for spreading. During this period, much of the nutrients can be lost through drying or dilution, surface runoff, volatilization or microbial digestion. Since different manure management systems either conserve or sacrifice varying amounts of nutrients, an estimate was made of the percentage of farms using specific systems. These percentages were

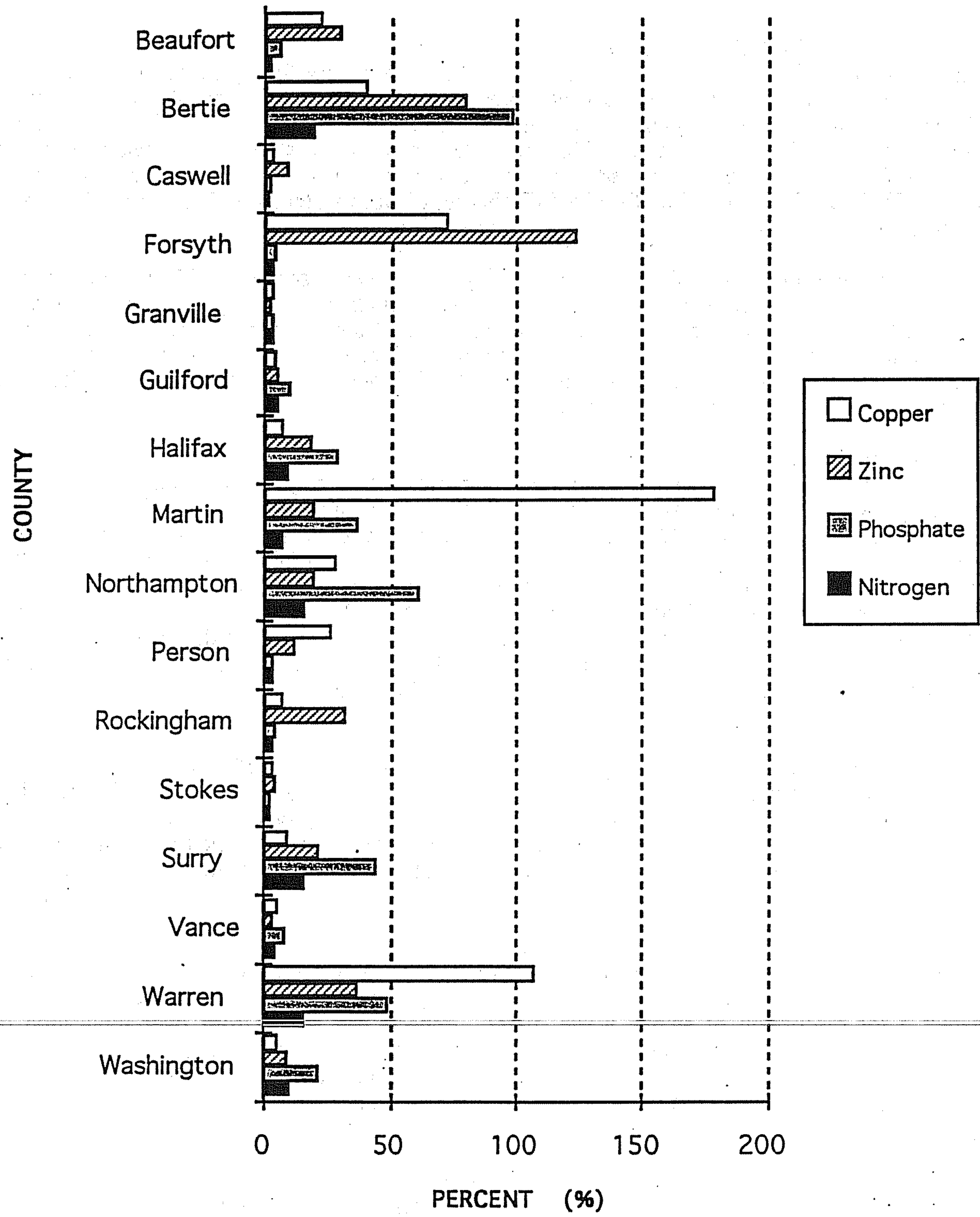


Figure 3.4 NC Livestock and Poultry Production Farm Percent of Field Crop Forage Nutrient Requirements Supplied by Plant Available Manure Nutrients for Counties in the Roanoke River Basin-1993 (Barker and Zublena, 1995)

applied to the manure characteristics appropriate to the specific method which gave the remaining nutrients after storage and treatment losses.

As indicated in Figure 3.4, the manure generated in the Roanoke basin counties generally meets less than 50% of the field crop and forage plant nutrient needs. There are some exceptions however, with some copper and zinc values close to or in excess of 100%. It should be noted that these figures do not take into account commercial fertilizer applications in the counties. If too much copper and zinc are being applied to the land, there is a potential, over time, for the development of toxicity in the soil as metals that are not used by the plants build up in that soil.

These data were calculated by Dr. James Barker and Dr. Joseph Zublena of NCSU for a draft report entitled "Livestock Manure Nutrient Assessment in North Carolina" (Barker and Zublena, 1995). The report was initiated to: 1) geographically depict where the livestock are located and identify "clustering effects", i.e., high densities of livestock production around support facilities such as feed mills, hatcheries, processing plants, etc.; 2) assess current generation of manure by county; 3) determine the amount of nutrients from manure which can be recovered and made available to agronomic crops; 4) determine the quantity of nutrients required for non-legume agronomic crops and forages in each county; and 5) calculate the percent of agronomic crop and forage nutrients which can be supplied by animal manure.

In the Roanoke River Basin, it is estimated that 85 (or 51%) of the miles of freshwater streams estimated to be impaacted from nonpoint sources of pollution are thought to be attributed to agriculture. The highest number of impacted stream miles in any subbasin attributed to agriculture is 36 miles in subbasin 01 (upper portion of the Dan River; primarily in Stokes County). Subbasins 06, 07 and 08 also have areas of impact thought to be attributable to agriculture. This information is derived from the table in Section 4.5 of Chapter 4 entitled Probable Sources of Use Support Impairment.

While, as noted above, the most widespread cause of freshwater stream impact associated with agriculture is sedimentation, nutrients, fecal coliform bacteria and biochemical oxygen demand and pesticides are all potential concerns. Nutrient-related problems, primarily seen as excessive algal or aquatic weed growth, are not always evident in the receiving stream adjoining a farm. Rather, they may be seen in a downstream impoundment, sluggish creek or estuary many miles away. Although the larger impoundments in the Roanoke basin are not considered overenriched with nutrients at this point in time (eutrophic), some are considered mesotrophic which is an indication of partial enrichment. One lake (White Millpond) is considered hypereutrophic (or extremely enriched), and has a use support rating of threatened because of this. Chapter 5 discusses programs aimed at minimizing agricultural nonpoint source pollution. Recommended management strategies for reducing nutrients and sediment runoff are found in Sections 6.4 and 6.6 respectively, in Chapter 6. A list of agricultural BMPs is included in Appendix V.

3.4.2 Urban

Runoff from urbanized areas, as a rule, is more localized but generally more severe than agricultural runoff. The rate and volume of runoff in urban areas is much greater due to the high concentration of impervious surface areas and to storm drainage systems that rapidly transport stormwater to nearby surface waters. These drainage systems, including curb and guttered roadways, allow urban pollutants to reach surface waters quickly and with little or no filtering by vegetated areas. These affects are further exacerbated by replacement of small streams and riparian vegetation with pipes. Urban pollutants include lawn care products such as pesticides and fertilizers; automobile-related pollutants such as fuel, lubricants, abraded tire and brake linings; lawn and household wastes (often dumped in storm sewers); and fecal coliform bacteria (from animals and failing septic systems). Many urban streams are rated as biologically poor. The population density map in Chapter 2 is a good indicator of where urban development and potential urban stream impacts are likely to occur. As summarized in Table 4.25 in Chapter 4, it is estimated that there are approximately 16 miles of streams in the Roanoke Basin that are thought to be impacted due to urban runoff. There are only two subbasins that have streams with impact due to urban runoff. These are subbasin 030206 which includes the City of Henderson, and 030209 which includes Williamston and Plymouth. Although urban runoff is not identified as a probable source of impact in Marlowe Creek (030205), it is suspected to have some contribution to water quality problems in that stream.

3.4.3 Construction

Construction activities that entail excavation, grading or filling, such as road construction or land clearing for development, can produce large amounts of sediment if not properly controlled. As a pollution source, construction-related activities are temporary in nature; however, as discussed under the section on sediment, above, the results can be severe and long-lasting. There are no streams in the basin with impact that is attributable to construction activities. However, in areas where the growth rate is high, such activities should be monitored to ensure that stream impact does not occur. A list of BMPs to address construction-related water quality impacts is presented in Appendix V.

3.4.4 Forestry

Forestry, a major industry in North Carolina, can impact water quality in a number of ways when forestry operations are improperly conducted. Ditching and draining of naturally forested low-lying lands in order to create pine or hardwood plantations can change the hydrology of an area and significantly increase the rate and flow of stormwater runoff. Clearing of trees through timber harvesting and construction of logging roads can produce sedimentation. Removing riparian vegetation along stream banks can cause water temperature to rise substantially, and improperly applied pesticides can result in toxicity problems. Application of best management practices (BMPs), however, can greatly reduce these impacts. A BMP compliance survey conducted by the NC Division of Forest Resources in 1995 showed a 92% level of compliance for forestry BMPs.A In the Roanoke, timber harvesting occurs throughout much of the upper basin and is often done at the onset of clearing for site development. As summarized in Table 4.12 in Chapter 4, it is estimated that there are approximately 40 miles of streams impacted due to forestry activities in subbasins 01 and 08. During the next basin planning cycle for the Roanoke, it is anticipated that these figures will improve as better information becomes available. A list of forestry BMPs is presented in Appendix V.

3.4.5 Mining

Mining is a common activity in the Piedmont and Coastal Plain regions and can produce high localized levels of stream sedimentation. Sediment may be washed from mining sites or it may enter streams from the wash water used to rinse some mined products. In addition, abandoned gold mined lands are suspected of being the sources of mercury in stream waters because of its historic use for the amalgamation of gold. It is estimated that 4 miles of streams have been impacted by mining activities in subbasin 06 according to Table 4.25 in Chapter 4. A list of BMPs to address mining is presented in Appendix V.

3.4.6 Onsite Wastewater Disposal

Septic tank soil absorption systems are the most widely used method of on-site domestic wastewater disposal in North Carolina. These systems can provide safe and adequate treatment of wastewater; however, improperly placed, constructed or maintained septic systems can serve as a significant source of pathogenic bacteria and nutrients. These pollutants may enter surface waters both through or over the soil. They may also be discharged directly to surface waters through *straight pipes* (i.e., direct pipe connections between the septic system and surface waters). These types of discharges, if unable to be eliminated, must be permitted under the NPDES program and be capable of meeting effluent limitations specified to protect the receiving stream water quality which includes a requirement for disinfection.

Onsite wastewater disposal is most prevalent in rural portions of the basin and at the fringes of urban areas. Nutrients from failing septic systems can contribute to eutrophication problems in some impoundments. A list of BMPs for onsite wastewater disposal is presented in Appendix V.

3.4.7 Solid Waste Disposal

Solid wastes may include household wastes, commercial or industrial wastes, refuse or demolition waste, infectious wastes or hazardous wastes. Improper disposal of these types of wastes can serve as a source of a wide array of pollutants. The major water quality concern associated with modern solid waste facilities is controlling the leachate and stabilizing the soils used for covering many disposal facilities. Properly designed, constructed and operated facilities should not significantly effect water quality.

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CHAPTER 4

WATER QUALITY AND USE SUPPORT RATINGS IN THE ROANOKE RIVER BASIN

4.1 INTRODUCTION

This chapter provides a detailed overview of water quality and use support ratings in the Roanoke River Basin. It is divided into two major parts and five sections.

Water Quality Monitoring and Assessment

- **Section 4.2** presents a summary of water quality monitoring programs conducted by the Environmental Sciences Branch of the Division of Water Quality's (DWQ) Water Quality Section including consideration of information reported by researchers and other agencies within the Roanoke River Basin. Seven monitoring programs are described. Basinwide data summaries are presented for several of the programs.
- **Section 4.3** summarizes water quality based on analyses of chemical water quality data from ambient monitoring stations along the mainstem of the river and tributary stations.
- **Section 4.4** presents a narrative summary of water quality findings for each of the 10 subbasins in the basin. This summary is based on the monitoring programs described in Section 4.2 Also included are subbasin watershed maps, which show the locations of monitoring sites, and tables summarizing benthic macroinvertebrate sampling efforts.

Use-Support Ratings

- **Section 4.5** introduces the concept of use-support ratings and describes how they are derived. Using this approach, water quality for specific surface waters in the basin is assigned one of the following four use-support ratings: fully supporting uses, fully supporting but threatened, partially supporting or not supporting uses.
- **Section 4.6** presents the use support ratings for many streams and lakes in the Roanoke basin through a series of tables and figures. Included is a color-coded 3-page use support map of the basin (Figure 4.19).

4.2 WATER QUALITY MONITORING PROGRAMS

DWQ's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. Below is a list of the seven major monitoring programs, each of which is briefly described in the following text.

- Benthic macroinvertebrate monitoring (Section 4.2.1 and Appendix II),
- Fish population and tissue monitoring(Section 4.2.2 and Appendix II),
- Lakes assessment (including phytoplankton monitoring) (Section 4.2.3 and Appendix II),
- Aquatic toxicity monitoring (Section 4.2.4),
- Special chemical/physical water quality investigations (Section 4.2.5),
- Sediment oxygen demand monitoring (Section 4.2.6), and
- Ambient water quality monitoring (covering the period 1990-1994) (Section 4.2.7).

4.2.1 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom of rivers, streams and lakes. The Division of Water Quality focuses its benthic macroinvertebrate monitoring efforts on streams and rivers and does not collect benthic macroinvertebrate data from lakes. The benthic organisms collected most often in freshwater monitoring are aquatic insect larvae. The use of benthos data has proven to be a reliable water quality assessment tool, as these organisms are relatively immobile and sensitive to subtle changes in water quality. Since many organisms in a community have life cycles of six months to one year, the effects of short term pollution (such as an oil or chemical spill) will generally not be overcome until the following generation appears. The benthic community also responds to, and shows the effects of, a wide array of potential pollutant mixtures.

Criteria have been developed to assign five bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the pollution-intolerant groups Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). These three groups are used to develop EPT ratings. Likewise, ratings can be assigned with a Biotic Index (Appendix II). This index summarizes tolerance data for all taxa in each collection. The two rankings are given equal weight in final site classification. Higher taxa richness values are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is inadequately assessed by a taxa richness analysis alone. Different classification criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina.

Benthic Macroinvertebrate Sampling in the Roanoke Basin - A total of 104 benthic macroinvertebrate collections at 55 sites have been made between 1983 and 1994. High flows during the summer of 1994 prevented collections at some sites, and these flows sometimes complicated evaluations of the data that were collected. The entire benthos data set suggests primarily Good (33% of samples) to Good-Fair (27%) water quality in the basin. Excellent bioclassifications (10% of samples) have been recorded in portions of the Dan River and Mayo River and tributaries in Hanging Rock State Park. Nonpoint and point source pollution impacts resulted in the Fair bioclassifications (18%) scattered throughout the Roanoke River basin. Poor biological ratings for the upper Cashie River were recorded primarily from older data. Recent extensive work on swamp streams, such as the Cashie River and its tributaries, suggests that different criteria should be used for such slow-flowing, swamp-like systems; therefore, those Poor bioclassifications may not reflect the true conditions of water quality.

Locations of and summary information for all the benthic macroinvertebrate collections in the Roanoke River basin are presented in maps and tables in sections 4.4.1 through 4.4.10. Summary information includes the site location, DWQ classification schedule Index Number, collection date, taxa richness and biotic index values and bioclassifications.

4.2.2 Fisheries Monitoring

To the public, the condition of the fishery is one of the most meaningful indicators of ecological integrity. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by chemical and physical changes in the environment. Water quality conditions that significantly affect lower levels of the food web will affect the abundance, species composition, and condition of the fish population. Two types of fisheries monitoring are conducted by DWQ and described briefly below. The first, called Fish Community Structure, involves assessing the overall health of the fish community within a stream. This information can be used as an indicator of the quality of the ecosystem the fish inhabit. The second, called Fish Tissue Analysis, involves analyzing fish tissues to determine whether they are accumulating metals or organic chemicals. This information is useful as an indicator of water quality and is also used to determine whether human consumption of these fish poses a potential health risk.

Fish Community Structure

The North Carolina Index of Biotic Integrity (NCIBI) is a modification of Karr's IBI (1981) which was developed as a method for assessing a stream's biological integrity by examining the structure and health of its fish community. The index, (which is described in more detail in Appendix II), incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. At this time, metrics for an Index of Biotic Integrity applicable to fish communities in reservoirs have not yet been developed.

The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

Fish Community Structure in the Roanoke Basin - Fish community structure (IBI) analyses were performed on data from 31 sites in the Roanoke River Basin collected by DWQ, the NC Wildlife Resources Commission and Fritz Rohde. These data indicated Good to Excellent water quality for the majority (24) of the sites sampled. Areas of Fair water quality included Marlowe Creek, Quankey Creek, Conoconnara Creek and the Cashie River. Locations of and summary information for all of the IBI samples collected in the Roanoke basin can be found in maps and tables located in sections 4.4.1 and 4.4.10.

Fish Tissue Analysis

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Therefore, by analyzing fish tissue, determinations about what chemicals are in the water can be made. Contamination of aquatic resources, including freshwater, estuarine, and marine fish and shellfish species has been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Therefore, results from fish tissue monitoring can serve as an important indicator of contamination of sediments and surface water. Fish tissue analysis results are also used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

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 and U.S. Environmental Protection Agency (EPA) recommended screening values for contaminants.

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. A list of fish tissue parameters accompanied by their FDA criteria are presented in Appendix II. At present, the FDA has only developed metals criteria for mercury (1.0 ppm). Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of the Water Quality Section.

Fish Tissue Analyses in the Roanoke Basin - Fish tissue samples were collected at 21 sites from 1980 to 1994 within the Roanoke drainage consisting of 502 observations. Samples were collected as part of the DWQ's ambient fish tissue monitoring program or were collected as part of special studies (dioxin, mercury, striped bass PCB study).

Fish samples collected within the Roanoke drainage show sporadic elevations in tissue contaminants. Metals and/or organic contaminants exceeded state or federal criteria at 12 of 21 (57%) stations. Organic contaminants were detected in fish at five (24%) of the sites and exceeded EPA criteria at five sites. All organics results remained below FDA criteria throughout the drainage. Dioxin contamination exceeded North Carolina's limit of 3 ppt at four (19%) of the sites. Most metals contaminants were non-detectable or present at trace levels; however, five (24%) of the sites contained fish individuals with mercury contamination exceeding EPA and/or FDA criteria. Significant mercury contamination was most often associated with older, top predator fish species. Elevations in contaminants suggest a need for further sampling, but may not indicate human health or ecological concerns.

Fish consumption advisories have been issued for several waterbodies within the Roanoke Drainage. Belews Lake (Stokes and Rockingham counties) and Hyco Reservoir (Caswell and Person counties) remain under limited advisories for certain fish species due to selenium contamination. For Hyco Lake the fish species affected by the advisory are common carp, white catfish and green sunfish. For Belews Lake, they are common carp, redear sunfish and crappie. The advisories recommend that the general population eat no more than one meal per week of fish from the lakes and that children and women of childbearing age do not consume fish from the locations. The Roanoke River from Williamston to Albemarle Sound, as well as all of Welch Creek, are posted with a consumption advisory for all species due to dioxin contamination. In the Roanoke River the advisories recommend consumption of no more than 2 meals per month for the general public and no consumption for children and women of childbearing age. In Welch Creek no consumption is advised.

4.2.3 Lakes Assessment Program (including Phytoplankton)

Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. The North Carolina Lakes Assessment Program seeks to protect these waters through monitoring, pollution prevention and control, and restoration activities. Assessments have been made at all publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed. Data are used to determine the trophic state of each lake; a relative measure of nutrient enrichment and productivity, and whether the designated uses of the lake have been threatened or impaired by pollution.

Phytoplankton are microscopic algae found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton populations respond to nutrient availability and other environmental factors such as light, temperature, pH, salinity, water velocity, and grazing by organisms in higher trophic levels. Phytoplankton may be useful as indicators of eutrophication and are often collected with ambient water quality samples from lakes. Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms" in which one or more species of algae may discolor the water or form visible mats on top of the water. Blooms may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. The Algal Bloom Program was initiated in 1984 to document suspected algal blooms with species identification, quantitative biovolume, and density estimates. Usually, an algal sample with a biovolume larger than 5000 mm^3/m^3, density greater than 10,000 units/ml, or chlorophyll *a* concentration approaching or exceeding 40 µg/l (the North Carolina state standard) constitutes a bloom. Bloom samples may be collected as a result of complaint investigations, fish kills, or during routine monitoring if a bloom is suspected. There were twelve lakes in the Roanoke River Basin sampled as part of the Lakes Assessment Program.

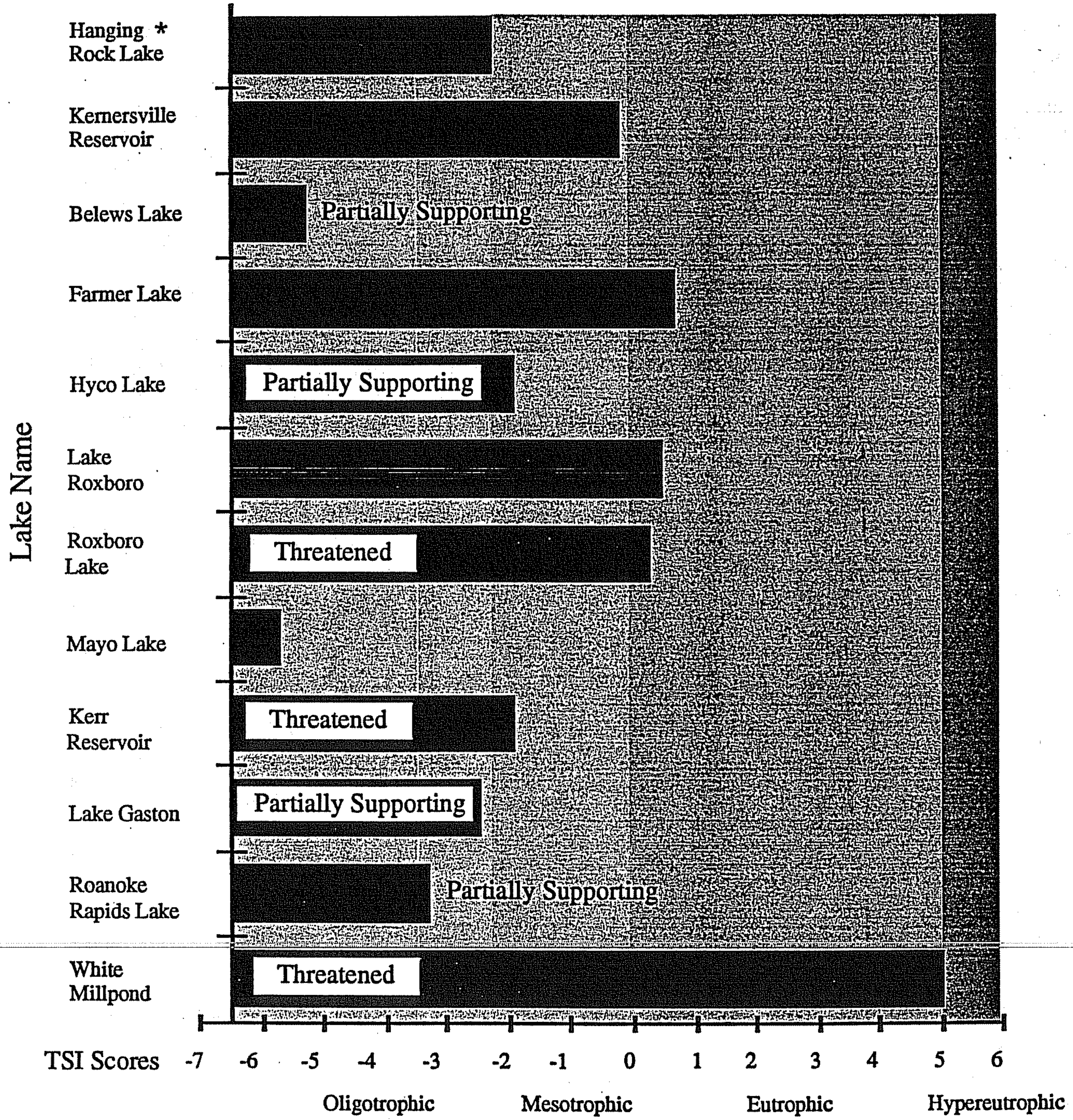
Lakes Studies in the Roanoke - Seven lakes have been sampled for the potential of supporting algal growth with the Algal Growth Potential Test (AGPT) in the Roanoke River Basin. These are Roanoke Rapids Lake, Lake Gaston, Belews Lake, Mayo Lake, Hyco Reservoir, Kerr Reservoir, and Hanging Rock Lake. The results of the Algal Growth Potential Test are mentioned in each of the appropriate subbasin discussions within the Basinwide Assessment Report Support Document for the Roanoke River Basin. The objective of the Algal Growth Potential Test is to assess a waterbody's potential for supporting algal biomass and to determine whether algal growth is limited by nitrogen, by phosphorus, or co-limited by both nutrients. When a waterbody supports algal growth at bloom levels without additional increases in nitrogen and/or phosphorus, the system may be subject to frequent nuisance algal blooms. The test exposes a standard alga, Selenastrum capricornutum, to the test water (this constitutes the control). Additional test samples are enriched with nitrogen or phosphorus. When one of these nutrients is added to a water sample which is growth limiting to that nutrient, the resulting mean standing crop (MSC) will generally reflect the level of added nutrient. In some cases, the bioavailable nitrogen and phosphorus in a sample may approach their optimum ratio for growth of the test alga and the addition of nutrients may not clearly identify the limiting nutrient. A waterbody may be protected from nuisance algal blooms if an AGPT value is consistently less than or equal to 5 mg/l.

Another measure of water quality in lakes is the North Carolina Trophic State Index (NCTSI). This is a numerical index that is used to evaluate the trophic status of lakes. Trophic status is a relative measure of nutrient enrichment and productivity. Oligotrophic lakes are those that have the lowest levels of enrichment and generally have good clarity and no problems with algal blooms. At the other end of the spectrum are eutrophic lakes which have a lot of plant productivity which can cause nuisance problems and have little clarity in the water column. Further details of the NCTSI can be found in Appendix II.

Figure 4.1 shows the most recent NCTSI scores for the twelve lakes of the Roanoke River basin. Each lake is individually discussed in the Basinwide Assessment Report Support Document in the appropriate subbasin section with a focus on the most recent available data. Only Hanging Rock Lake was monitored intensively during the growing seasons of 1991 through 1993 as part of a reference lake program to determine if this lake was representative of a minimally impacted lake in this region of the state. All of the lakes in the Roanoke River Basin were sampled most recently in 1994. Five of the twelve lakes were fully supporting their designated uses. Three of those lakes were listed as Threatened which identifies some cause for concern if precautions are not taken. Four lakes are designated as Partially Supporting.

LAKE NAME	STATUS	CAUSES
Kerr Reservoir	Threatened	Elevated Nutrients, Algae Blooms, violation of State water quality standard for dissolved gases
Roxboro Lake	Threatened	Algal Blooms
White Millpond	Threatened	Algal Blooms, Elevated Nutrients, Aquatic Macrophytes
Belews Lake	Partially Supporting	Restricted Fish Consumption Advisory (Selenium)
Hyco Reservoir	Partially Supporting	Restricted Fish Consumption Advisory (Selenium)
Lake Gaston	Partially Supporting	Aquatic Macrophyte Infestation
Roanoke Rapids Res.	Partially Supporting	Aquatic Macrophyte Infestation

Lakes designated as oligotrophic include Hanging Rock Reservoir, Belews Lake, Mayo Lake, Lake Gaston, and Roanoke Rapids Reservoir. Kernersville Reservoir, Hyco Reservoir and Kerr Reservoir are considered mesotrophic. Eutrophic lakes include Farmer Lake, Lake Roxboro, and Roxboro Lake. White Millpond has been designated hypereutrophic.



All lakes sampled in 1994. Special sampling conducted on Kerr Reservoir in 1995.
* Reference Lake

Figure 4.1 North Carolina Trophic Status Index Values for Lakes in the Roanoke River Basin

Notable lakes:
White Millpond is identified as Threatened due to elevated nutrients, algal blooms, and an infestation of aquatic macrophytes (duckweed). The millpond is shallow and is located in a swamp. A dissolved oxygen measurement of 3.1 mg/l was recorded at one of the two lake sampling sites in 1994. Roxboro Lake is also considered threatened because of algal bloom conditions documented in 1994. The results of a study conducted in 1995 to ascertain water quality conditions in the Nutbush Creek arm of Kerr Reservoir help designate this waterbody as Threatened. The study revealed elevated nutrients, algal bloom conditions, and violations of the water quality standard for dissolved gases.Belews Lake and Hyco Reservoir were identified as Partially Supporting in the 1992-1993 305(b) Report due to a fish consumption advisory related to elevated levels of selenium. High selenium values in both lakes are associated with runoff from coal ash ponds. Corrective measures to prevent further runoff into the lakes have been put into place and the lakes continue to be monitored for selenium.

Roanoke Rapids Reservoir is experiencing a severe problem with aquatic macrophyte infestation which has impaired boat navigation on the lake. Approximately 33% of the lake surface is covered with hydrilla (Hydrilla verticillata), Brazilian elodea (Egeria densa), and Eurasian watermilfoil (Myriophyllum spicatum) (Demont, pers. comm.). Because of this problem, Roanoke Rapids Reservoir is Partially Supporting its designated uses. Like Roanoke Rapids Lake, Lake Gaston has problems with aquatic macrophyte infestation and is designated partially supporting.

4.2.4 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. The Aquatic Survey and Toxicology Unit maintains a compliance summary 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.

Aquatic Toxicity Monitoring in the Roanoke - There are 34 facilities in the basin that 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. These facilities are listed in Appendix II.

4.2.5 Chemical/Physical Characterizations

Water quality simulation models are often used for the purpose of constructing wasteload allocations. These models must adequately predict water body responses to different waste loads so that appropriate effluent limits can be included as requirements in National Pollutant Discharge Elimination System (NPDES) permits. Where large financial expenditures or the protection of water quality is at risk, models should be calibrated and verified with actual in-stream field data. Because sufficient historical data are often lacking, intensive water quality surveys are required to provide the field data necessary to accomplish model calibration and verification. Intensive water quality surveys are performed on water bodies below existing or proposed wastewater dischargers and usually consist of a time-of-travel dye study, flow measurements, physical and chemical samples, long-term biochemical oxygen demand (BOD_{lt}) analysis, water body channel geometry, and effluent characterization analysis.

4.2.6 Sediment Oxygen Demand

If oxygen depletion is suspected due to the characteristics of benthic sediments, then sediment oxygen demand (SOD) studies may be performed. Each stream reach is divided into a series of model segments. The number of stream segments that must be evaluated with an intensive survey depends on the individual study and the spatial resolution desired. Intensive surveys and SOD evaluations are reported as a series of field data tables and summaries of laboratory analysis reports.

SOD Studies in the Roanoke Basin - In 1993, five SOD studies were conducted in the Roanoke River Basin. These studies were conducted in June, July and September for the purpose of providing water quality data for assimilative capacity modeling of the Roanoke River. Average SOD rates (corrected to 20°C) for the five tests ranged from a very low rate of - 0.1908 gr/m^2/day (of oxygen consumed) near Odom, to a higher rate of - 1.4917 gr/m^2/day near Weldon, indicating the presence of oxygen consuming sediments.

4.2.7 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine (saltwater) water quality monitoring stations (about 380 statewide) strategically located for the collection of physical and chemical water quality data. The type of water quality data, or parameters, that are collected is determined by the waterbody's freshwater or saltwater classification and corresponding water quality standards. Table 4.1 summarizes the types of water quality data collected at ambient stations. AMS data for the Roanoke Basin are summarized in Section 4.3.

Table 4.1 Ambient Monitoring System Parameters

C and SC WATERS (minimum monthly coverage for all stream stations)
- dissolved oxygen,
- pH,
- conductivity,
- temperature,
- salinity (SC),
- secchi disk (where appropriate),
- nutrients: total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite,
- total suspended solids,
- turbidity,
- hardness,
- chlorides (SC),
- fecal coliforms,
- metals: aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, silver, zinc

NUTRIENT-SENSITIVE WATERS: Chlorophyll *a* (where appropriate)

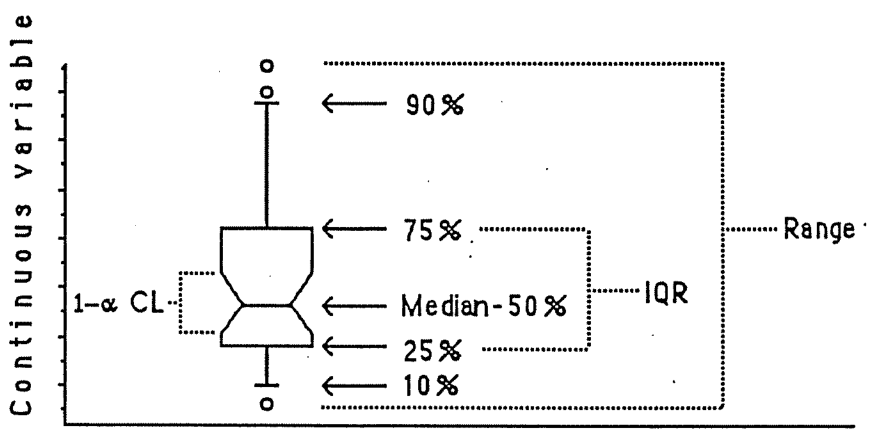
WATER SUPPLY
- chlorides,
- total coliforms,
- manganese,
- total dissolved solids

SA WATERS: Fecal coliforms (tube method where appropriate)

Ambient water quality data are often summarized using box and whisker plots (for example see Figure 4.4). Figure 4.2 provides an explanation of how to interpret the plots.

Figure 4.2 Box and Whisker Plots

Box and whisker plot are useful for comparing sets of data comprised of a single variable by the visualization of selected order statistics. After the data have been ordered from low to high, the 10th, 25th, 50th, 75th, and 90th percentiles are calculated for plot construction. Box and whisker plots display the following important information: 1) the interquartile range (IQR) which measures the distribution and variability of the bulk of the data (located between the 25th and 75th percentiles), 2) the desired confidence interval (1- CL) for measuring the statistical significance of the median (50th percentile), 3) indication of skew from comparing the symmetry of the box above and below the median, 4) the range of the data from the lowest to highest values, and 5) the extreme values below the 10th percentile and above the 90th percentile (depicted as dots).



Visual comparison of confidence level notches about the medians of two or more box plots can be used to roughly perform hypothesis testing (Figure 4.1). If the box plots represent data from samples assumed to be independent, then overlapping notches indicate no significant difference in the samples at a prescribed level of confidence. Formal tests should subsequently be performed to verify preliminary conclusions based on visual inspection of the plots.

4.3 AMBIENT WATER QUALITY SUMMARY FOR THE ROANOKE RIVER BASIN

This section presents a summary of overall water quality in the North Carolina portion of the Roanoke River Basin. The discussion is divided into the two major drainages of the basin: the Dan River drainage and tributaries and the Roanoke River drainage. Also included is a discussion of overall water quality trends. Table summaries of ambient water chemistry data for all Ambient Monitoring System (AMS) stations within the Roanoke River Basin are located in the Basinwide Assessment Report Support Document. These tables summarize data from 1990 through 1994 for common selected chemical parameters and include station summary information, descriptive statistics for parametric data, water quality criteria information for the station's classification, a yearly breakdown of selected parametric data and descriptive statistics for parametric data from summer months. The April-October months are used in summer modeling applications, June-September months are used in worse-case, lowest-flow analyses.

AMS stations for the basin are listed in Table 4.2 below. North Carolina has 21 stations in the Roanoke River Basin.

Table 4.2 Ambient Monitoring System Stations Within the Roanoke Basin.

Primary No	STORET #	Station Name	Subbasin
Dan River Drainage			
02068500	N0150000	DAN RIVER AT NC HWY 704 NEAR FRANCISCO NC	030201
02070500	N1400000	MAYO R @ SR 1358 NEAR PRICE NC	030202
02071000	N2300000	DAN RIVER AT SR 2150 NEAR WENTWORTH NC	030203
02074000	N2450000	SMITH RIVER AT NC HWY 14 AT EDEN NC	030203
02074218	N3000000	DAN RIVER AT SR 1716 NEAR MAYFIELD NC	030203
02075198	N3500000	DAN RIVER @ NC HWY 62 @ NC-VA LINE @ MILTON NC	030203
02077200	N4110000	HYCO CREEK AT US HWY 158 NEAR LEASBURG NC	030205
02077303	N4250000	HYCO RIVER BELOW AFTERBAY DAM NR MCGHEES MILL	030205
02077348	N4400000	MARLOWE CREEK AT SR 1322 NEAR WOODSDALE NC	030205
02077500	N4510000	HYCO RIVER AT US HWY 501 NR DENNISTON VA	030205
02077670	N4590000	MAYO CREEK AT SR 1501 NEAR BETHEL HILL NC	030205
02079264	N5000000	NUTBUSH CREEK AT SR 1317 NEAR HENDERSON NC	030206
02079717	N6400000	SMITH CREEK NEAR PASCHALL NC	030207
Roanoke River Drainage			
02080500	N7300000	ROANOKE RIVER AT ROANOKE RAPIDS, NC	030208
02081000	N8200000	ROANOKE RIVER NEAR SCOTLAND NECK, NC	030208
02081022	N8300000	ROANOKE RIVER @ NC HWY 11 NEAR LEWISTON, NC	030208
02081054	N8550000	ROANOKE RIVER @ US HWYS 13-17 @ WILLIAMSTON NC	030209
02081101	N8950000	CASHIE RIVER @ SR1219 NEAR LEWISTON NC	030210
02081135	N9250000	ROANOKE RIVER 1.3 MI US WELCH CK NR PLYMOUTH NC	030209
02081141	N9600000	ROANOKE RIVER AT SANS SOUCI NC	030209
0208114330	N9700000	ALBEMARLE S. (BATCHELOR BAY) NR BLACK WALNUT	030209

Figure 4.3 shows the locations of the ambient stations on the mainstem segments of the Roanoke basin. Figures 4.4 through 4.9 depict the results of ambient monitoring data throughout the basin for turbidity (Figure 4.4), metals that exceed established criteria levels (Figure 4.5), total phosphorus (Figure 4.6), nitrate/nitrite-nitrogen (Figure 4.7), dissolved oxygen (Figure 4.8) and fecal coliform bacteria (Figure 4.9). Analysis of these figures is presented in the narrative discussions of the ambient data for the Dan River mainstem, Dan River tributaries and the Roanoke River drainage.

Table 4.3. summarizes by parameter data collected at ambient stations in the Roanoke Basin for those stations where any of the results exceeded the associated water quality criterion. Each station is listed with associated parameter, along with the total number of samples, those samples with less than detection level recorded, and the number of samples for that parameter that represented an excursion from a water quality criterion. It should be noted that the criteria are presented as numerical and represent instantaneous measurements. The actual standard may include a narrative, such as turbidity, and, as in some metals criteria, may be based on extended exposure at or above the criteria to expect chronic toxicity of the most sensitive species of organism. Therefore the table is useful for relative comparisons between locations and screening areas where frequent excursions of individual or multiple parameters suggest waters that might be targeted for more detailed evaluations and/or specific management strategies. A more thorough evaluation can include review of temporal and spatial trends, association of concentrations to flow, degree of excursion from the criterion, or use of other analytical methods.

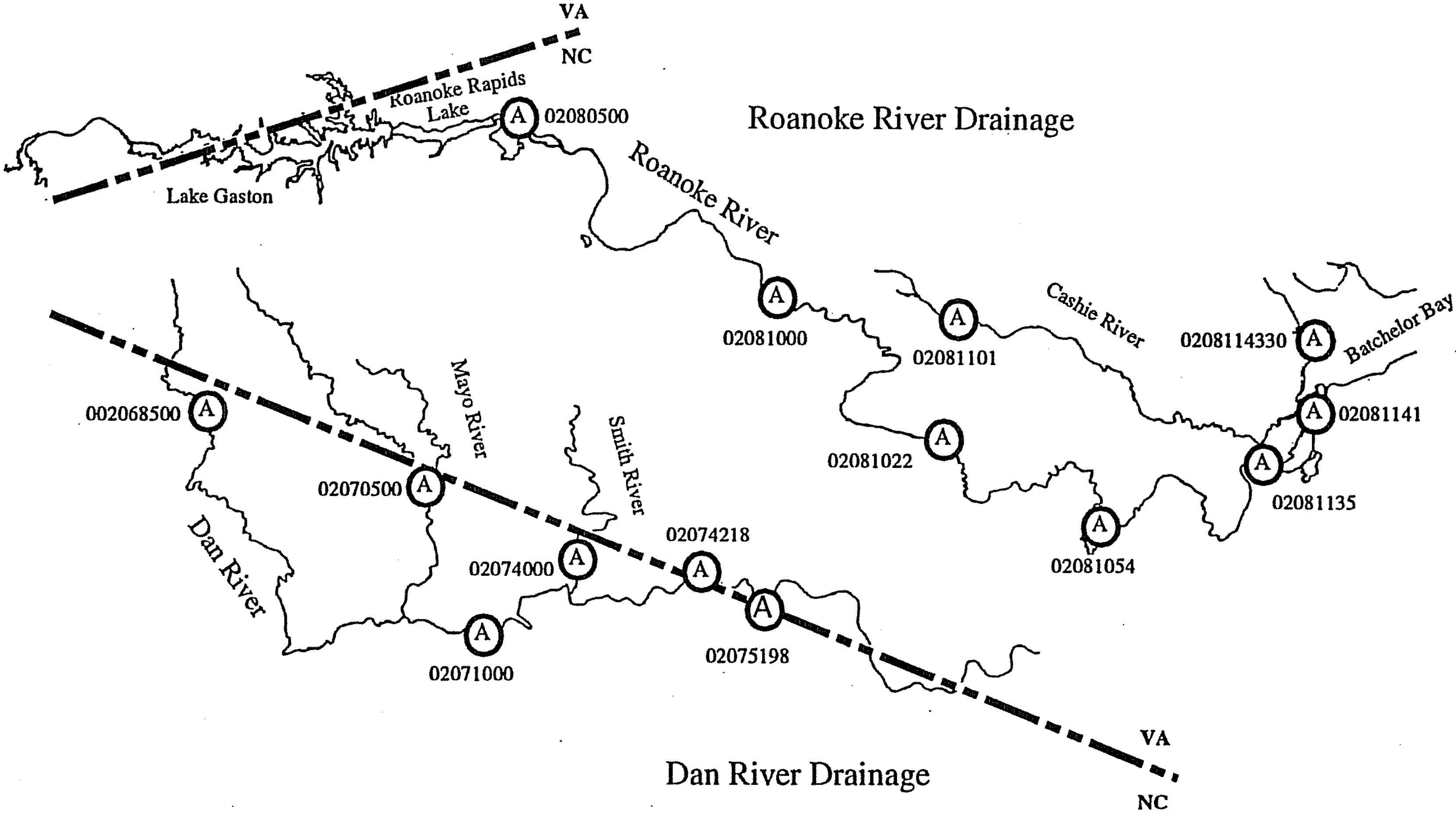


Figure 4.3 Ambient Monitoring System Stations on the Mainstem Segments of the Roanoke River Basin

Figure 4.4 Box Plots for Turbidity (NTU) for Roanoke River Basin AMS Stations. January 1990 to December 1994

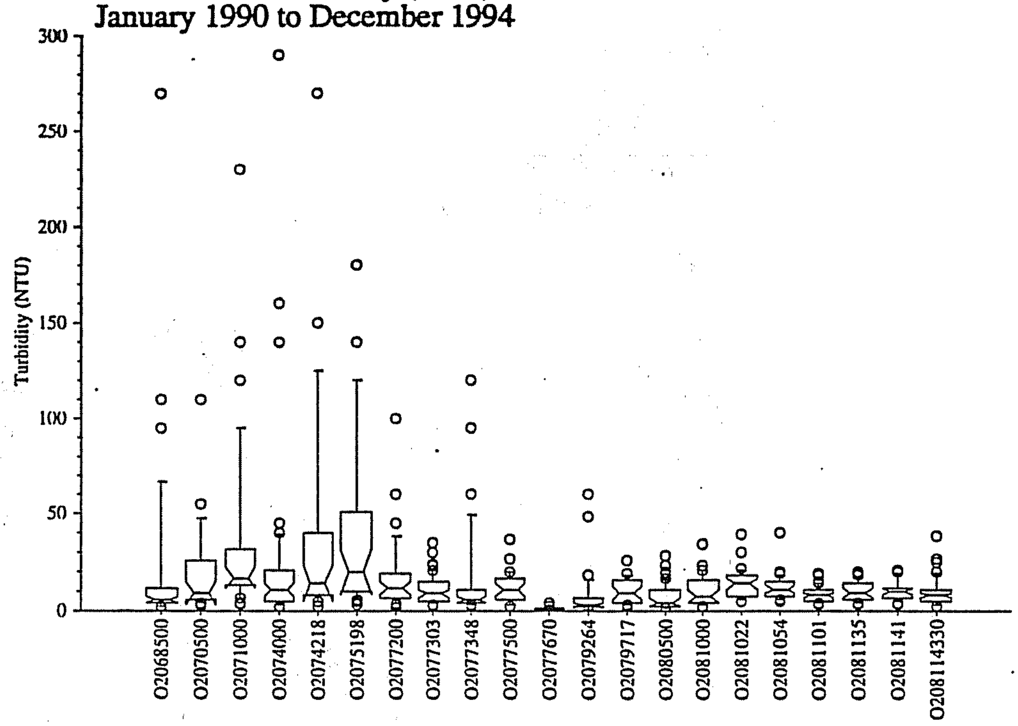
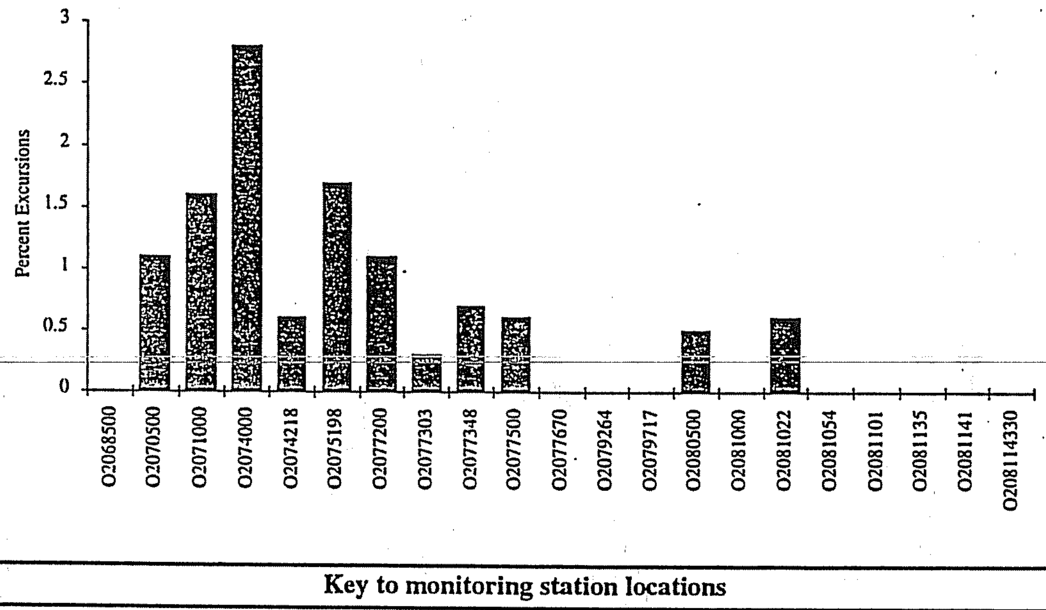


Figure 4.5 Metals Samples Expressed as Percentage of Total Samples. January 1990 to December 1994



Key to monitoring station locations

Primary No	Station Name	Subbasin	Primary No	Station Name	Subbasin
Dan River Drainage			Roanoke River Drainage		
02068500	Dan River at NC Hwy 704 near Francisco NC	030201	02080500	Roanoke River at Roanoke RAPIDS, NC	030208
02070500	Mayo R @ SR 1358 Near Price NC	030202	02081000	Roanoke River near SCOTLAND NECK, NC	030208
02071000	Dan River at SR 2150 near WENTWORTH NC	030203	02081022	Roanoke River @ NC Hwy 11 near Lewiston, NC	030208
02074000	SMITH River at NC Hwy 14 at EDEN NC	030203	02081054	Roanoke River @ US HwyS 13-17 @ Williamston NC	030209
02074218	Dan River at SR 1716 near MAYFIELD NC	030203	02081101	Cashie River @ SR1219 near LEWISTON NC	030210
02075198	Dan River @ NC Hwy 62 @ NC-VA Line @ Milton NC	030203	02081135	Roanoke River 1.3 mi.US Near Welch Cr, Plymouth NC	030209
02077200	Hyco Cr at US Hwy 158 near LEASBURG NC	030205	02081141	Roanoke River at Sans Souci NC	030209
02077303	Hyco River below afterbay Dam NR McGhees Mill	030205	0208114330	Albemarle S. (Batchelor Bay) nr Black Walnut	030209
02077348	MARLOW Cr at SR 1322 near WOODSDALE NC	030205			
02077500	Hyco River at US Hwy 501 NR DENNISTON VA	030205			
02077670	Mayo Cr at SR 1501 near BETHEL HILL NC	030205			
02079264	Nutbush Cr at SR 1317 near HENDERSON NC	030206			
02079717	SMITH Cr near PASCHALL NC	030207			

Figure 4.6 Box Plots for Total Phosphorus (mg/l) for Roanoke River Basin AMS Stations. January 1990 to December 1994

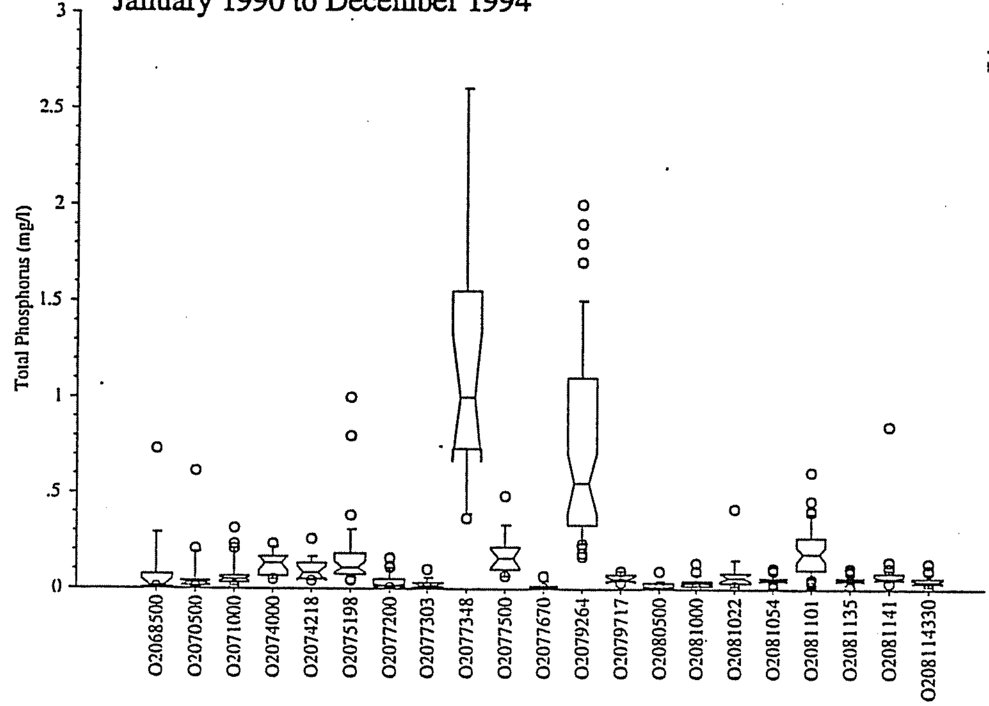
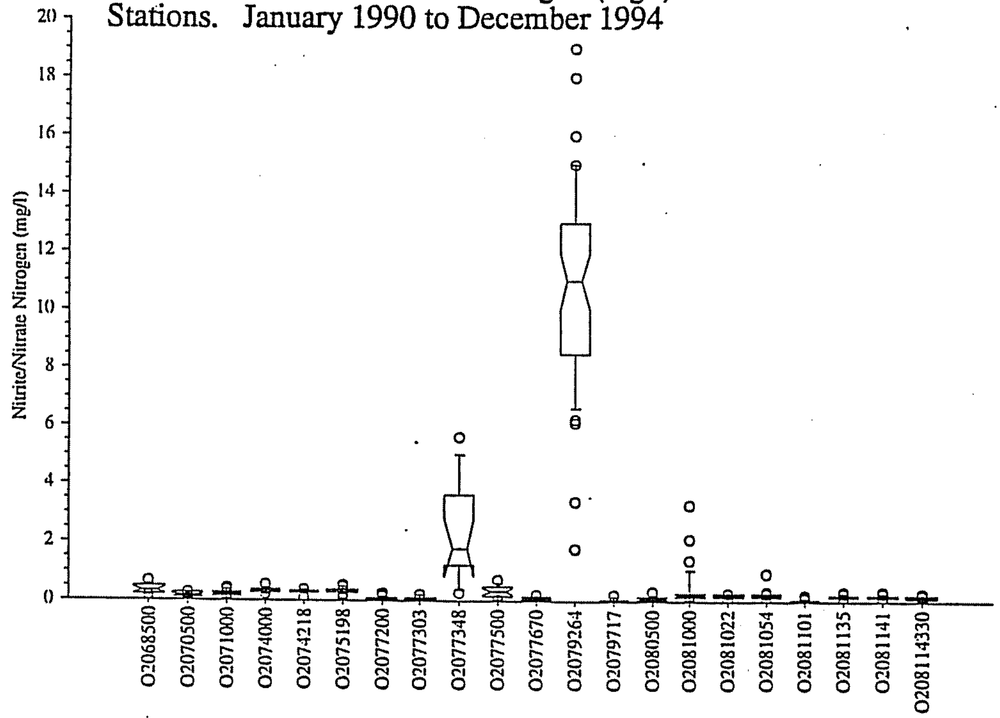


Figure 4.7 Box Plots for Nitrate/NitriteNitrogen (mg/l) for Roanoke River Basin AMS Stations. January 1990 to December 1994



Key to monitoring station locations

Primary No	Station Name	Subbasin
Dan River Drainage		
02068500	Dan River at NC Hwy 704 near Francisco NC	030201
02070500	Mayo R @ SR 1358 Near Price NC	030202
02071000	Dan River at SR 2150 near WENTWORTH NC	030203
02074000	SMITH River at NC Hwy 14 at EDEN NC	030203
02074218	Dan River at SR 1716 near MAYFIELD NC	030203
02075198	Dan River @ NC Hwy 62 @ NC-VA Line @ Milton NC	030203
02077200	Hyco Cr at US Hwy 158 near LEASBURG NC	030205
02077303	Hyco River below afterbay Dam NR McGhees Mill	030205
02077348	MARLOW Cr at SR 1322 near WOODSDALE NC	030205
02077500	Hyco River at US Hwy 501 NR DENNISTON VA	030205
02077670	Mayo Cr at SR 1501 near BETHEL HILL NC	030205
02079264	Nutbush Cr at SR 1317 near HENDERSON NC	030206
02079717	SMITH Cr near PASCHALL NC	030207
Roanoke River Drainage		
02080500	Roanoke River at Roanoke RAPIDS, NC	030208
02081000	Roanoke River near SCOTLAND NECK, NC	030208
02081022	Roanoke River @ NC Hwy 11 near Lewiston, NC	030208
02081054	Roanoke River @ US HwyS 13-17 @ Williamston NC	030209
02081101	Cashie River @ SR1219 near LEWISTON NC	030210
02081135	Roanoke River 1.3 mi.US Near Welch Cr, Plymouth NC	030209
02081141	Roanoke River at Sans Souci NC	030209
0208114330	Albemarle S. (Batchelor Bay) nr Black Walnut	030209

Figure 4.8 Box Plots for Dissolved Oxygen (mg/l) for Roanoke River Basin AMS Stations. January 1990 to December 1994

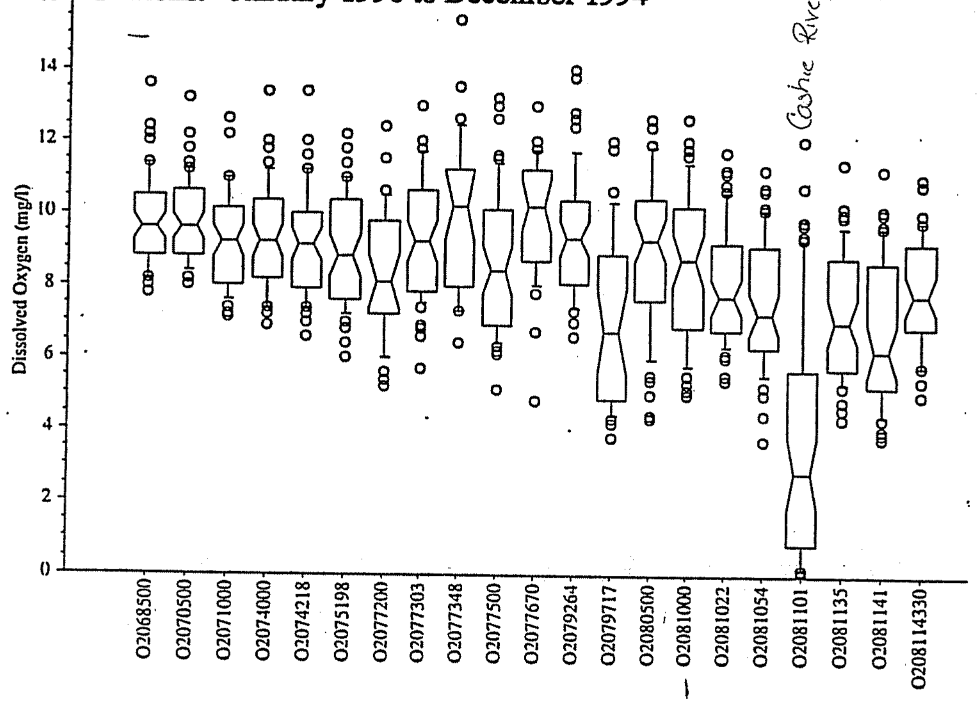
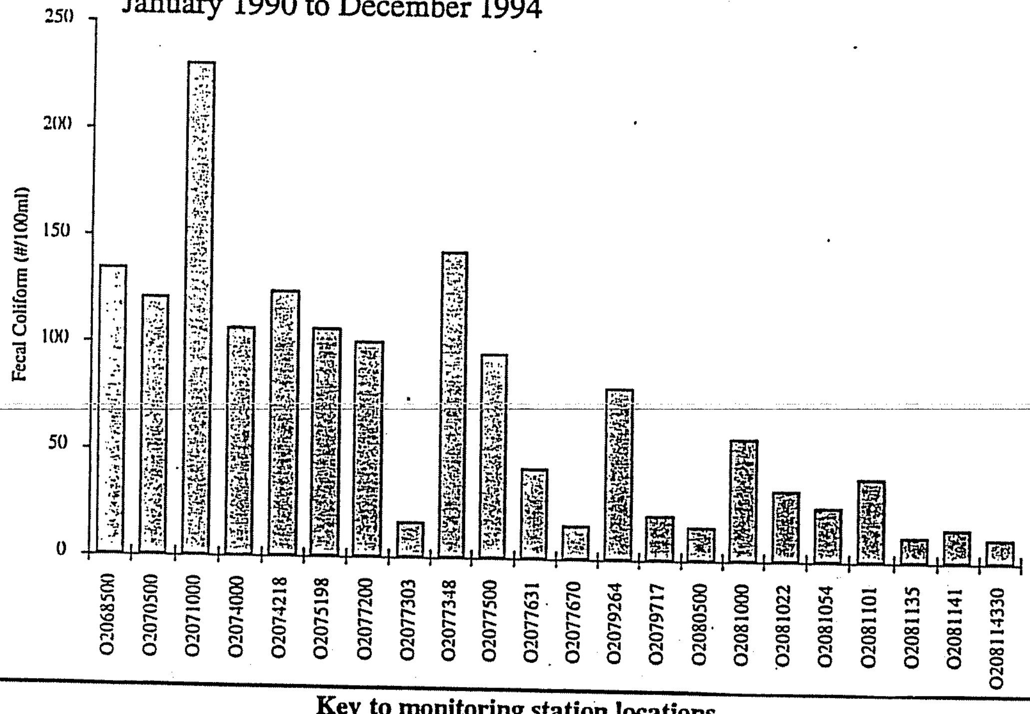


Figure 4.9 Fecal Coliform Geometric Mean for Roanoke River Basin AMS Stations. January 1990 to December 1994



Key to monitoring station locations

Primary No	Station Name	Subbasin
Dan River Drainage		
02068500	Dan River at NC Hwy 704 near Francisco NC	030201
02070500	Mayo R @ SR 1358 Near Price NC	030202
02071000	Dan River at SR 2150 near WENTWORTH NC	030203
02074000	SMITH River at NC Hwy 14 at EDEN NC	030203
02074218	Dan River at SR 1716 near MAYFIELD NC	030203
02075198	Dan River @ NC Hwy 62 @ NC-VA Line @ Milton NC	030203
02077200	Hyco Cr at US Hwy 158 near LEASBURG NC	030205
02077303	Hyco River below afterbay Dam NR McGhees Mill	030205
02077348	MARLOW Cr at SR 1322 near WOODSDALE NC	030205
02077500	Hyco River at US Hwy 501 NR DENNISTON VA	030205
02077670	Mayo Cr at SR 1501 near BETHEL HILL NC	030205
02079264	Nutbush Cr at SR 1317 near HENDERSON NC	030206
02079717	SMITH Cr near PASCHALL NC	030207

Primary No	Station Name	Subbasin
Roanoke River Drainage		
02080500	Roanoke River at Roanoke RAPIDS, NC	030208
02081000	Roanoke River near SCOTLAND NECK, NC	030208
02081022	Roanoke River @ NC Hwy 11 near Lewiston, NC	030208
02081054	Roanoke River @ US HwyS 13-17 @ Williamston NC	030209
02081101	Cashie River @ SR1219 near LEWISTON NC	030210
02081135	Roanoke River 1.3 mi.US Near Welch Cr, Plymouth NC	030209
02081141	Roanoke River at Sans Souci NC	030209
0208114330	Albemarle S. (Batchelor Bay) nr Black Walnut	030209

Table 4.3 Summary of Ambient Monitoring System Station Data with Excursions from the NC Water Quality Criteria Greater than Zero. January 1990 to December 1994.

Station Number	Station Name	Parameter/Criterion	Samples All	Samples <Det	Samples >Crit
02077200	HYCO CREEK AT US HWY 158 NEAR LEASBURG NC	Cadmium (µg/l) [2]	30	29	1
02074000	SMITH RIVER AT NC HWY 14 AT EDEN NC	Chromium (µg/l) [50]	30	29	1
02079717	SMITH CREEK NEAR PASCHALL NC	Dissolved Oxygen (mg/l) [4]	29	0	1
02081054	ROANOKE RIVER @ US HWYS 13-17 @ WILLIAMSTON NC	Dissolved Oxygen (mg/l) [4]	56	0	1
02081101	CASHIE RIVER @ SR1219 NEAR LEWISTON NC	Dissolved Oxygen (mg/l) [4]	57	0	36
02081141	ROANOKE RIVER AT SANS SOUCI NC	Dissolved Oxygen (mg/l) [4]	54	0	2
02074000	SMITH RIVER AT NC HWY 14 AT EDEN NC	Lead (µg/l) [25]	30	29	1
02075198	DAN RIVER @ NC HWY 62 @ NC-VA LINE @ MILTON NC	Lead (µg/l) [25]	29	26	1
02070500	MAYO R @ SR 1358 NEAR PRICE NC	Manganese (µg/l) [200]	15	1	1
02071000	DAN RIVER AT SR 2150 NEAR WENTWORTH NC	Manganese (µg/l) [200]	17	0	2
02080500	ROANOKE RIVER AT ROANOKE RAPIDS, NC	Manganese (µg/l) [200]	10	0	1
02071000	DAN RIVER AT SR 2150 NEAR WENTWORTH NC	Mercury (µg/l) [0.012]	30	27	3
02074000	SMITH RIVER AT NC HWY 14 AT EDEN NC	Mercury (µg/l) [0.012]	30	29	1
02075198	DAN RIVER @ NC HWY 62 @ NC-VA LINE @ MILTON NC	Mercury (µg/l) [0.012]	29	28	1
02077200	HYCO CREEK AT US HWY 158 NEAR LEASBURG NC	Mercury (µg/l) [0.012]	30	29	1
02077303	HYCO RIVER BELOW AFTERBAY DAM NR MCGHEES MILL	Mercury (µg/l) [0.012]	55	54	1
02077500	HYCO RIVER AT US HWY 501 NR DENNISTON VA	Mercury (µg/l) [0.012]	55	53	2
02080500	ROANOKE RIVER AT ROANOKE RAPIDS, NC	Mercury (µg/l) [0.012]	32	31	1
02074000	SMITH RIVER AT NC HWY 14 AT EDEN NC	Nickel (µg/l) [25]	30	29	1
02070500	MAYO R @ SR 1358 NEAR PRICE NC	Total Residue (mg/l) [500]	56	0	1
02074000	SMITH RIVER AT NC HWY 14 AT EDEN NC	Total Residue (mg/l) [500]	55	0	1
02068500	DAN RIVER AT NC HWY 704 NEAR FRANCISCO NC	Turbidity (NTU) [10]	52	0	16
02070500	MAYO R @ SR 1358 NEAR PRICE NC	Turbidity (NTU) [50]	30	0	3
02071000	DAN RIVER AT SR 2150 NEAR WENTWORTH NC	Turbidity (NTU) [50]	30	0	4
02074000	SMITH RIVER AT NC HWY 14 AT EDEN NC	Turbidity (NTU) [50]	54	0	3
02074218	DAN RIVER AT SR 1716 NEAR MAYFIELD NC	Turbidity (NTU) [50]	30	0	7
02075198	DAN RIVER @ NC HWY 62 @ NC-VA LINE @ MILTON NC	Turbidity (NTU) [50]	29	0	7
02077200	HYCO CREEK AT US HWY 158 NEAR LEASBURG NC	Turbidity (NTU) [50]	30	0	2
02077348	MARLOWE CREEK AT SR 1322 NEAR WOODSDALE NC	Turbidity (NTU) [50]	29	0	3
02079264	NUTBUSH CREEK AT SR 1317 NEAR HENDERSON NC	Turbidity (NTU) [50]	29	1	1

Dan River Mainstem

The Dan River Mainstem has four AMS sites in North Carolina. The upper Dan River is classified as trout waters and the AMS site near Francisco has recorded 16 samples of 52 total above the criterion for turbidity in trout waters (10 NTU). All of the Dan River sites have consistently elevated data for parameters such as fecal coliform, iron, copper and residue-related parameters (turbidity, total residue, total suspended residue) compared to other sites in the basin. Elevated data for these parameters are indicative of non-point source contributions.

Figure 4.5 shows the number of excursions of cadmium, chromium, lead, mercury and nickel as a percentage of total combined station samples for all stations in the basin. The percent of excursions begins to increase with the Dan River Wentworth site. Two tributaries of the Dan River, the Mayo and Smith Rivers, have sites that also show an elevated percentage in the same metal parameters. AMS sites in the area of Rockingham county around Madison, Mayodan and Eden, have relatively frequent excursions of the heavy metal criteria compared to the other basin sites and this may be due to point sources and/or urban runoff in this area.

Dan River Tributaries

Tributaries to the Dan River are covered by nine AMS sites. The tributaries are the Mayo River, Smith River, Hyco Creek, Hyco River, Marlowe Creek, Mayo Creek, Nutbush Creek and Smith Creek. As mentioned in the section discussing the Dan River mainstem, the Smith Creek and Mayo River sites show a number of heavy metals present in excess of water quality criteria. The Hyco River and Hyco Creek sites also show some excursions of metal criteria (Figure 4.5) and the lower site below the dam at McGhee's Mill recorded some low pH samples. The Marlowe Creek site had slightly elevated fecal coliform data (Figure 4.9) and very high copper and nutrient data Figures 4.6 and 4.7. This site is located downstream from the Roxboro Wastewater Treatment Plant (WWTP). The site at Nutbush Creek had slightly high fecal coliform samples and very elevated copper and nutrient data. The Henderson WWTP which is upstream of this site has recently completed significant plant upgrades that include nutrient controls and most recent data reflect that improvement. These data also suggest a nonpoint source contribution in the drainages of Nutbush and Marlowe Creeks. At the Smith Creek site, one low dissolved oxygen sample (3.8 mg/l) of 29 total was recorded.

There have been selenium problems in some of the lakes in the Dan River drainage, however, only two stream stations in the Roanoke River Basin have recorded selenium levels above detection. Hyco River near McGhee's Mill had 11 samples of 109 total above detection level with a median value of 7.0 µg/l. Hyco River near Denniston, Virginia had 4 samples of 107 total above detection level with a median value of 5.5 µg/l. No other stream station in the Roanoke River Basin recorded a sample above the detection level.

Roanoke River Drainage

The Roanoke River Mainstem has six AMS sites and one site at the mouth of the Roanoke in Bachelor Bay. There is also one site on a major tributary, the Cashie River. Throughout the mainstem, data consistently show elevated levels of copper and iron. These data reflect characteristics of the Piedmont soils throughout the upper drainage. In the lower section (from the Williamston site) there are a total of three out of 163 low dissolved oxygen samples (Figure 4.8) and three out of 165 low pH samples. The Cashie River site had 36 of 57 total dissolved oxygen samples below the criterion of 4 mg/l, and 14 of 55 total pH samples below the criterion of 6 SU. This section of the Cashie is classified as swamp water and these low numbers are likely the result of natural conditions in this slow moving black water system. Similarly, the lower Roanoke River has many swampy characteristics and the low dissolved oxygen and pH could be due to this condition.

General Water Quality Chemistry Trends in the Basin

Box plots (see Figure 4.2 for explanation) for dissolved oxygen data in Figure 4.6 show a general spatial decline in levels from the Dan River downstream. The lowest readings were recorded from the lower Roanoke River stations as the river becomes swampy. Two stations, Smith Creek and the Cashie River, had very low dissolved oxygen concentrations. The Cashie River, as mentioned previously, is classified as swamp waters. Nutrients were particularly elevated in Nutbush and Marlowe Creeks. Figures 4.6 and 4.7 illustrate this using total phosphate and nitrate/nitrite-nitrogen, respectively, as examples.

Fecal Coliform Bacteria

Fecal coliform bacteria behave differently than most other water quality parameters, and these differences must be considered when using them to evaluate water quality. Available information was reviewed to identify potentially impaired waters and locate potential sources of pollutants so that targeting efforts and appropriate management strategies can be developed. As sampled in the ambient monitoring system, fecal coliform bacteria are most useful as a screening tool to estimate the cumulative inputs from multiple sources, but in some instances can be used to locate a single large source of bacteria.

A summarization of fecal coliform information is listed in Table 4.4. The primary screening tool used in identifying potential problem locations for fecal coliform bacteria is the geometric mean of the fecal samples taken at each site. Sites with 10 or more fecal coliform samples within the last 5 years, that have a geometric mean exceeding 200 /100ml, are considered highest priority. This information will be reflected in the Use Support Rating for that stream or river (Section 4.5). The fecal coliform standard for the sampled waters in this basin is 200/100 ml. Those numbers in parentheses under the second column in Table 4.4 (Samples > 200/100 ml) show the percentage of the samples at each site that exceeded the standard.

The only station with a geometric mean greater than 200/100 ml in the ambient network was the Dan River at Wentworth (230/100 ml). This station also had the most samples exceeding 400/100ml (35%). Although this station may have a localized source and clearly recorded the highest bacteria levels, other stations in the Dan River drainage also demonstrated moderate levels on occasion. As seen in Figure 4.9, the geometric means in the Dan River mainstem all exceeded 100/100ml. Further research into sources of bacteria and associated land use would be advisable.

The Roanoke River stations generally had much lower levels of fecal coliform bacteria, ranging from a geometric mean of 57/100 ml at Scotland Neck, to 11/100ml at Bachelor Bay. Nutbush Creek which had historically high counts had a geometric mean of 80/100 ml for the past 5 years. This improvement is likely in part due to improved treatment at the Henderson WWTP. Marlowe Creek had a geometric mean of 143/100ml, suggesting a review of potential sources above that site would be useful.

Table 4.4 Summary of Fecal Coliform Data from Roanoke River Basin AMS Stations - January 1990 to December 1994.

Station Number	Station Name	Samples	Geometric Mean	Samples > 200/100ml(5)	Samples > 400/100ml(5)
O2068500	DAN RIVER AT NC HWY 704 NEAR FRANCISCO NC	15	135	5 (33.3)	4 (26.7)
O2070500	MAYO R @ SR 1358 NEAR PRICE NC	15	121.6	5 (33.3)	3 (20)
O2071000	DAN RIVER AT SR 2150 NEAR WENTWORTH NC	14	230.7	6 (42.9)	5 (35.7)
O2074000	SMITH RIVER AT NC HWY 14 AT EDEN NC	15	107.2	3 (20)	3 (20)
O2074218	DAN RIVER AT SR 1716 NEAR MAYFIELD NC	15	124.5	6 (40)	3 (20)
O2075198	DAN RIVER @ NC HWY 62 @ NC-VA LINE @ MILTON NC	14	107.5	4 (28.6)	3 (21.4)
O2077200	HYCO CREEK AT US HWY 158 NEAR LEASBURG NC	15	101.3	4 (26.7)	3 (20)
ROA030CSUR	HYCO LAKE @ MOUTH HYCO CK NEAR CONCORD NC	1	10	0 (0)	0 (0)
ROA030E	HYCO LAKE DS NC HWY 57 NR CONCORD NC	1	10	0 (0)	0 (0)
ROA030ESUR	HYCO LAKE BELOW NC HWY 57 NEAR CONCORD NC	1	10	0 (0)	0 (0)
ROA030F	HYCO LAKE AT POWER PLANT NEAR CEFF0 NC	1	10	0 (0)	0 (0)
ROA030FSUR	HYCO LAKE @ POWER PLANT AT CEFFO NC	2	10	0 (0)	0 (0)
ROA030G	HYCO LAKE AT MAIN DAM NR MCGHEES MILL NC	1	10	0 (0)	0 (0)
ROA030GSUR	HYCO LAKE @ MAIN DAM NR MCGHEES MILL NC	1	10	0 (0)	0 (0)
O2077303	HYCO RIVER BELOW AFTERBAY DAM NR MCGHEES MILL	15	16.7	1 (6.7)	1 (6.7)
O2077348	MARLOWE CREEK AT SR 1322 NEAR WOODSDALE NC	14	143.8	6 (42.9)	4 (28.6)
O2077500	HYCO RIVER AT US HWY 501 NR DENNISTON VA	15	96.2	3 (20)	1 (6.7)
O2077631	MAYO CREEK @ SR1547 NR ALLENSVILLE NC	6	42.4	0 (0)	0 (0)
O2077670	MAYO CREEK AT SR 1501 NEAR BETHEL HILL NC	15	15.7	0 (0)	0 (0)
O2079264	NUTBUSH CREEK AT SR 1317 NEAR HENDERSON NC	15	80.9	4 (26.7)	1 (6.7)
O2079717	SMITH CREEK NEAR PASCHALL NC	15	20.9	0 (0)	0 (0)
O2080500	ROANOKE RIVER AT ROANOKE RAPIDS, NC	14	15.8	0 (0)	0 (0)
O2081000	ROANOKE RIVER NEAR SCOTLAND NECK, NC	14	57.4	1 (7.1)	1 (7.1)
O2081022	ROANOKE RIVER @ NC HWY 11 NEAR LEWISTON, NC	55	33.2	8 (14.5)	4 (7.3)
O2081054	ROANOKE RIVER @ US HWYS 13-17 @ WILLIAMSTON NC	15	25.6	0 (0)	0 (0)
O2081101	CASHIE RIVER @ SR1219 NEAR LEWISTON NC	29	38.8	3 (10.3)	1 (3.4)
O2081135	ROANOKE RIVER 1.3 MI US WELCH CK NR PLYMOUTH NC	13	12.1	0 (0)	0 (0)
O2081141	ROANOKE RIVER AT SANS SOUCI NC	15	15.4	0 (0)	0 (0)
O208114330	ALBEMARLE SOUND(BATCHELOR BAY) NR BLACK WALNUT	41	11.4	0 (0)	0 (0)

Water Quality of the Virginia Portion of the Roanoke River Basin

The majority of the Roanoke River basin is contained in the State of Virginia. In North Carolina subbasins 030201 - 030204, water quality monitoring stations have been located near the state line on waters flowing from Virginia into North Carolina in order to gauge the quality of the water entering our State. Generally, water quality entering North Carolina from Virginia is good, but there are some of concern that may warrant further investigation. Elevated fecal coliform concentrations and turbidity readings in a number of sampling results from the Dan River and the Mayo River indicate that these waters may be receiving pollution from nonpoint sources in Virginia. Another area of concern is the Smith River which enters North Carolina after flow regulation from Philpott Reservoir and receiving wastewater from the Martinsville, Virginia wastewater treatment plant which has exhibited some problems in the past.

Further discussion of the quality of water entering North Carolina from Virginia can be found in the water quality summaries by subbasin in the next section. Also, at the end of this chapter, use support ratings for the Roanoke River Basin in Virginia are presented.

4.4 NARRATIVE WATER QUALITY SUMMARIES BY SUBBASIN

4.4.1 Subbasin 01 - Upper Reaches of the North Carolina Portion of the Dan River

Description

Roanoke River subbasin 01 contains the uppermost reaches of the Dan River in North Carolina, although headwater reaches of the Dan River are in Virginia. Major tributaries within the North Carolina section of this subbasin include Town Fork Creek, Snow Creek, and Double Creek. These tributaries and major sections of the Dan River are deeply entrenched, suggesting the effects of long term erosion. A US Department of Agriculture publication notes that over 21 tons/acre/year are eroding from cultivated cropland in the Upper Dan River (US Department of Agriculture, Natural Resources Conservation Service, 1992). This compares to only 7.3 tons/acre/year for cultivated cropland for the nearby Upper Tar River basin. This subbasin is borderline between mountain and piedmont ecoregions and contains some characteristics of both. As a result of fairly steep to moderate topography, headwater reaches of most tributaries are forested while many downstream sections are intensively farmed. This subbasin contains 63 permitted dischargers, although only one facility has a design flow of > 0.5 MGD: Duke Power Company which discharges to Belews Lake. Figures 4.10 and 4.11 show sampling locations for ambient monitoring, lakes assessment, fish community, fish tissue and benthic macroinvertebrates.

Overview of Water Quality

Ambient water quality information is currently being collected from one location in this subbasin, the Dan River near Francisco. This ambient monitoring location is near the Virginia/North Carolina state line and represents water quality conditions of the Dan River as it flows into North Carolina. These data have indicated good water quality, with few violations in water quality standards. However, elevated concentrations of fecal coliform and turbidity have been recorded from approximately one third of all samples collected from this location. These observations suggest the potential effects of non-point source runoff. In addition, field teams have noted that the river is very turbid during high flow events and the effects of sedimentation are evident in low-flow or pool habitats. Another factor that has the potential to influence water quality at this site is the Pinnacles hydropower project operated by the City of Danville, Virginia. This facility is required to maintain a minimum release of 30 cfs or the inflow into the reservoir, whichever is less.

Benthic macroinvertebrate samples have been collected from 15 locations in this subbasin since 1983. These data are presented below in Table 4.5. Good water quality conditions have been recorded from two mainstem Dan River locations within this subbasin using benthic macroinvertebrate data. Good or Good/Fair bioclassifications have been recorded from North Double Creek, Snow Creek, and Town Fork Creek. These data suggest that non-point sources of pollution are responsible for some minor impacts to the biota of North Double Creek and that non-point sources and the effluent from the Walnut Cove WWTP were responsible for a Good/Fair bioclassification at the Town Fork monitoring location. Excellent bioclassifications have been recorded only from small headwater tributaries, mainly in Hanging Rock State Park.

Good or Good/Excellent ecological health ratings were given to all nine fish community monitoring locations in this subbasin based on IBI values. These data are presented below in Table 4.6. All fish data in this subbasin were collected by Rohde during 1992-93 mostly from mainstem locations on the Dan River, and one location on the Little Dan River. The Dan River

Roanoke River Basin
Subbasin 030201

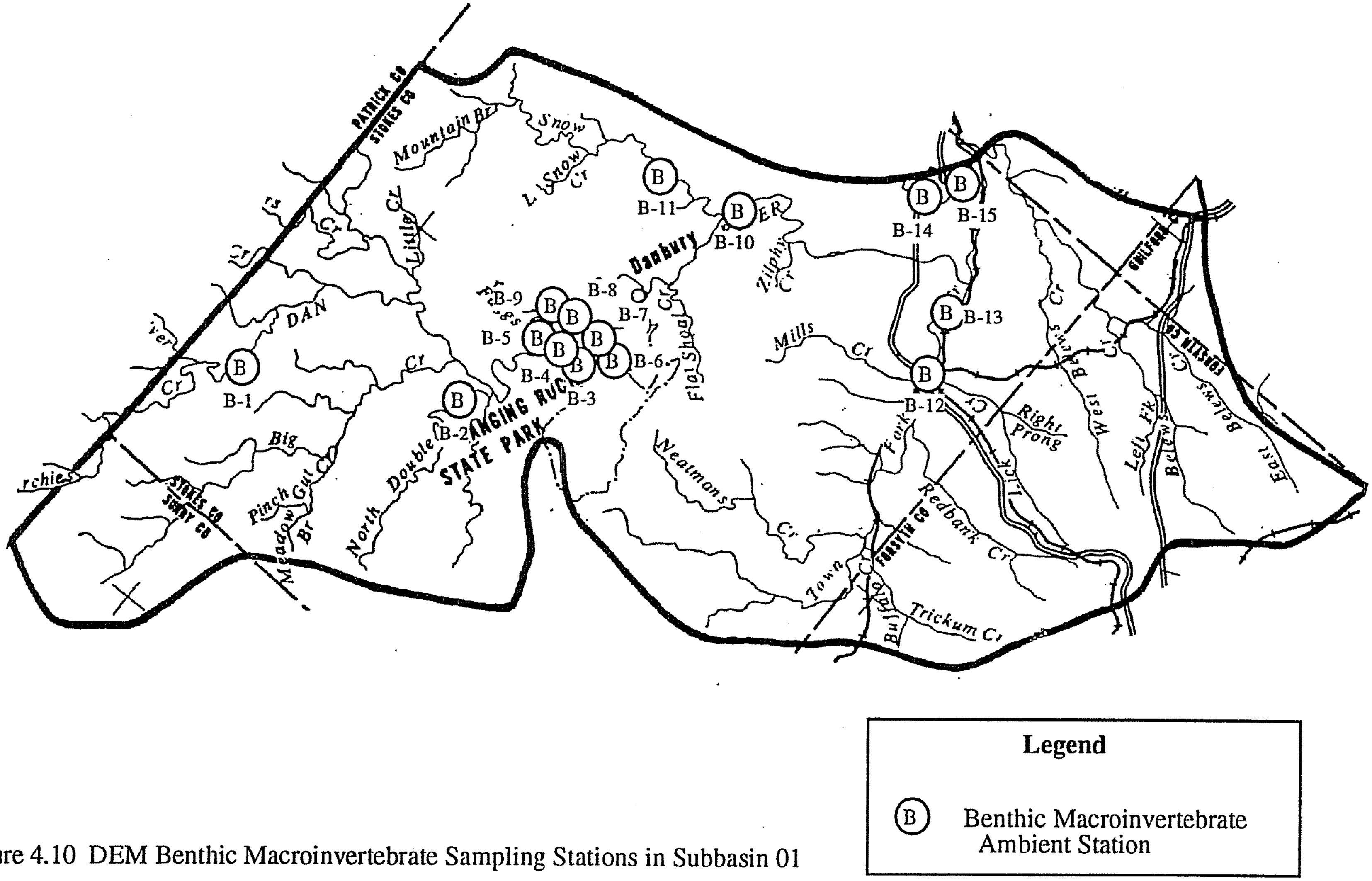


Figure 4.10 DEM Benthic Macroinvertebrate Sampling Stations in Subbasin 01

Roanoke River Basin
030201

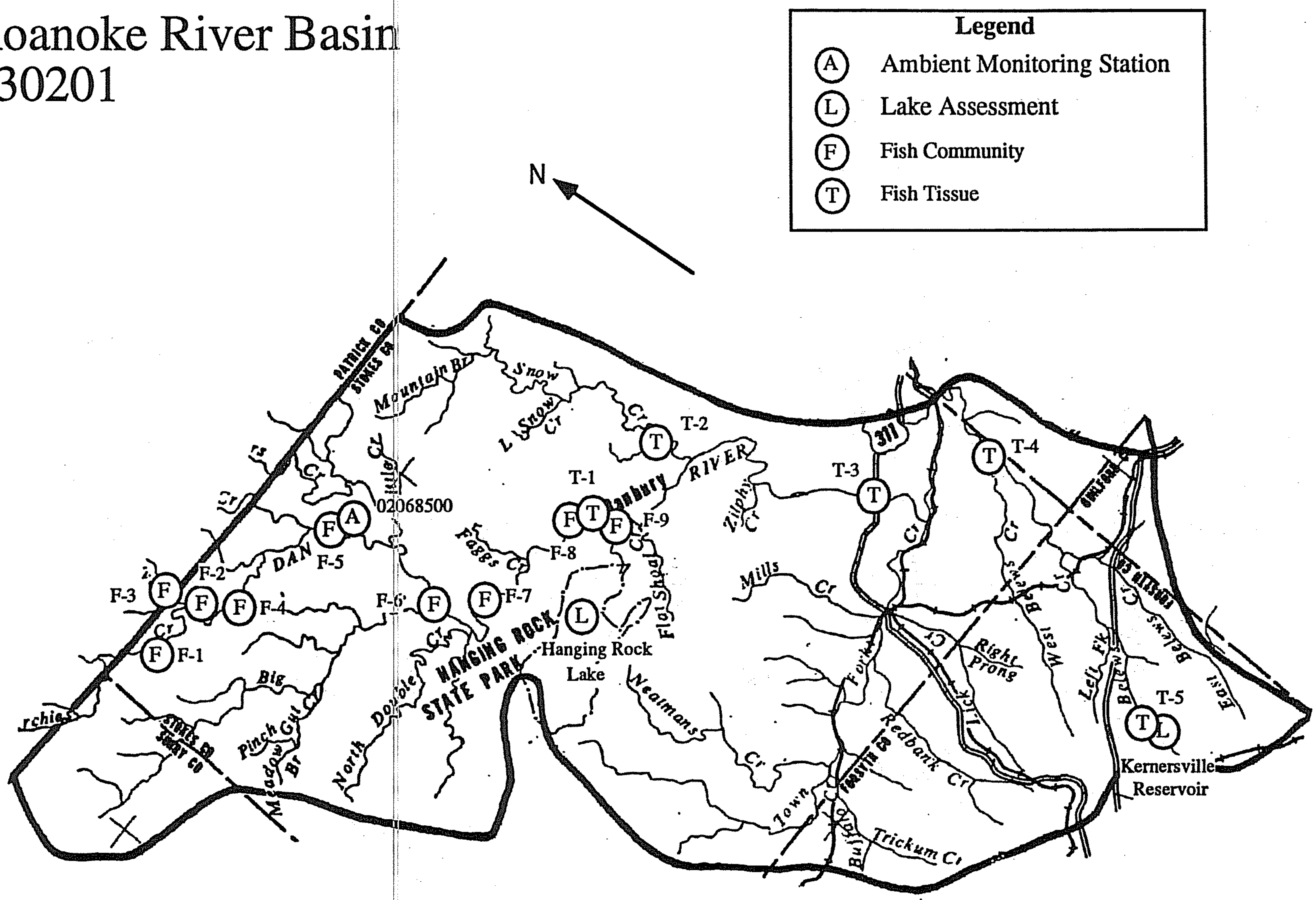


Figure 4.11 Locations of Benthic Macroinvertebrate Ambient stations in Subbasin 01

was given a Good ecological health rating at all sites except a midbasin site at SR 1486, which received a Good-Excellent rating. The Little Dan River was sampled three times and received two Good-Excellent ecological health ratings and one Good rating. The percentage of omnivorous species was slightly elevated suggesting moderate nutrient enrichment at many locations. Belews Lake remains under a fish consumption advisory due to elevated selenium levels from Duke Power's ash basin discharge.

Table 4.5 Benthic Macroinvertebrate Data Collected from 1983 to1994 in the Roanoke Basin

ROA 01

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Dan R, NC 704 at Francisco, Stokes	A/B-1	22-(1)	08/94	57/28	3.71/3.48	Good
				07/90	94/48	4.34/3.54
	Excellent					
			07/88	90/38	3.95/2.94	Good
			07/86	85/38	4.10/3.16	Good
			08/84	86/36	4.64/3.45	Good
North Double Cr, SR 1504, Stokes	/B-2	22-10	08/94	-/17	-/4.63	Good-Fair
Cascade Cr, ab Swimming Lake, Stokes	13/B-3	22-12	03/93	-/34	-/1.61	Excellent
			08/91	-/26	-/2.07	Good
			03/91	-/35	-/1.69	Excellent
			09/90	-/21	-/2.75	Good
Cascade Cr, SR 2012, Stokes	14/B-4	22-12	09/90	-/23	-/2.99	Good-Fair
Cascade Cr, nr SR 1001, Stokes	15/B-5	22-12	03/91	-/26	-/2.94	Good
			09/90	-/26	-/3.48	Good
Indian Cr, ab trail, Stokes	10/B-6	22-13	03/93	-/30	-/1.47	Excellent
			03/91	-/25	-/1.38	Good
Indian Cr, be trail, Stokes	10/B-7	22-13	03/93	-/34	-/1.54	Excellent
			03/91	-/27	-/1.22	Excellent
			09/90	-/26	-/2.57	Excellent
Indian Cr, SR 1001, Stokes	11/B-8	22-13	09/90	-/22	-/2.33	Good
Indian Cr, NC 89/8, Stokes	11/B-9	22-13	09/90	-/27	-/2.76	Good
Dan R, SR 1695, Stokes	/B-10	22-(19.5)	08/94	45/20	4.52/3.74	Good
Snow Cr, SR 1673, Stokes	/B-11	22-20-(5.5)	08/94	-/22	-/3.87	Good
Town Fk Cr, US 311, Stokes	/B-12	22-25-(13.5)	02/88	-/19	-/4.43	Good-Fair
Town Fk Cr, SR 1917, Stokes	/B-13	22-25-(13.5)	08/94	-/15	-/4.59	Good-Fair
				02/88	-/24	-/4.21
	Good-Fair					
UT Dan R, US 311, Stokes	5/B-14	22-(28.5)	02/87	-/21	-/4.00	Good-Fair
UT Dan R, nr Raceway, Stokes	6/B-15	22-(28.5)	02/87	-/15	-/4.40	Fair

Table 4.6 Basin Fish Community Assessment Sites in Roanoke Subbasin 01, 1992-1993, North Carolina Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi^2)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Dan R	SR 1416	71	920717	Stokes	50	Good	ROHDE
F-2	Dan R	at L Dan R	75	920716	Stokes	52	Good	ROHDE
F-3	Little Dan R	off SR 1422	32	920720	Stokes	52	Good	ROHDE
F-3	Little Dan R	off SR 1422	32	921221	Stokes	54	Good-Excellent	ROHDE
F-3	Little Dan R	off SR 1422	32	930821	Stokes	54	Good-Excellent	ROHDE
F-4	Dan R	SR 1432	111	920718	Stokes	50	Good	ROHDE
F-5	Dan R	NC 704	129	920717	Stokes	52	Good	ROHDE
F-6	Dan R	NC 89	172	920720	Stokes	50	Good	ROHDE
F-7	Dan R	SR 1486	254	930911	Stokes	54	Good-Excellent	ROHDE
F-8	Dan R	SR 1668	268	920718	Stokes	50	Good	ROHDE
F-9	Dan R	SR 1652	275	920721	Stokes	50	Good	ROHDE
F-9	Dan R	SR 1652	275	930911	Stokes	50	Good	ROHDE

Lake monitoring investigations have been conducted on three lakes within this subbasin; Hanging Rock Lake, Kernersville Reservoir, and Belews Lake. A 1994 DWQ investigation at Hanging Rock Lake showed elevated levels of ammonia and nitrite. The NCTSI score of -2.3 indicated oligotrophic status and therefore Hanging Rock Lake fully supports all of its designated uses. Hanging Rock Lake was one of sixteen lakes selected statewide as representative of a minimally impacted lake by which other lakes in the same ecoregion could be compared. Kernersville Reservoir is currently classified WS-IV, CA and is used for an emergency water supply. A 1994 DWQ investigation noted that all nutrient levels at the one sampling station were moderate except for ammonia, which was elevated at 0.08 mg/l. The NCTSI score of -0.2 indicated a mesotrophic status. Kernersville Reservoir fully supports its designated uses. Belews Lake was most recently sampled by DWQ on August 16, 1994. Nutrients were present in low amounts except for ammonia (NH_3) and nitrite and nitrate ($NO_2 + NO_3$). Belews Lake is classified WS-IV, B and C. The NCTSI score of -5.3 indicated oligotrophic status. Belews Lake was listed as Partially Supporting in the 1992-1993 EPA 305(b) Report due to elevated levels of selenium in fish tissue.

<u>Potential HQW or ORW Streams</u>
The watersheds of Cascade and Indian Creeks have been studied to determine whether or not water quality is excellent. Results of benthic macroinvertebrate sampling indicate that portions of these streams do have excellent water quality and therefore may qualify for consideration for reclassification to High Quality Waters or Outstanding Resource Waters.

4.4.2 Subbasin 02 - North Carolina Portion of the Mayo River

<u>Description</u>
Roanoke River subbasin 02 contains a very short (approximately 10 stream miles) reach of the Dan River and the entire North Carolina section of the Mayo River. However, most of the Mayo River catchment is in Virginia. Other large tributaries in this subbasin include Hogans Creek and Beaver Island Creek. The only two municipal areas in the catchment are Madison and Mayodan. Most of the land use within the catchment appears to be agricultural or forest. Figure 4.12 shows sampling locations in this subbasin for ambient water quality, lake assessment, benthic macroinvertebrates, fish community and fish tissue.

<u>Overview of Water Quality</u>
Ambient water quality information is currently being collected from one location in this subbasin, the Mayo River near Price. This ambient monitoring location is near the Virginia/North Carolina state line and represents water quality conditions of the Mayo River as it flows from Virginia into North Carolina. These data indicate very good water quality conditions, with very few exceedences in water quality standards. Approximately one third of all fecal coliform samples collected from this location were higher than the North Carolina criterion for this parameter. These data may indicate the effects of non-point source runoff in the catchment above this monitoring location.

Benthic macroinvertebrate samples have been collected only at Mayo River sites in this subbasin. These data (Table 4.7) indicate primarily Good bioclassifications in the Mayo River near the North Carolina/Virginia state line but a decline in biological integrity prior to the confluence with the Dan River. This subbasin contains 18 permitted wastewater dischargers, although only two facilities have a design flow of > 0.5 MGD. The Mayodan WWTP (design flow = 1.25 MGD) discharges to the Mayo River near the confluence with the Dan River. This facility has a 6% instream waste concentration at low flow, and is currently meeting permit requirements. The only other large municipal facility is the Madison WWTP (design flow = 0.775 MGD) which discharges to the Dan River.

Roanoke River Basin
Subbasin 030202

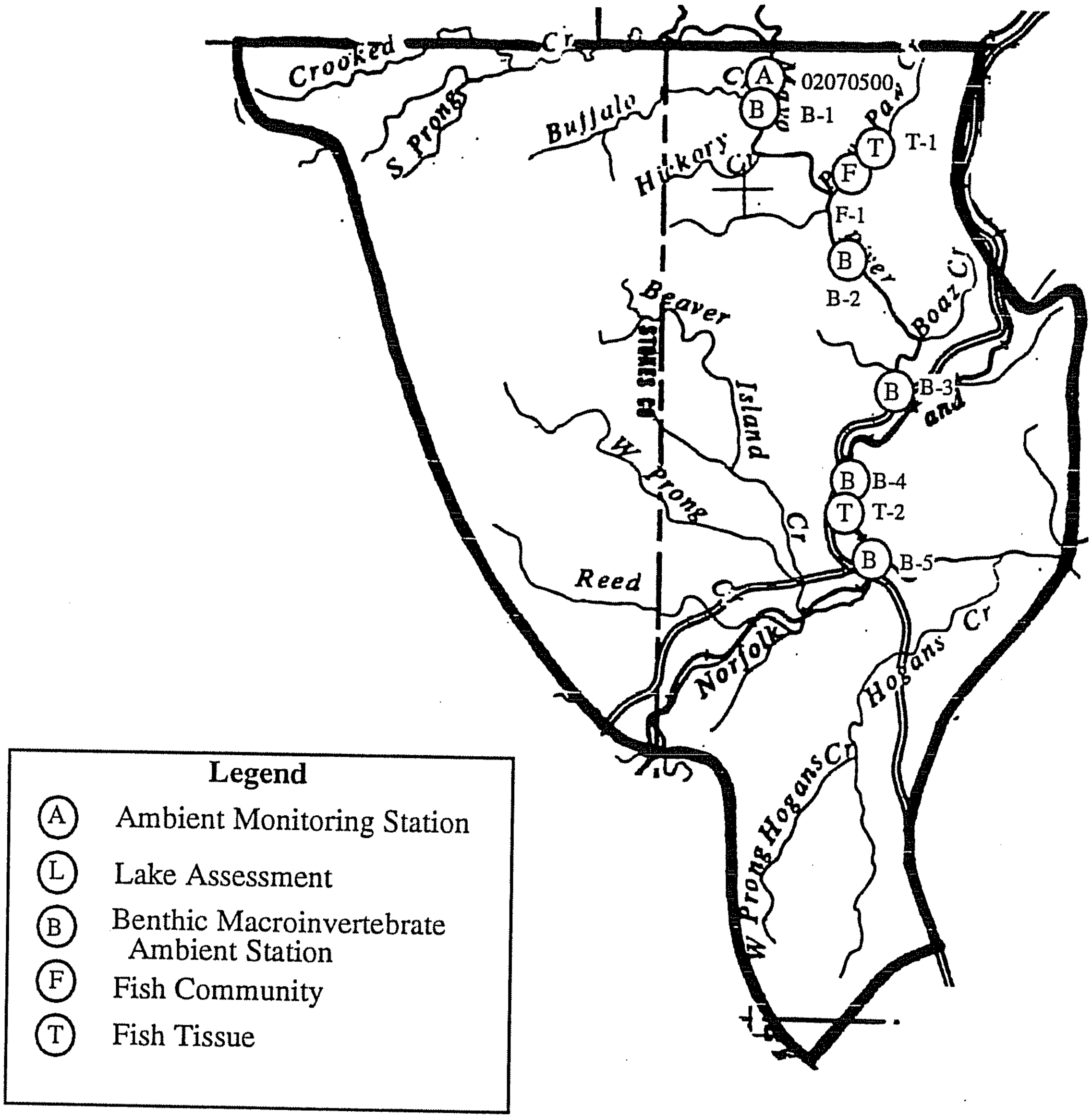


Figure 4.12 DEM Monitoring Stations in Subbasin 02

Table 4.7 Benthic Macroinvertebrate Data Collected from 1983 to 1994 in Subbasin 02

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Mayo R, SR 1358 nr Price, Rockingham	B/B-1	22-30-(1)	08/94	64/38	3.48/3.18	Excellent
			08/89	79/42	4.75/3.99	Good
			03/89	96/54	3.65/2.81	Good
			07/87	87/40	4.56/3.94	Good
			07/86	102/37	4.95/3.71	Good
Mayo R, NC 770, Rockingham	16/B-2	22-30-(9.5)	03/89	-/37	-/3.49	Good-Fair
Mayo R, US 220 Bus, Rockingham	17/B-3	22-30-(9.5)	03/89	-/44	-/3.29	Good-Fair
Mayo R, NC 135, Rockingham	18/B-4	22-30-(10)	08/89	-/28	-/4.12	Good
Mayo R, SR 2177, Rockingham	-/B-5	22-30-(10)	09/94	71/33	4.70/4.33	Good

Fish community structure sampling was performed at Paw Paw Creek, a small tributary of the Mayo River which received an ecological health rating of Good (see Table 4.8). Paw Paw Creek has a very diverse fish population with 26 species, including the bigeye jumprock, Scartomyzon aniommus, which is listed as special concern in North Carolina. Fish tissue samples have been collected from two locations in this subbasin; the Dan River at Madison and Paw Paw Creek. Fish tissue data from these two locations detected no organic compounds or metals above the EPA recommended screening value or the FDA criteria for fish consumption.

Table 4.8 Basin Fish Community Assessment Sites in Roanoke Subbasin 02, North Carolina Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi^2)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Paw Paw Cr	SR 1360	9	900803	Rockingham	52	Good	NCDWQ

4.4.3 Subbasin 03 - Dan River before it enters Virginia

Description

Roanoke River subbasin 03 contains approximately 25 river miles of the Dan River, prior to flowing into Virginia. The Smith River is a major tributary of the Dan in this subbasin. Most of the Smith River catchment is in Virginia, and flow in North Carolina is regulated by Philpott Reservoir. Other smaller tributaries include Jacobs Creek, Buffalo Creek, and Wolf Island Creek. Eden and Reidsville are the only two major municipal areas in the subbasin. Land use in this subbasin is typical of the piedmont ecoregion containing some rolling topography and dominated by agricultural activities and forest. Figure 4.13 shows the different sampling sites in this subbasin.

Overview of Water Quality

Ambient water quality data are currently being collected from three locations in this subbasin; the Dan River near Wentworth, the Smith River at Eden, and the Dan River near Mayfield. The ambient monitoring location on the Smith River is located near the Virginia/North Carolina state line and represents water quality conditions of the Smith River as it flows into North Carolina. Data from this location has noted very few exceedances to North Carolina water quality standards. However, flow is regulated due to discharge from the Philpott Reservoir and water quality problems have been noted downstream of the Martinsville WWTP. This facility has been responsible for elevated concentrations of chloride and total dissolved solids in the Smith River. Prior to 1990, only sporadic violations in North Carolina water quality standards for chlorides (230 mg/l) were noted at the ambient monitoring location near Eden. Since 1990, no violations have occurred at this location, however, two elevated chloride concentrations ($\geq$ 100 mg/l) were recorded during July and September, 1993.

Roanoke River Basin
Subbasin 030203

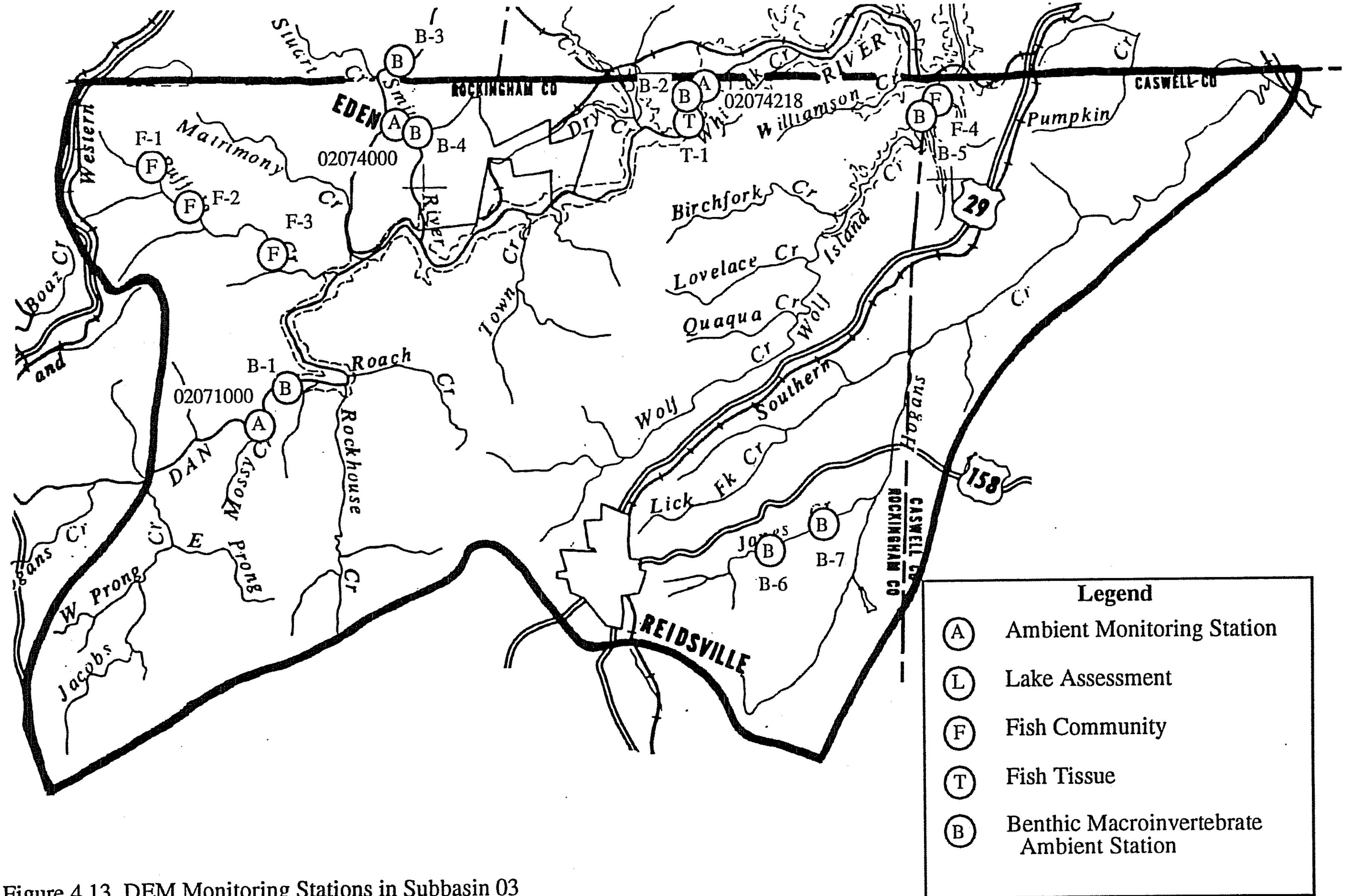


Figure 4.13 DEM Monitoring Stations in Subbasin 03

The two other ambient monitoring locations on the Dan River are above (near Wentworth) and below (near Mayfield) the confluence with the Smith River. Although there are few violations in water quality standards, there are noticeable differences in water quality between these two locations. The Smith River and the effluents from several large facilities (Eden-Mebane Bridge WWTP, Miller Brewing Company, Fieldcrest Cannon, and Eden Dan River WWTP) are located between these two ambient monitoring locations. Median conductivity values are 40% higher at the Mayfield location than at the Wentworth location, possibly due to the combined instream waste concentrations of these facilities.

Benthic macroinvertebrate samples have been collected from 7 locations in this subbasin since 1983 the results of which are summarized below in Table 4.9. Good and Good/Fair bioclassifications have been assigned to most of these locations. However, Excellent bioclassifications were assigned to the Dan River near Wentworth in 1987 and the Dan River near Mayfield in 1991. Fair bioclassifications were assigned to the Smith River during investigations conducted in 1984 and 1986. The Fair bioclassifications at these Smith River locations is the result of flow regulation and the impacts from the Martinsville WWTP.

Table 4.9 Benthic Macroinvertebrate Data Collected from 1983 through 1994 in Subbasin 03

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Dan R , SR 2150 at Wentworth, Rockingham	L/B-1	22-(31.5)	08/89	65/27	5.31/4.46	Good
			07/87	93/33	5.57/4.47	Excellent
Dan R, SR 1761 at Mayfield, Rockingham	D/B-2	22-(39)	08/91	56/27	4.93/4.07	Excellent
			07/87	69/27	5.09/4.09	Good
			07/86	62/21	5.88/4.62	Good-Fair
			09/84	57/18	5.66/4.28	Good-Fair
			08/83	66/23	5.43/4.52	Good
Smith R , VA 922 nr state line	B-3	22-40-(1)	09/84	64/22	5.64/4.31	Fair
Smith R, NC 14 near Eden, Rockingham	C/B-4	22-40-(3)	08/94	58/18	5.66/4.44	Good-Fair
			07/90	81/31		5.41/3.95
	Good-Fair					
			07/88	70/24	6.01/5.05	Good-Fair
			07/86	57/18	6.12/4.67	Fair
Wolf Island Cr, NC 700 at Pelham, Caswell	E/B-5	22-48	07/88	82/24	5.79/4.75	Good
			07/85	68/25	5.28/4.45	Good
			08/83	76/24	5.36/4.20	Good
Jones Cr, SR 2632, Rockingham	/B-6	22-50-3	01/92	-/29	-/4.56	Good
Jones Cr, SR 2571, Rockingham	/B-7	22-50-3	12/87	83/27	5.55/4.49	Good

Fish ecological health ratings were available from four locations in the subbasin (see Table 4.10).

Table 4.10 ~~Basin Fish Community Assessment Sites in Roanoke Subbasin 03, North Carolina~~ Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi^2)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Buffalo Cr	SR 1509	3	800915	Rockingham	50	Good	NCWRC
F-2	Buffalo Cr	SR 1515	6	930508	Rockingham	48	Good	ROHDE
F-3	Buffalo Cr	NC 770	16	800915	Rockingham	46	Fair-Good	NCWRC
F-4	Wolf Island Cr	NC 700	69	941005	Caswell	54	Good-Excellent	
NCDWQ								

Buffalo Creek was sampled at two sites by the North Carolina Wildlife Resources Commission as part of the national 208 program in 1980. This investigation resulted in a Good ecological health rating at the upstream location and a Fair-Good rating downstream. It was noted that non-point sources of pollution are likely contributors to the lower ecological health rating in this catchment. A Good ecological health rating was given to this stream based on data collected by Rohde in 1993. In addition to the Buffalo Creek catchment, fish community structure was also determined for Wolf Island Creek. Wolf Island Creek was sampled at the lower end of the drainage and received a Good-Excellent ecological health rating with excellent fish diversity of 26 species. Fish tissue samples have been collected from the Dan River near Mayfield. These data have detected a single mercury value exceeding the EPA recommended screening value.

4.4.4 Subbasin 04 - Three Tributaries to the Dan River: Moon Creek, Rattlesnake Creek and Country Line Creek

Description

Roanoke River subbasin 04 contains a very short reach of the Dan River (approximately 8 river miles in length) and three large tributaries: Moon Creek, Rattlesnake Creek, Country Line Creek. The Dan River in this subbasin flows into North Carolina from Virginia, after receiving effluent from the Danville Northside WWTP, and then flows back into Virginia. The Dan River forms the headwaters of John H. Kerr Reservoir, which straddles the North Carolina/Virginia state line.

Tributary streams within this subbasin are low gradient, sediment dominated systems typical of the piedmont ecoregion. Land use appears to be primarily agricultural with row crops and pasture. Yanceyville is the only town within the subbasin. This subbasin contains 9 permitted dischargers, although none of these facilities have a design flow of $\geq$ 0.5 MGD.

Figure 4.14 shows the various sampling sites in this subbasin.

Overview of Water Quality

Ambient water quality information is currently being collected from one location in this subbasin, the Dan River at Milton. This location is near the Virginia state line and represents water quality conditions of the Dan River as it leaves North Carolina. However, the Dan River flows into Virginia prior to this location and receives waste from the Danville, Virginia WWTP. Good water quality conditions have been recorded at this location with very few exceedances in North Carolina water quality standards. Median conductivity values at this location for the last five years have averaged 129 uMhos, which may reflect flow from the Danville facility.

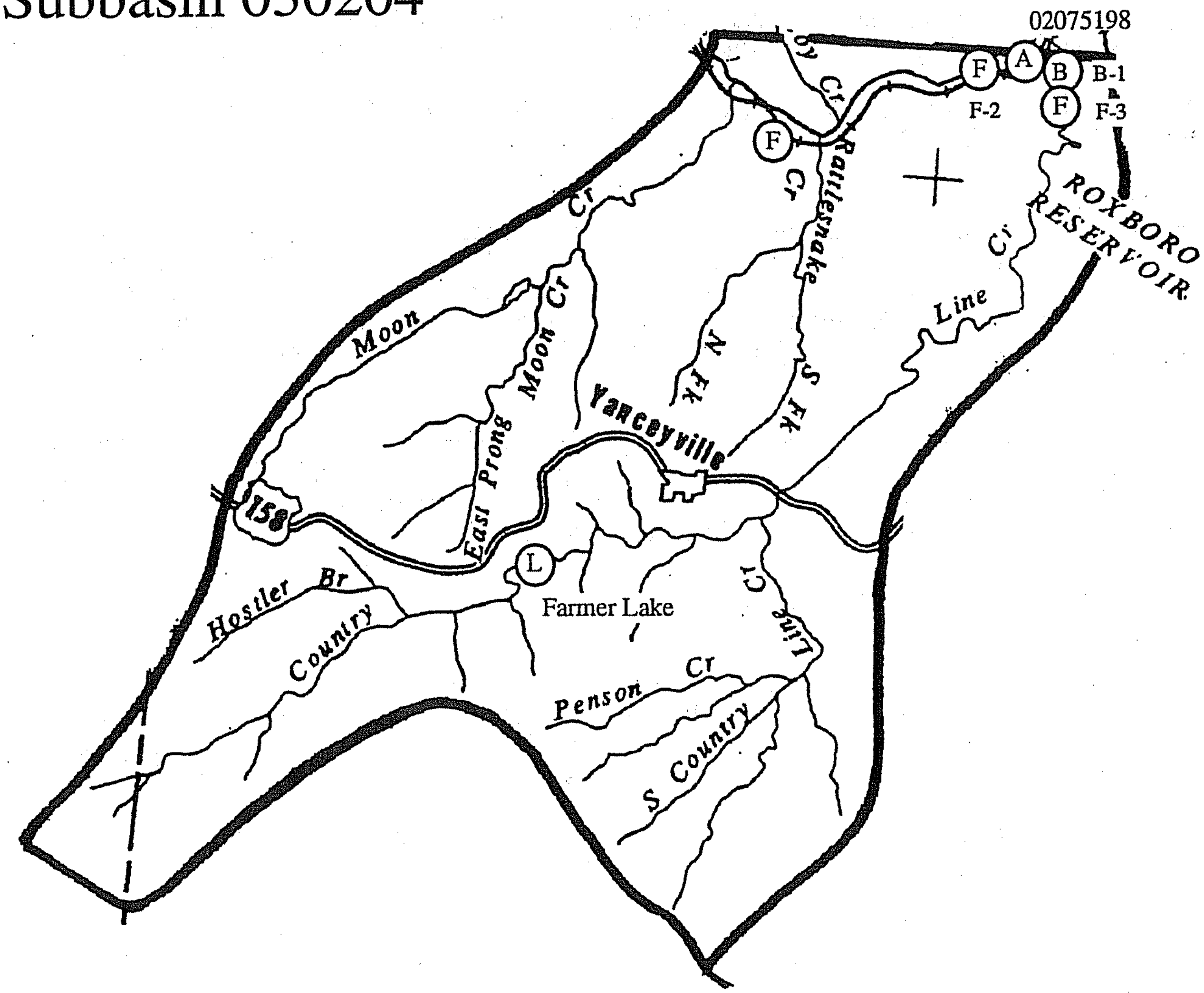
Benthic macroinvertebrate data from Country Line Creek (see Table 4.11) have resulted in Good and Good/Fair bioclassifications. Although this location is below the Yanceyville WWTP, the catchment is dominated by agricultural landuse. The lower bioclassification noted at this location in 1994 may be a response to high flows and scour prior to collection rather than stress due to the Yanceyville facility.

Table 4.11 Benthic Macroinvertebrate Data Collected Collected from 1983 through 1994 in Subbasin 04

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Country Line Cr, NC 57, Caswell	F/B-1	22-56-(3.7)	08/94	-/14	-/4.42	Good-Fair
				07/90	73/26	5.44/4.37
	Good					
			07/87	78/26	5.62/4.90	Good
			08/83	72/19	5.78/4.26	Good-Fair

Ecological health ratings based on fish community analyses at Moon Creek, Cane Creek, and Country Line Creek were all Good (Table 4.12). All three also have moderate nutrient enrichment, as evidenced by unbalanced trophic composition. resulting in a moderate proportion of omnivores.

Roanoke River Basin
Subbasin 030204



Legend	
(A)	Ambient Monitoring Station
(F)	Fish Community
(B)	Benthic Macroinvertebrate Ambient Station
(L)	Lake Assessment

Figure 4.14 DEM Monitoring Stations in Subbasin 04

Table 4.12 Basin Fish Community Assessment Sites in Roanoke Subbasin 04, North Carolina Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi^2)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Moon Cr	SR 1511	47	940907	Caswell	52	Good	NCDWQ
F-2	Cane Cr	SR 1527	20	941005	Caswell	48	Good	NCDWQ
F-3	Country Line Cr	NC 57	138	940907	Caswell	50	Good	NCDWQ

Lake monitoring information has been collected from one reservoir in this subbasin, Farmer Lake. A 1994 DWQ investigation noted moderate mean nutrient levels with higher nutrient concentrations generally found at the most upstream station in the lake. Turbidity was highest at the upstream station as well. The NCTSI score of 0.7 indicated slightly eutrophic conditions. Farmer Lake, which is currently classified as WS-II, fully supports all of its designated uses.

4.4.5 Subbasin 05 - Hyco River and Reservoir

Description

Roanoke River subbasin 05 contains the watershed of Hyco Reservoir and the Hyco River which flows into Virginia. This subbasin also contains Mayo Creek and the headwaters of the Mayo Reservoir. Both of these systems flow into the Hyco River, an arm of John H. Kerr Reservoir in Virginia. Figure 4.15 shows the sampling sites located in this subbasin.

Tributary streams within this subbasin are low gradient, sandy streams typical of the piedmont ecoregion. Land use appears to be primarily agricultural with row crops and pasture. This subbasin contains 23 permitted dischargers, although there is only one large ($\geq$ 0.5 MGD) WWTP in the subbasin. Roxboro has a 5.0 MGD facility (instream waste concentration = 99.87 %) that discharges to Marlowe Creek. Additionally, Carolina Power and Light Company discharges 20.0 MGD of cooling water to Mayo Reservoir.

Overview of Water Quality

Ambient water quality data are currently being collected from five locations in this subbasin: Hyco Creek near Leasburg, Hyco River near Mcghees Mill, Marlowe Creek near Woodsdale, Hyco River near Denniston, Virginia, and Mayo Creek near Bethel Hill. Water quality information from Hyco Creek and Marlowe Creek illustrate typical water quality conditions of small streams dominated by agricultural landuse in this subbasin. However, the Marlowe Creek location is below the Roxboro WWTP. These two streams had few exceedances of water quality standards. Some exceedances in fecal coliform criterion have been noted at both of these locations, which may reflect the effects of non-point source runoff. Elevated nutrients in Marlowe Creek are likely in part due to the WWTP.

Mayo Creek near Bethel Hill and Hyco River below Mcghees Mill are located immediately below reservoir dams. Extremely low concentrations of most parameters have been recorded from these locations. The most downstream ambient monitoring location in this subbasin is the Hyco River near Denniston, Virginia. Water quality data from this location have noted very few exceedances of North Carolina standards.

As evidenced in Table 4.13, water quality conditions have varied considerably at the ambient monitoring location on Hyco Creek using benthic data. Sedimentation appears to be the primary factor contributing to the Fair bioclassification recorded at the Hyco Creek site during 1994

Roanoke River Basin
Subbasin 030205

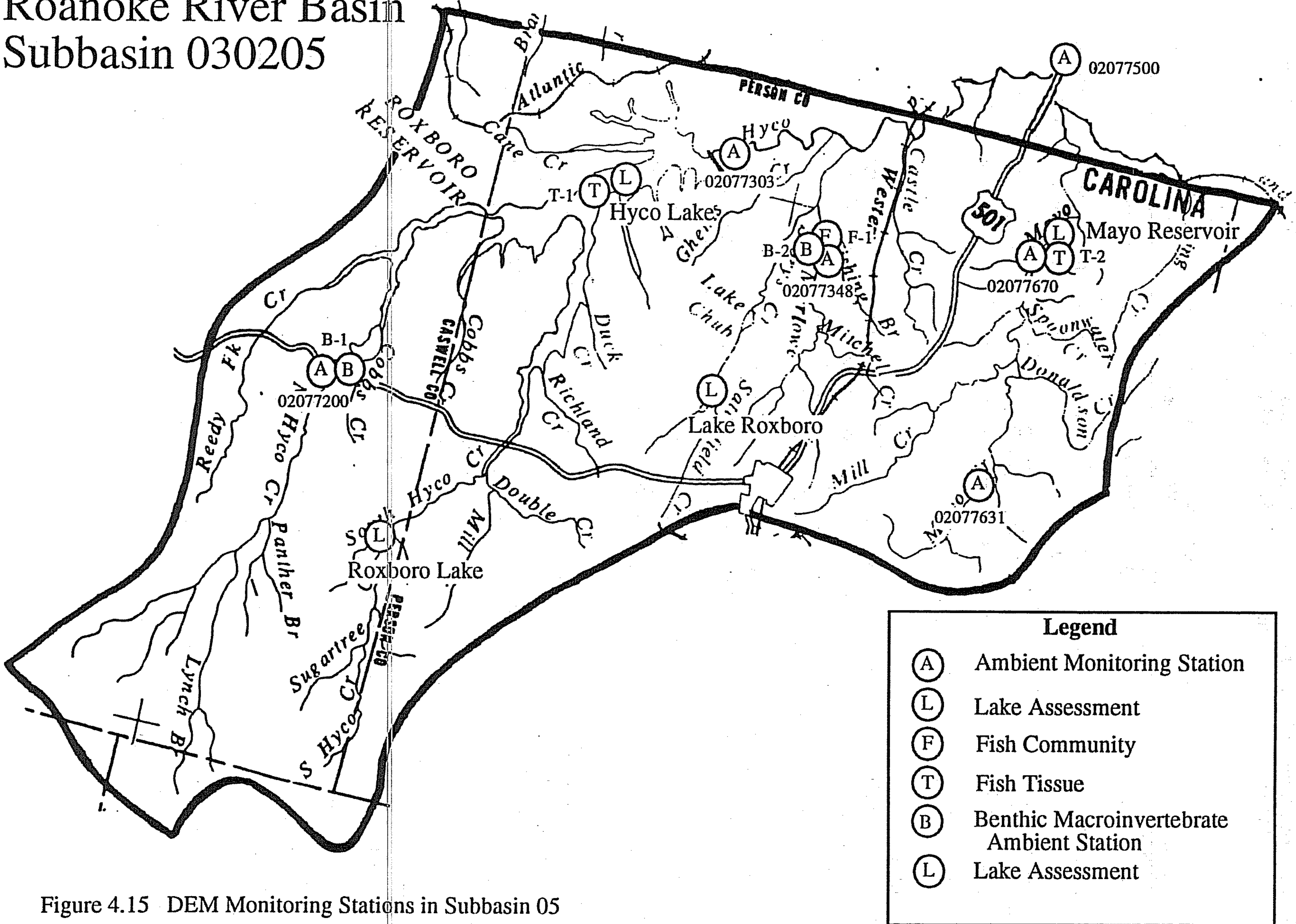


Figure 4.15 DEM Monitoring Stations in Subbasin 05

basinwide monitoring. A Fair bioclassification also was recorded at a monitoring location on Marlowe Creek below the Roxboro WWTP, but EPT values were much lower than at Hyco Creek.

Table 4.13 Benthic Macroinvertebrate Data Collected Collected from 1983 through 1994 in Subbasin 05

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Hyco Cr, US 158 nr Leasburg, Caswell	G/B-1	22-58-1	08/94	-/10	-/5.93	Fair
					07/90	65/20
	5.83/5.10	Good-Fair				
			07/87	74/23	5.77/5.14	Good
			07/86	78/21	5.87/5.07	Good-Fair
Marlowe Cr, SR 1322, Person	/B-2	22-58-12-6	08/94	33/5	6.87/6.43	Fair

A fish community structure sample was collected from Marlowe Creek below the Roxboro WWTP. This site was given a Fair ecological health rating as a result of the absence of intolerant species and an unbalanced trophic condition. Fish tissue samples were collected at Hyco and Mayo lakes in this subbasin. The fish consumption advisory at Hyco Reservoir, due to elevated selenium levels, was revised in May 1995 to include only common carp, white catfish and green sunfish. Mayo Lake has also exhibited elevated levels of selenium in its biota as a result of receiving ash pond discharges from the CP&L Mayo Electric Generating Plant. However, selenium levels in Mayo Lake have remained below the limits that would require a fish advisory.

Lake monitoring investigations have been conducted at four lakes in this subbasin; Hyco Reservoir, Lake Roxboro, Roxboro Lake (also called Lake Isaac Walton), and Mayo Reservoir. A 1994 DWQ lakes investigation of Hyco Reservoir noted varying amounts of nutrient levels throughout the lake. However, Hyco Reservoir has experienced elevated levels of selenium, a heavy metal toxic to fish and waterfowl in high concentrations, in the water column, sediment, and fish tissue. The 1994 TSI of -1.9 is consistent with the TSI of -3.5 in 1990. These values indicate that the lake is oligotrophic. Hyco Reservoir is classified as Partially Supporting, due to the fish consumption advisory. A 1994 DWQ investigation of Lake Roxboro resulted in a TSI of 0.5: a eutrophic status. This is a change from the mesotrophic status recorded in 1988 when the lake was previously sampled. Lake Roxboro is currently classified WS-II, B and fully supports all of its designated uses. The 1994 DWQ investigation of Roxboro Lake, which is the primary water supply for the town of Roxboro, showed nutrient levels to be low to moderate. The 1994 TSI of 0.3 was consistent with the 1988 TSI of 1.4, indicating a eutrophic status. Roxboro Lake is currently classified WS-II CA and is considered threatened due to algal bloom conditions documented in 1994. A TSI value of -5.7 was given to Mayo Reservoir during a 1994 DWQ investigation. The 1994 TSI value is similar to historical values indicating an oligotrophic status. Mayo Reservoir is currently classified C. No violations of state water quality standards were observed and the reservoir fully supported its designated uses. However, current levels of selenium in the biota and infestation by aquatic macrophytes warrant continued monitoring of Mayo Reservoir.

4.4.6 Subbasin 06 - Headwater Tributaries of John H. Kerr Reservoir

<u>Description</u>

Roanoke River subbasin 06 contains many small to medium-sized headwater tributaries of John H. Kerr Reservoir. These tributaries include Aarons Creek, Grassy Creek, Island Creek, and Nutbush Creek. This is a piedmont ecoregion charaterized by low, rolling hills and streams of moderate gradient. Most stream systems appear to carry heavy sediment bedloads and are very turbid after heavy rain events. Headwater reaches of many tributaries are forested, while downstream reaches appear to be farmed. Row crops and pasture are the most prevalent agricultural land use. Henderson is the only metropolitan area in the subbasin. Figure 4.16 shows the sampling sites located in this subbasin.

Overview of Water Quality

Ambient water quality information is currently being collected from Nutbush Creek near Henderson. This ambient monitoring station is located below the Henderson WWTP and summarizes water quality of Nutbush Creek prior to flowing into the Nutbush Creek arm of Kerr Reservoir. Most conventional water quality parameters fail to note any violations in water quality standards. However, extremely high conductivity values have been recorded from this location. In addition, the Henderson WWTP is currently under Judicial Order of Consent for failure to maintain toxicity limits.

Benthic macroinvertebrate samples have been collected from 7 locations in this subbasin since 1983. These data are summarized in Table 4.14. Fair bioclassifications have been found at most of these locations. However, Good/Fair bioclassifications have been recorded from Island and Little Island Creeks and a Poor bioclassification was assigned to an unnamed tributary to (UT) Anderson Creek below the Vulcan Materials-Greystone quarry. Fair bioclassifications were given to three locations on Nutbush Creek above and below the Henderson WWTP during an intensive investigation conducted there in 1994.

Table 4.14 Benthic Macroinvertebrate Data Collected Collected from 1983 through 1994 in Subbasin 06

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Island Cr, SR 1445, Granville	/B-1	23-4	08/94	-/17	-/5.10	Good-Fair
L Island Cr, SR 1342, Vance	7/B-2	23-4-3	05/88	-/21	-/4.88	Good-Fair
Nutbush Cr, NC 39 ab WWTP, Vance	8/B-3	23-8-(1)	11/94	58/12	6.80/6.07	Fair
			10/94	54/12	6.83/5.67	Fair
			05/88	43/6	7.25/6.53	Poor
Nutbush Cr, below WWTP, Vance	/B-4	23-8-(1)	11/94	48/7	7.19/6.20	Fair
Nutbush Cr, SR 1317, Vance	9/B-5	23-8-(1)	10/94	50/8	6.60/6.20	Fair
			08/94	44/8	6.62/6.73	Fair
			05/88	35/3	7.97/6.31	Poor
Anderson Cr, I-85, Vance	19/B-6	23-8-6-(1)	02/90	49/13	6.95/5.71	Fair
UT Anderson Cr, NC 1/158 be Quarry, Vance	20/B-7	23-8-6-(1)	02/90	18/2	7.55/7.75	Poor

Ecological health ratings have been assigned to three locations in this subbasin based on fish community structure analyses (presented in Table 4.15). These three locations are Grassy, Island, and Nutbush Creeks. All sites in this subbasin received an ecological health rating of Good. However, the data from Grassy Creek and Nutbush Creek indicate some problems. Both of these sites were deficient in the numbers of species, darters, suckers, and intolerant species. Fish tissue samples were collected at one location at Kerr Lake within this subbasin. Fish tissue data from this location failed to detect organic compounds or metals above the EPA recommended screening value or the FDA criteria for fish consumption.

Table 4.15 Basin Fish Community Assessment Sites in Roanoke Subbasin 06, North Carolina Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi^2)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Grassy Cr	SR 1436	61	940602	Granville	48	Good	NCDWQ
F-2	Island Cr	SR 1445	35	940620	Granville	48	Good	NCDWQ
F-3	Nutbush Cr	SR 1317	7	941004	Vance	48	Good	NCDWQ

Roanoke River Basin
Subbasin 030206

Legend

- (A) Ambient Monitoring Station
- (L) Lake Assessment
- (F) Fish Community
- (T) Fish Tissue
- (B) Benthic Macroinvertebrate Ambient Station

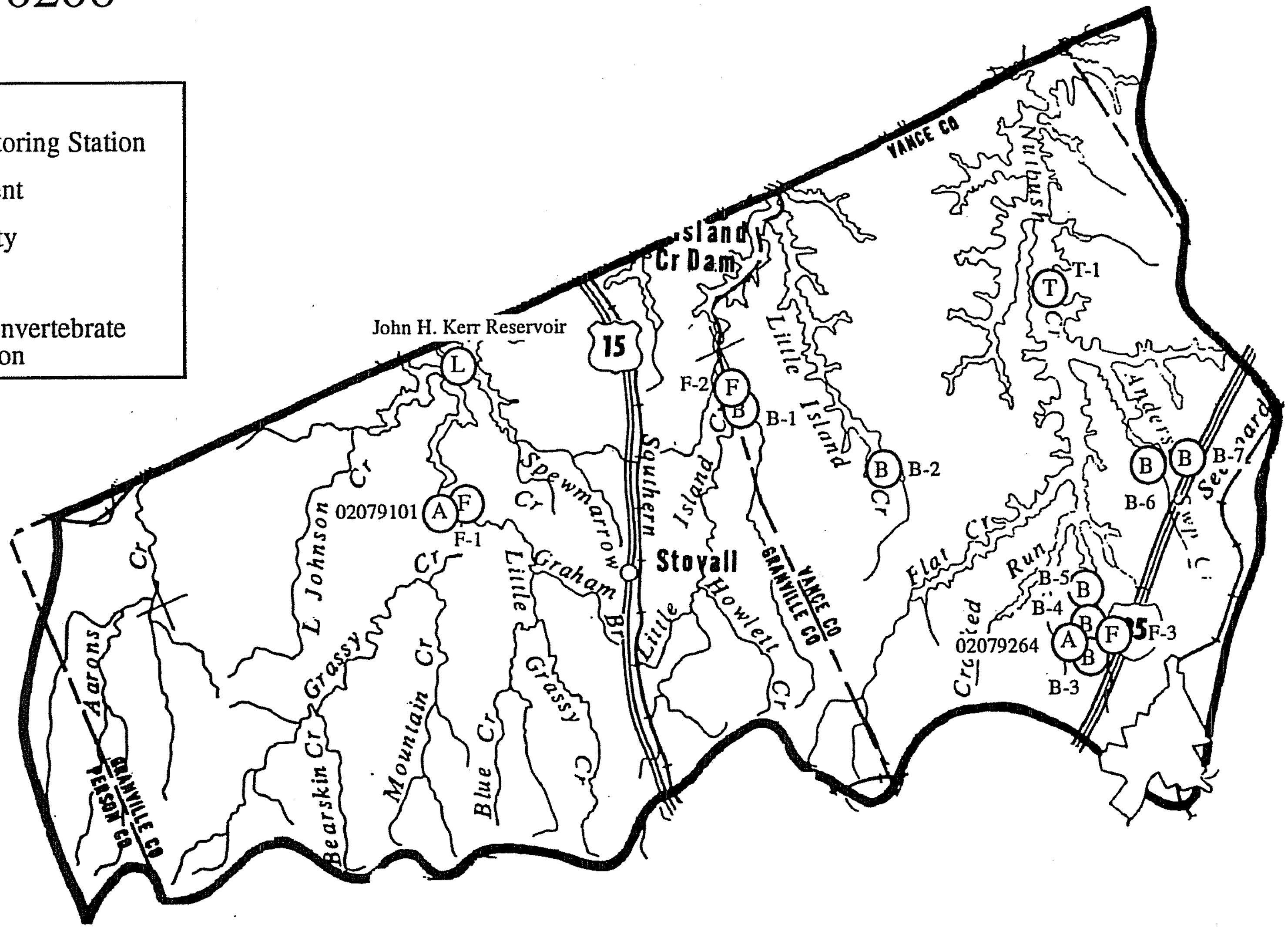


Figure 4.16 DEM Monitoring Stations in Subbasin 06

The Nutbush arm of Kerr Reservoir has been monitored by DWQ six times since 1982 as part of DWQ's lake monitoring program. The most recent investigation (1994) showed low levels of nutrients, low chlorophyll *a* values and a mean Secchi depth measurement of 1.9 meters. The lake has historically been borderline between mesotrophic and eutrophic. The lake, with a TSI of -1.9, is currently ranked as mesotrophic. Kerr Reservoir is currently classified WS-III, B, C and was identified as Threatened in the 1992-1993 305(b) Report due to elevated nutrients (total phosphorus), phytoplankton blooms, and elevated dissolved oxygen.

4.4.7 Subbasin 07 - Lake Gaston and Tributaries

Description

This subbasin is located within the piedmont ecoregion and consists mainly of Lake Gaston and many small tributaries to the lake. Land use in the area is a combination of agriculture and forestry. There are no large (≥0.5 MGD) dischargers in this subbasin. Figure 4.17 shows the sampling locations in this subbasin.

Overview of Water Quality

Macroinvertebrate and fish community surveys were done on Smith Creek and Sixpound Creeks in this subbasin (see Tables 4.16 and 4.17 below). Smith Creek is potentially affected by nonpoint source runoff with additional input from the Warren County Welcome Center WWTP discharge (0.01 MGD) by way of a tributary, Blue Mud Creek. At the time of this writing, this was the only permitted discharge in subbasin 07. Although the fish data produced a higher rating (Good) than the macroinvertebrate data (Fair), the fish data did give indications of habitat degradation. Sixpound Creek also appears to show the effects of nonpoint runoff as both the macroinvertebrate and fish data indicated similar ratings, Fair and Fair-Good, respectively.

Table 4.16 Benthic Macroinvertebrate Data Collected from 1983 through 1994 in Subbasin 07

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Smith Cr, US 1 nr Paschal, Warren	H/B-1	23-10	08/94	53/6	6.94/6.15	Fair
			07/89	59/12	6.75/5.06	Fair
			07/86	56/10	6.22/5.13	Good-Fair
			08/84	56/12	6.41/5.31	Good-Fair
Sixpound Cr, SR 1306, Warren	-/B-2	23-13	08/94	-/12	-/5.32	Fair

Table 4.17 Basin Fish Community Assessment Sites in Roanoke Subbasin 07, North Carolina Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi²)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Smith Cr	US 1	53	940512	Warren	50	Good	NCDWQ
F-2	Six Pound Cr	SR 1306	10	940512	Warren	46	Fair-Good	NCDWQ

Ambient water chemistry is collected in this subbasin at the Smith Creek sampling location. Median conductivity values have shown a slight increase since 1990, while median dissolved oxygen values have shown a decrease during the same time period.

Lake Gaston is the only lake sampled in subbasin 07. It is ranked as oligotrophic because of the 1994 TSI score of -2.5. Lake Gaston has been shown to have low to moderate nutrient levels since 1982 and is considered partially supporting its uses due to aquatic macrophyte infestation. The lake has prolific growths of aquatic weeds, expecially hydrilla, which is continuing to expand.

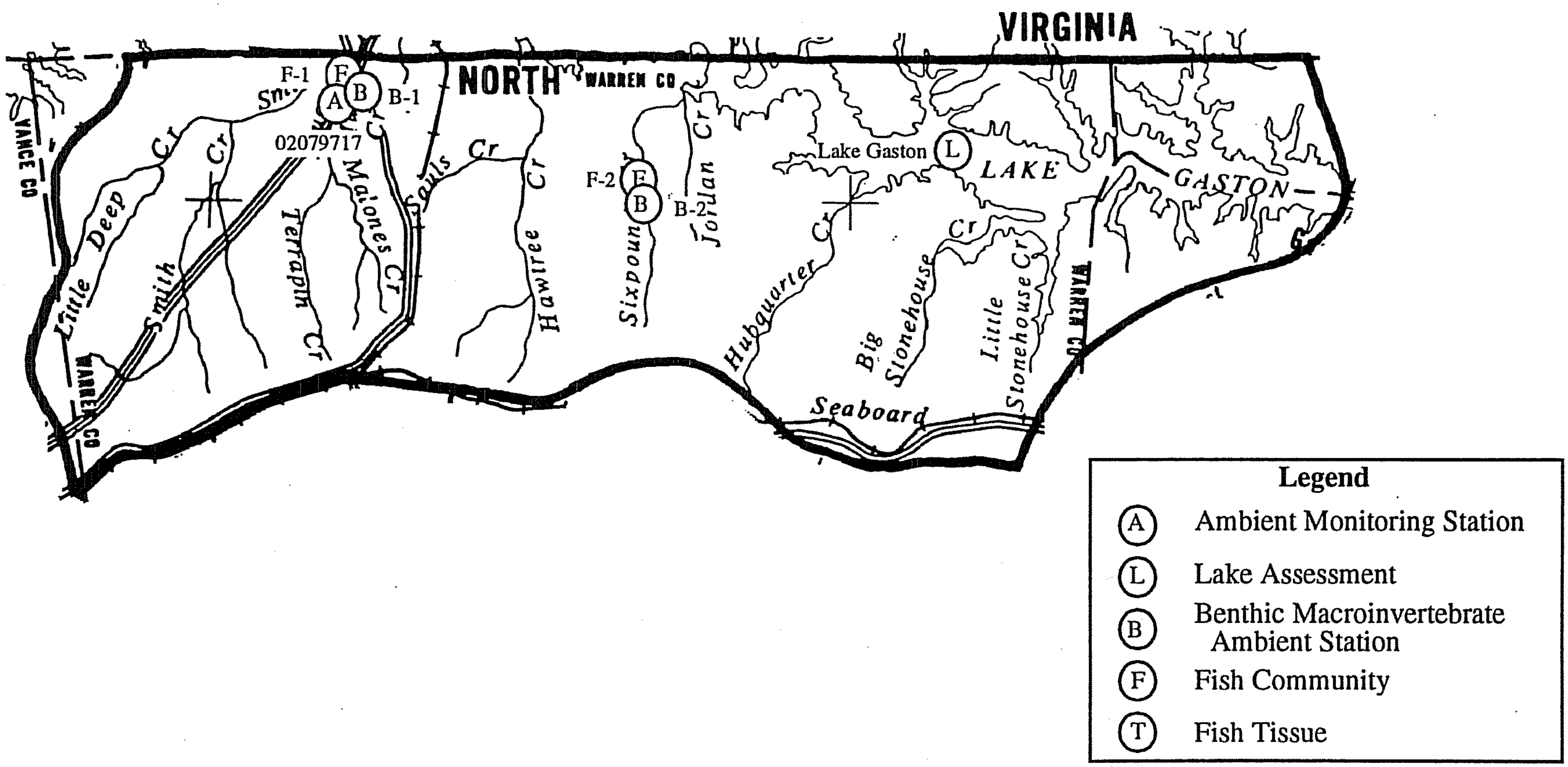


Figure 4.17 DEM Monitoring Stations in Subbasin 07

4.4.8 Subbasin 08 - Roanoke Rapids Lake and the Roanoke River

Description

The upper areas of this subbasin are within the piedmont ecoregion, while the lower portions are within the coastal plain. The main water bodies are Roanoke Rapids Lake and approximately 60 miles of the Roanoke River. With the exception of the Roanoke Rapids/Weldon urban area, most of the land use in the subbasin is forest land or agriculture. Figure 4.18 shows the locations of the sampling sites in this subbasin.

Overview of Water Quality

The main stem Roanoke River has been assigned Good bioclassifications based on macroinvertebrate data from two locations. These data are presented in Table 4.18. The Good ratings indicate that although there are several large dischargers potentially impacting the river, their effluents were not having much effect on the macroinvertebrate community in the Roanoke River. Deep Creek, located in the piedmont portion of this subbasin, was assigned a Good-Fair bioclassification. Another tributary to the Roanoke River, Quankey Creek, is located in the transitional zone between the piedmont and coastal plain, and was rated with coastal plain criteria. This stream had a Fair bioclassification. Sampling for macroinvertebrates and assigning water quality ratings to many of the streams in the coastal plain section of this subbasin is complicated by the swampy nature of these streams and the lack of flowing water in them during the summer months.

Table 4.18 Benthic Macroinvertebrate Data Collected from 1983 through 1994 in Subbasin 08

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Deep Cr, US 158, Halifax	-/B-1	23-24-(1)	08/94	64/13	6.44/5.65	Good-Fair
Roanoke R, be US 158 be Weldon, Halifax	-/B-2	23-(26)	09/94	45/16	5.20/4.48	Good
Roanoke R, US 258, Scotland Neck, Halifax	I/B-3	23-(26)	09/94	45/16	4.87/4.26	Good
			07/87	46/12	5.82/4.74	Good-Fair
			07/85	49/16	5.91/4.81	Good
Quankey Cr, ab WWTP, Halifax	-/B-4	23-30	12/92	51/7	6.39/5.69	Fair
Quankey Cr, be WWTP, Halifax	-/B-5	23-30	12/92	57/9	6.28/5.28	Fair
Conoconnara Swp, NC 561, Halifax	1/B-6	23-33	07/84	39/3	7.47/6.26	NR

Fish community surveys (see Table 4.19) were also conducted on two of the tributary locations from which macroinvertebrate data was collected, Deep Creek and Quankey Creek. The fish data suggested a slightly higher (Good) ecological health rating for Deep Creek than did the macroinvertebrate data (Good-Fair), but indicated the same Fair rating for Quankey Creek. Two other tributaries receiving Fair ecological health ratings based on fish data included Conoconnara Swamp and Kehukee Swamp.

Table 4.19 Basin Fish Community Assessment Sites in Roanoke Subbasin 08, North Carolina Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi^2)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Deep Cr	US 158	24	940921	Halifax	50	Good	NCDWQ
F-2	Quankey Cr	SR 1619	32	940921	Halifax	44	Fair	NCDWQ
F-3	Conoconnara Cr	NC 561	36	940921	Halifax	40	Fair	NCDWQ
F-4	Keehuckee Cr	SR 1804	19	941027	Halifax	46	Fair-Good	NCDWQ

In July of 1995 there was a fish kill in the area of the Roanoke River just below Roanoke Rapids dam known as the "Potholes" area. This area was the original river channel before construction of the dam, and it is flooded when the spillway gates at the dam are opened. When

Roanoke River Basin
Subbasin 030208

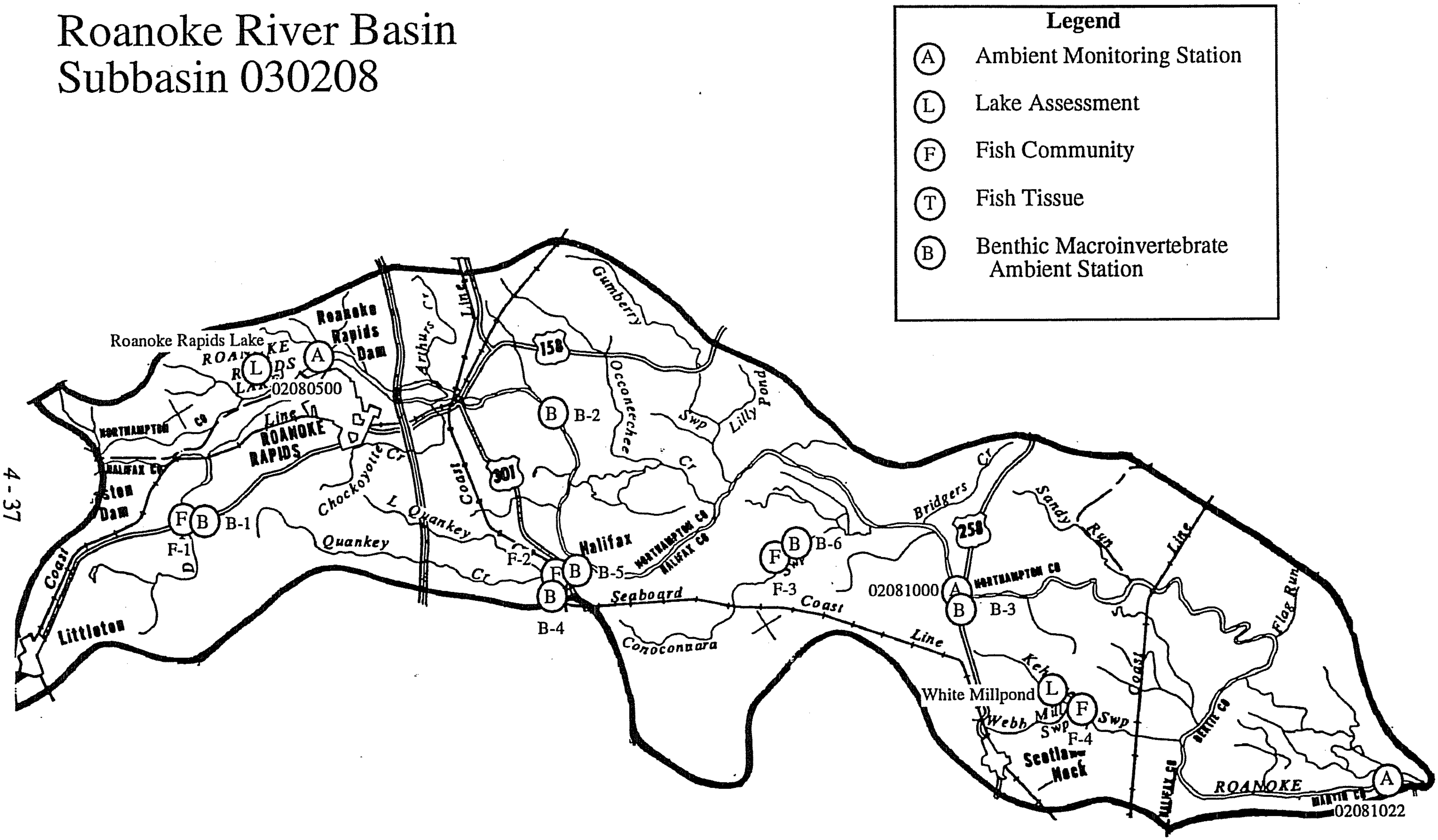


Figure 4.18 DEM Monitoring Stations in Subbasin 08

the spillway gates are closed, water levels in the potholes recede quickly and strand fish that were attracted to the area during the high flows (Kornegay and Jones, 1995). This situation occurred in the summer of 1995 as the result of large rainfall events. Fish stranded in the pools below the dam were killed as temperatures increased to intolerable levels for the fish. Approximately 2,250 of the fish killed during this event were striped bass. (Kornegay and Jones, 1995)

Fish tissue samples have been collected from four Roanoke River sites in this subbasin. Some of the samples from two locations, near Weldon and Scotland Neck, had organic contaminants above detection limits. Several from the Weldon location exceeded EPA screening values. Four samples from the Roanoke River near Weldon also exceeded EPA and FDA criteria for mercury.

Three chemical/physical characterizations have been carried out on sections of the river in the subbasin since 1983. These studies indicated no unusual water quality problems. Ambient chemistry data from the Roanoke River at Roanoke Rapids, near Scotland Neck, and near Lewiston, also have not suggested any significant water quality problems.

Roanoke Rapids Reservoir and White Millpond are the two lakes monitored in subbasin 08. Roanoke Rapids Reservoir is partially supporting its designated use primarily due part to large growths of aquatic plants. Samples collected since 1983 have shown low to moderate nutrient levels in the reservoir. White Millpond has been sampled twice since 1988 and has and continues to experience hypereutrophic conditions. The pond is considered as support threatened due to elevated nutrients, algal blooms, and aquatic macrophyte (duckweed) growths.

Sediment Oxygen Demand (SOD) studies were conducted at four locations in the Roanoke River in 1993. The results of the studies indicated no demand for the site near Odom, but an oxygen demand was indicated for the sites near Weldon, Scotland Neck, and Perdue.

4.4.9 Subbasin 09 - Lower Roanoke River

Description

This subbasin is located in the coastal plain ecoregion of the state. The two largest towns in subbasin 09 are Williamston and Plymouth. Primary land uses in the area are agriculture and forest. Figure 4.19 shows the locations of the sampling sites in this subbasin.

Overview of Water Quality

Based on macroinvertebrate data (Table 4.20), the Roanoke River has been assigned Good bioclassifications from the upper end of this subbasin to below Williamston. The lower section

~~Table 4.20 Benthic Macroinvertebrate Data Collected Collected from 1983 through 1994 in~~ Subbasin 09

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Roanoke R, nr NC 125/903, be Hamilton, Martin	-/B-1	23-(26)	09/94	51/19	5.20/4.37	Good
Roanoke R, US 17 bel Williamston, Martin	-/B-2	23-(26)	09/94	53/17	5.70/4.79	Good
Conoho Cr, SR 1415, Martim	-/B-3	23-49	08/94	23/0	7.34/-	NR
Roanoke R, NC 45 nr Sans Souci, Bertie	K/B-4	23-(53)	09/94	52/9	7.56/6.29	Good-Fair
			06/92	60/8	7.53/6.02	Good-Fair
			07/90	51/10	7.48/6.23	Good-Fair
			07/88	62/7	7.92/6.68	Good-Fair
			07/86	50/8	7.68/6.77	Good-Fair
			07/85	37/4	8.16/6.50	Fair-Poor
			07/84	43/6	7.63/6.18	Fair-Poor
			07/83	38/6	8.07/5.42	Fair-Poor
Conaby Cr, SR 1114, Washington	-/B-5	23-56	04/94	68/5	7.03/5.89	NR
Conaby Cr, SR 1325, Washington	-/B-6	23-56	04/94	41/0	7.69/-	NR

Roanoke River Basin
Subbasin 030209

Legend

- (A) Ambient Monitoring Station
- (L) Lake Assessment
- (F) Fish Community
- (T) Fish Tissue
- (B) Benthic Macroinvertebrate Ambient Station

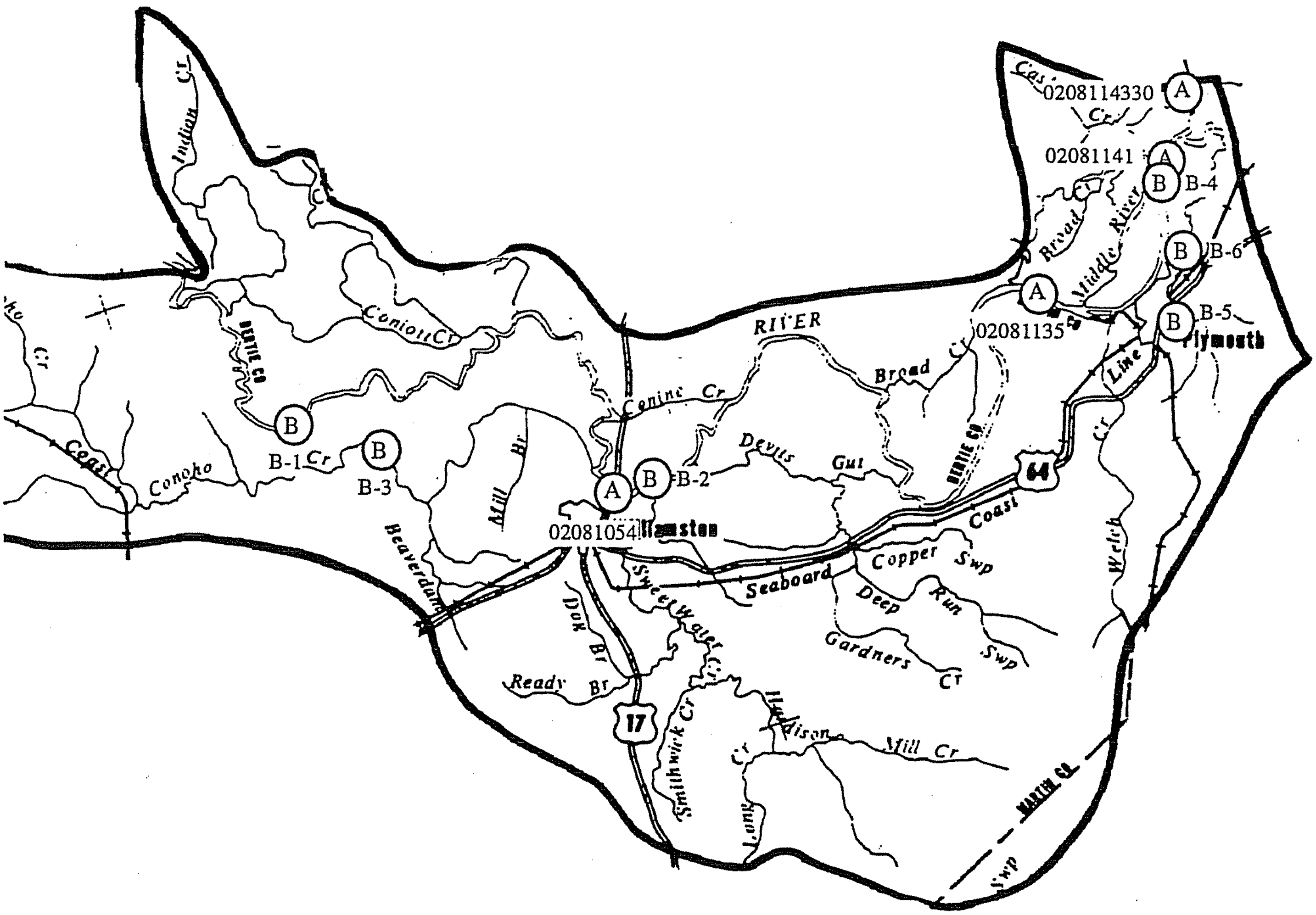


Figure 4.19 DEM Monitoring Station in Subbasin 09

of the river near, the Plymouth and Sans Souci area, 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 Sans Souci area has produced a Good-Fair bioclassification in this section of the Roanoke River. Tributaries to the Roanoke River in subbasin 09, such as Conoho Creek and Conaby Creek are swampy and may experience periods of very little or no flow. Therefore, they were not rated.

Fish tissue samples have been collected from six sites on the Roanoke River in this subbasin. The Roanoke River from Williamston to the mouth remains under a fish consumption advisory due to dioxin contamination. Only one of the samples analyzed for organics from both Hamilton and Jamesville was over the EPA screening values. One sample from the Jamesville location also exceeded the EPA criteria for mercury. Sites near Sans Souci and the mouth of the river had more samples with organics levels over the EPA screening values. The Roanoke River near Williamston had the highest percentage of samples with elevated mercury values, with 29 out of 41 samples having mercury levels that exceeded both EPA and FDA criteria.

In late July and early August of 1995 a fish kill occurred in the Roanoke River between Norfleet and Jamesville. Rapid reductions in flow from Roanoke Rapids Lake caused water levels downstream to recede carrying anoxic water from adjacent wetlands into the the river channel and decreasing levels of dissolved oxygen. Approximately 7,000 striped bass and 15,875 fish of other species were killed during events of low dissolved oxygen. (Kornegay and Jones, 1995)

Ambient water chemistry has been collected from sites on the Roanoke River near Williamston, Plymouth, and Sans Souci. Although the data have shown nolong term water chemistry problems in these areas, other water quality indicators, such as fish kills and self-monitoring data from Weyerhauser, provide evidence of problems with low dissolved oxygen levels.

Some areas in this lower basin, including Conaby Creek, experienced dense growth of alligatorweed which can cause navigational problems and result in depressed oxygen levels below the dense mats. The Division of Water Resources is working to treat these growths.

4.4.10 Subbasin 10 - The Cashie River and Tributaries

Description

This subbasin is located entirely within the coastal plain and consists of the Cashie River and its tributaries. Land use in the area is primarily forest and a mix of agricultural activities. Windsor is the largest town in subbasin 10. Figure 4.20 shows the sampling sites in this subbasin.

Overview of Water Quality

Assigning bioclassifications based on macroinvertebrate data to streams in this subbasin is difficult due to the swampy characteristics of the streams and stagnant water conditions common in this area. The only stream sampled for macroinvertebrates in subbasin 10 was the Cashie River at Sans Souci. These data are presented in Table 4.21. Old macroinvertebrate data from the upper segments of the river have indicated low water quality, but recent studies of swamp streams suggest that the old ratings assigned may be inaccurate. The current downstream site on the Cashie River at Sans Souci was rated using draft coastal plain B criteria (criteria specific to non-flowing coastal systems) and was assigned a Good-Fair rating. This rating suggests a downstream improvement in water quality for the river.

Roanoke River Basin
Subbasin 030210

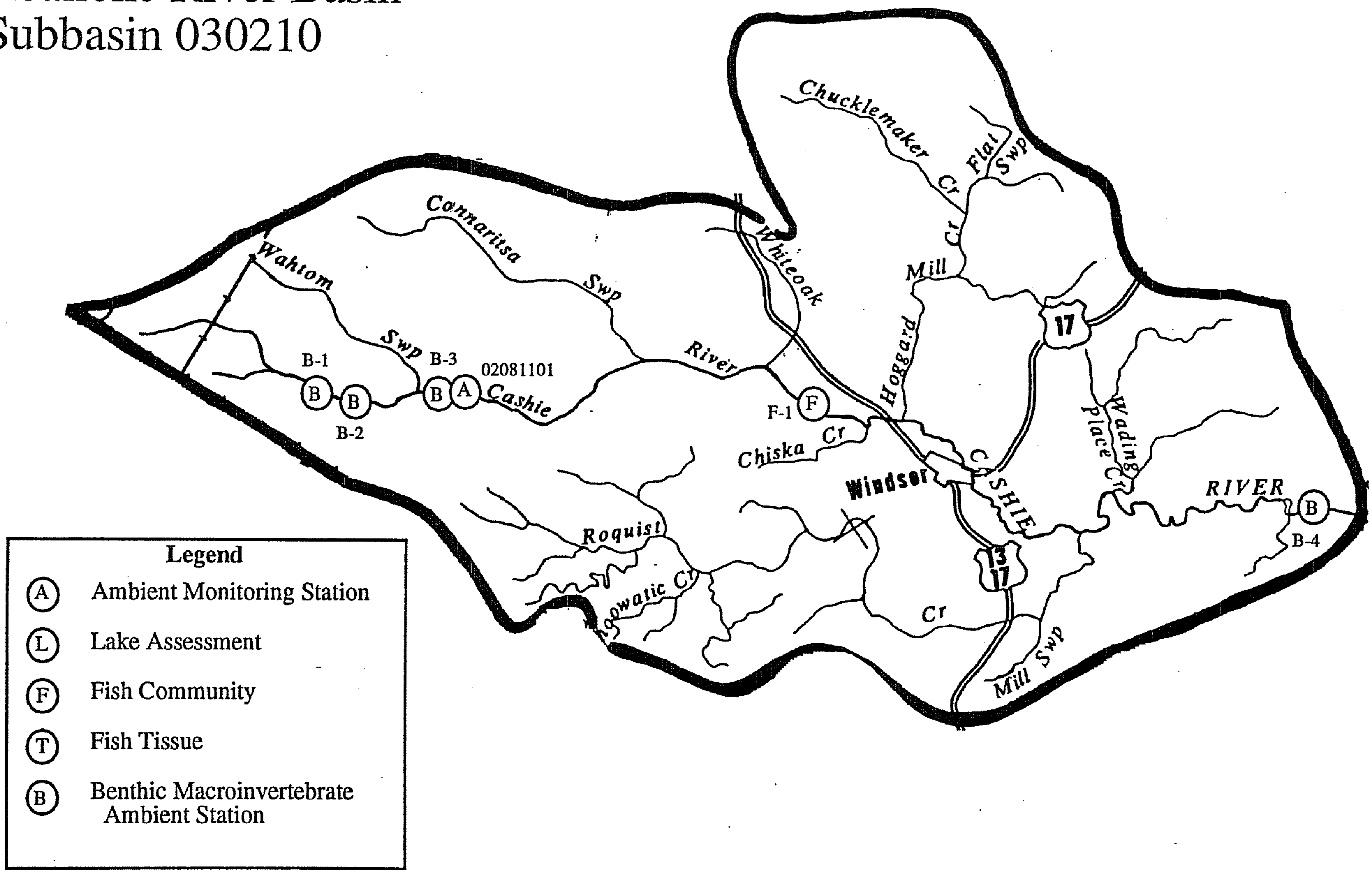


Figure 4.20 DEM Monitoring Stations in Subbasin 10

Table 4.21 Benthic Macroinvertebrate Data Collected Collected from 1983 through 1994 in Subbasin 10

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Cashie R ab WWTP, Bertie	2/B-1	24-2	06/84	37/0	8.61/-	Poor
Cashie R be WWTP, Bertie	3/B-2	24-2	06/84	41/0	8.39/-	Poor
Cashie R, SR 1219, nr Lewiston, Bertie	J/B-3	24-2	06/84	43/2	8.22/7.00	Poor
			07/83	34/2	8.54/7.00	Poor
Cashie R, SR 1500 at San Souci, Bertie	-/B-4	24-2-(9)	09/94	56/9	8.13/6.34	Good-Fair

A fish community analysis was conducted in 1994 at an upstream location on the Cashie River. The site was assigned a Fair rating with extremely low dissolved oxygen levels and stagnant water recorded at the time of sampling. The same conditions were noted in 1984 during a chemical/physical characterization of the area. Current ambient chemistry data from the Cashie River near Lewiston has continually noted low dissolved oxygen levels, with 63 percent of the measurements taken between 1990 and 1994 being below the state criterion of 4.0.

Table 4.22 Basin Fish Community Assessment Sites in Roanoke Subbasin 10, North Carolina Index of Biotic Integrity (NCIBI) Scores and Ratings.

Site	Stream	Location	Drainage Area(mi^2)	Date	County	NCIBI Score	NCIBI Rating	Collector
F-1	Cashie R	SR 1257	108	941026	Bertie	40	Fair	NCDWQ

4.5 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.5.1 Introduction to Use Support

Determining the *use support* status of a waterbody, (that is, how well a waterbody supports its designated uses), is another important method of interpreting water quality data and assessing water quality. Use support assessments are presented in this Section using figures, tables and maps for freshwater streams, lakes and estuaries within the Roanoke River Basin.

Surface waters (streams, lakes or estuaries) are rated as either *fully supporting* (S), *support-threatened* (ST), *partially supporting* (PS), or *nonsupporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and swimming) are being fully supported, partially supported or are not supported. For instance, saltwaters classified for commercial shellfish harvesting (SA) would be rated as fully supporting if bacterial levels in the water were low enough to allow harvesting (≤14 MPN). However, if fecal coliform bacteria levels were too high to allow shellfish to be harvested (>14 MPN), but not too high to prevent swimming (<200 MPN), then the waters would be rated as partially supporting since they only support the swimming. If the waters were impacted to the point that even swimming was disallowed, the waters would be rated as nonsupporting. Streams rated as either partially supporting or nonsupporting are considered *impaired*. The support-threatened category for freshwater rivers and streams refers to those waters classified as good-fair based on water quality data, in contrast to excellent or good which are considered fully supporting. An overall fully supporting rating, however, does include both fully supporting and support-threatened waters. Streams which had no data to determine their use support were listed as non-evaluated (NE).

For the purposes of this document, the term *impaired* refers to waters that are rated either partially supporting or not supporting their uses based on specific criteria discussed more fully below. There must be a specified degree of degradation before a stream is considered impaired.

This differs from the word impacted, which can refer to any noticeable or measurable change in water quality, good or bad.

4.5.2 Interpretation of Data

The assessment of water quality presented below involved evaluation of available water quality data to determine a water body's use support rating. In addition, an effort was made to determine likely causes (e.g., sediment or nutrients) and sources (e.g., agriculture, urban runoff, point sources) of pollution for waters that did not support their designated uses (i.e., those found to be either partially or nonsupporting). These data consisted of biological and chemical ratings, reports of citizen complaints, responses to mailings requesting water quality information, land-use reviews of topographic maps, and best professional judgment (see Data Analysis Methodology section for more details). By including best professional judgments (i.e., perceived water quality problems) in deciding the overall water quality ratings and the potential sources of pollution, a much broader, but less precise, picture of water quality conditions in the basin was developed.

Interpretation of these data compiled by DWQ should be done cautiously. The methodology used to acquire the numbers must be understood, as should the purpose for which the numbers were generated. The intent of this use-support assessment was to gain an overall picture of the relative contribution made by different categories of pollution within the Cape Fear basin. In order to comply with guidance received from EPA to identify likely sources of pollution for all impaired stream mileage, DWQ used the data mentioned above.

The data are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Since the assessment methodology is geared toward general conclusions, it is important to not manipulate the data to support policy decisions beyond the accuracy of these data. For example, according to this report, nonpoint source pollution is thought to be the most widespread source of the impairment of water quality. However, this does not mean that there should be no point source control measures. As discussed in previous sections of this chapter, and in Chapter 6, many stream miles in the basin are impacted by point source dischargers, but the degree of impact has not resulted in a partial or nonsupport rating. What is clear from the plan is that all categories of point and nonpoint source pollution have the potential to cause significant water quality degradation if proper controls and practices are not utilized.

This threat to water quality from all types of activities heightens the need for point and nonpoint source pollution control. It is important to not neglect any source (or potential source) of pollution in developing appropriate management and control strategies. Data exist which document water quality problems from every major pollution category that has been considered in this report. Certainly, the potential for further problems remains high as long as the activity in question continues carelessly. Because of this potential, neglecting one pollution source in an overall control strategy can mask the benefits achieved from controlling all other sources.

4.5.3 Assessment Methodology - Freshwater Bodies

Many types of information were used to make use support assessments and to determine causes and sources of use support impairment. Chemical, physical and biological data as well as wastewater treatment plant self-monitoring data and toxicity data were the primary sources of information used to make use support assessments. Information was also obtained from other agencies, workshops, and pertinent reports.

The most recent water quality chemical data (January 1988 through August 1993) were interpreted for use support utilizing the STAND(ards) program available through the STORET system. The program determines water quality standard violations and computes percentages of the values in violation based on applicable North Carolina water quality standards. According to EPA guidance, use support determinations based on chemical data are to be made as follows:

Fully Supporting - for any one pollutant, criteria exceeded in ≤ 10% of the measurements,
Partially Supporting - for any one pollutant, criteria exceeded in 11- 25% of the measurements, and
Not Supporting - for any one pollutant, criteria exceeded in > 25% of the measurements.

The following parameters were evaluated in the STAND(ards) program: dissolved oxygen (surface values), temperature, pH, turbidity, fecal coliform bacteria (exceedance of 200 MF/100 ml geometric mean), chlorophyll *a*, ammonia, arsenic, cadmium, chromium, copper, lead, nickel, mercury, zinc, chloride, fluoride and selenium.

Another valuable data source used for the report was biological rankings from 1983 through 1994 as determined from benthic macroinvertebrate surveys discussed in section 4.2. The most recent report on these surveys (NCDEHNR, DEM 1995) is available from DWQ's Environmental Sciences Branch. Data from North Carolina's Biological Monitoring Ambient Network (BMAN), in addition to special macrobenthic studies were ranked on a five point scale. This scale is based on taxa richness for the three pollution intolerant groups of macroinvertebrates: Ephemeroptera, Plecoptera and Trichoptera (EPT).

Collected specimens are identified to the lowest possible taxonomic level. Total species (or taxa) richness values for the EPT groups are calculated and biological classifications assigned to each station (Excellent, Good, Good-Fair, Fair or Poor). Higher species richness values are associated with better water quality. For ranking purposes, stations classified as "Poor" with regard to biological data are rated not supporting (NS) and stations classified as "Fair" are rated partially supporting (PS). Stations classified as "Good-Fair" are rated as support-threatened (ST) and those having a Good to Excellent biological classification are rated as supporting their designated uses (S).

Other types of DWQ-collected data used to make use support assessments were toxicity data related to discharging facilities, fish tissue and fish community structure data and phytoplankton bloom information. In addition, fish consumption advisories and information from other agencies, workshops held in 1987 and pertinent reports were utilized. In general, stream segments which received a discharge from a facility significantly out of compliance with permit limits or failing their whole effluent toxicity test were rated as support-threatened, unless water quality data indicated otherwise. Streams which had a fish consumption advisory in place were rated as partially supporting. Assessments were made on either a monitored (M) or evaluated (E) basis. A *monitored* basis represents data which are less than five years old. An *evaluated* basis refers to the use of best professional judgment or data older than five years. Overall ratings were determined for stream segments as follows:

1. *Biological ratings* generally were preferred over any other source of information since they are a direct measurement of aquatic life support.
2. *Chemical ratings* (when biological ratings were unavailable) were preferred over information from older reports or information from workshops.
3. *Workshop "evaluations"* or best professional judgments were preferred over information from older reports.
4. Information from older reports was used when no other information was available.

After overall ratings were assigned, probable sources of pollution (point or nonpoint) for partially supporting and nonsupporting streams were sought. Information on point sources, such as permit compliance records, was reviewed in order to identify major and minor dischargers potentially affecting streams. The Aquatic Survey and Toxicology Unit was also consulted to identify facilities known to have toxic effects based on chronic and acute toxicity tests. Information related to nonpoint source pollution (e.g., agricultural, urban and construction) was obtained from other agencies (federal, state and local), citizens, land-use reviews and best professional judgment.

Causes of use support impairment, such as sedimentation and low dissolved oxygen, were also identified for specific stream segments. For ambient water quality stations, those parameters which exceeded the water quality standard >10% of the time for the review period were included as probable causes. For segments without ambient stations, information from reports, other agencies and best professional judgment were used. In general, facility self-monitoring data and facility aquatic toxicity data were not included in the cause or overall problem parameter column since these data may not reflect instream conditions occurring during the reporting period because they are based on 7Q10 conditions.

Once all monitored and evaluated information was located on water basin maps, remaining "unassessed" streams and segments were evaluated to have the same use-support if they were a direct or indirect tributary to monitored or evaluated segments rated supporting and support-threatened. Partially and nonsupporting segments were not extended. US Geological Survey (USGS) 7.5 minute topographic maps (1:24,000 scale) and orthophotoquads were used to determine probable sources for all impaired streams when other sources, such as WWTP compliance data, were insufficient.

4.6 USE SUPPORT RATINGS FOR THE ROANOKE RIVER BASIN

Use Support ratings for all monitored and evaluated surface waters in the basin are presented on color-coded maps in Figure 4.21 (a, b and c - 3 pages). Use support ratings and background information for all monitored stream segments are presented in Table 4.23 (2 pages).

4.6.1 Freshwater Streams and Rivers

Of the 2,390 miles of freshwater streams and rivers in the Roanoke basin, use support ratings were determined for 92% or 2,206 miles with the following breakdown: 56% were rated fully supporting, 27% support-threatened, 9% partially supporting, and 8% not evaluated. Table 4.24 and Figure 4.22 present the use support determinations by subbasin. The data used to assess the Roanoke basin indicate that the majority of the waters are supporting their classified uses. These data include bioclassifications for macrobenthic invertebrates (54 sites), and fish community structure (26 sites), ambient data (21 sites), and compliance and toxicity data. Although the data indicates that the majority of the waters are supporting their uses, there are still problems in the basin that need to be addressed, particularly,erosion and sedimentation. A US Department of Agriculture publication notes that over 21 tons/acre/year are eroding from cultivated cropland in the Upper Dan River (US Dept. of Agriculture, Soil Conservation Service, 1992). Field teams that sampled benthic macroinvertebrates and fish noted the effects of sedimentation at many of the sites.

A decline in bioclassification was also noted at some of these sites. This decline suggests that if the problem is not addressed in the near future, the waters will become unable to support their uses and use support ratings will drop.

Probable causes and sources of impairment were determined for about 83% of the impaired streams with the information summarized in Tables 4.25 and 4.26. When a stream segment had more than one cause or source listed, the total stream segment information was added to each cause or source. This means that the miles of stream impaired by the combination of all sources or all causes may be more than the total miles of partially and not supporting streams presented in Table 4.24. As an example, if a 10-mile long stream segment was determined to be impaired as a result of both point sources and urban development, then 10 miles would be entered under both the urban column and point source column in Table 4.25. Where the sources of impairment could not be identified, no mileage for that segment was entered into the table.

Table 4.25 lists all potential sources of pollution and the affected mileage. Information on sources of impairment for stream miles rated partially supporting indicate that nonpoint sources contributed to the impairment of 180 miles of streams (83% of total impaired stream miles) and noncompliant point sources contributed to the impairment of 86 miles of streams (40% of total stream miles.) Agriculture was the most widespread nonpoint source, followed by forestry and in place contaminents (indicated as 'Other' in table 4.25.)

Table 4.26 lists all potential causes of use support impairment and affected mileage. Fish consumption advisories resulted in a partially supporting rating for 62 stream miles (29% of total impaired stream miles.) In subbasin 01 the advisory is due to elevated levels of selenium in fish tissue from the overflow of the ash basin at Duke Power Company. In subbasin 05, the advisory is due to elevated levels of selenium in fish tissue from the Carolina Power and Light coal ash settling basins located in the arms of Hyco Lake. In subbasin 10, the advisory is due to elevated levels of dioxin in fish tissue. Sediment contributed to the impairment of 38 stream miles (18% of total impaired streams.)

4.6.2 Lakes

Twelve lakes in the Roanoke basin totaling 42,268 acres were monitored and assigned use support ratings. Of these 12 lakes, five are fully supporting their uses, three are support threatened and four are partially supporting their uses. Table 4.27 lists the lakes by subbasin, describes their size, classification, trophic status and provides information on their use support status. A brief discussion of lakes not fully supporting their uses is provided below.

Belews lake, classified WSIV B C and 4,030 acres in size is located in subbasin 01. Hyco lake, classified B and 3,750 acres in size, is located in subbasin 05. Both lakes are currently rated partially supporting due to fish consumption advisories. Runoff from coal ash ponds resulted in elevated levels of selenium in fish tissue. Corrective measures to prevent further runoff have been put into place, and the lakes continue to be monitored for selenium.

Roanoke Rapids Reservoir, classified WSIV&B CA and 4,893 acres in size, is located in subbasin 08, immediately downstream from Lake Gaston. This reservoir is currently rated partially supporting due to a severe problem with aquatic macrophyte infestation which has impaired boat navigation on the lake. Lake Gaston, classified WS-IV, WS-IV CA, WS-V and B

4.6.3 Use Support Ratings for the Roanoke River in Virginia

Tables 4.28 and 4.29 provide general information on use support ratings for the Roanoke River Basin in Virginia (Virginia Department of Environmental Quality, 1994). The majority of the waters are considered fully supporting their uses, but over 40% of the waters were identified as not assessed. In the State of Virginia overall, fecal coliform bacteria were the leading cause of water quality impairment and the Roanoke River Basin is ranked as having the second highest number of river miles showing problems from elevated concentrations of fecal coliform bacteria. The second leading cause of water quality impairment in Virginia is habitat alteration, and, again, the Roanoke River Basin is among the top two river basins in that state showing impairment as a result.

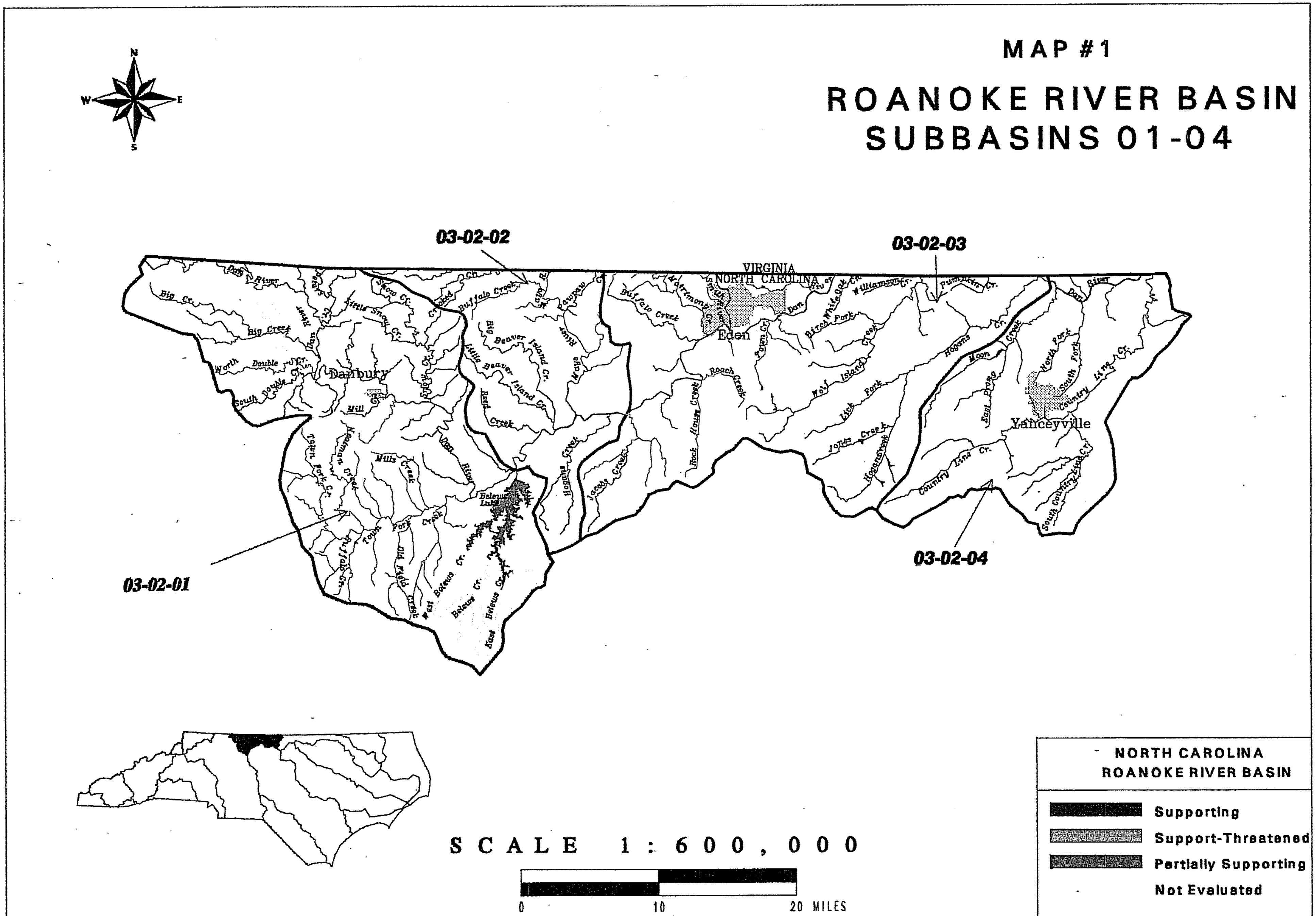


Figure 4.21a Use Support Map of the Upper Roanoke Basin (Subbasins 01 through 04)

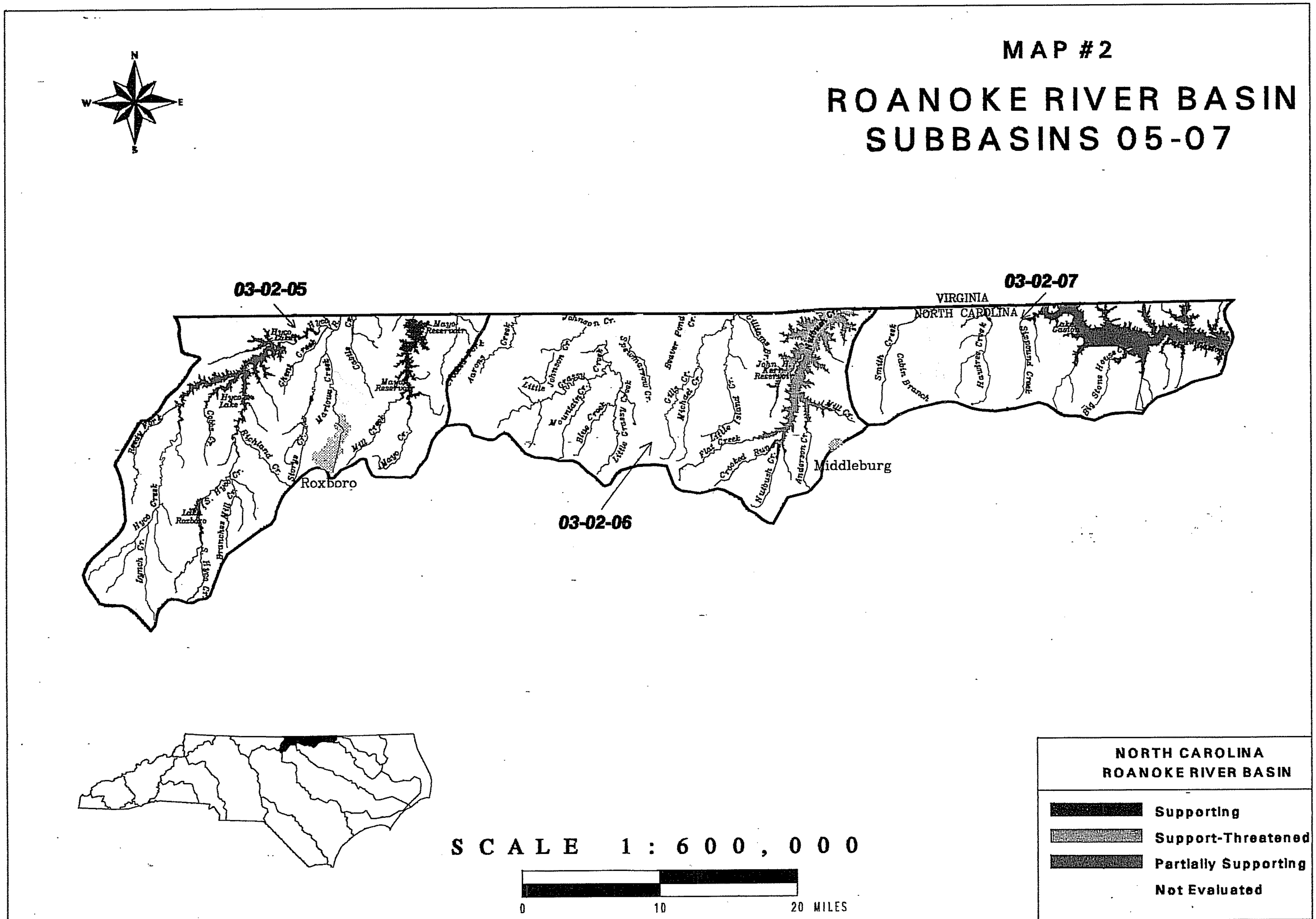


Figure 4.21b Use Support Map of the Middle Roanoke Basin (Subbasins 05 through 07)

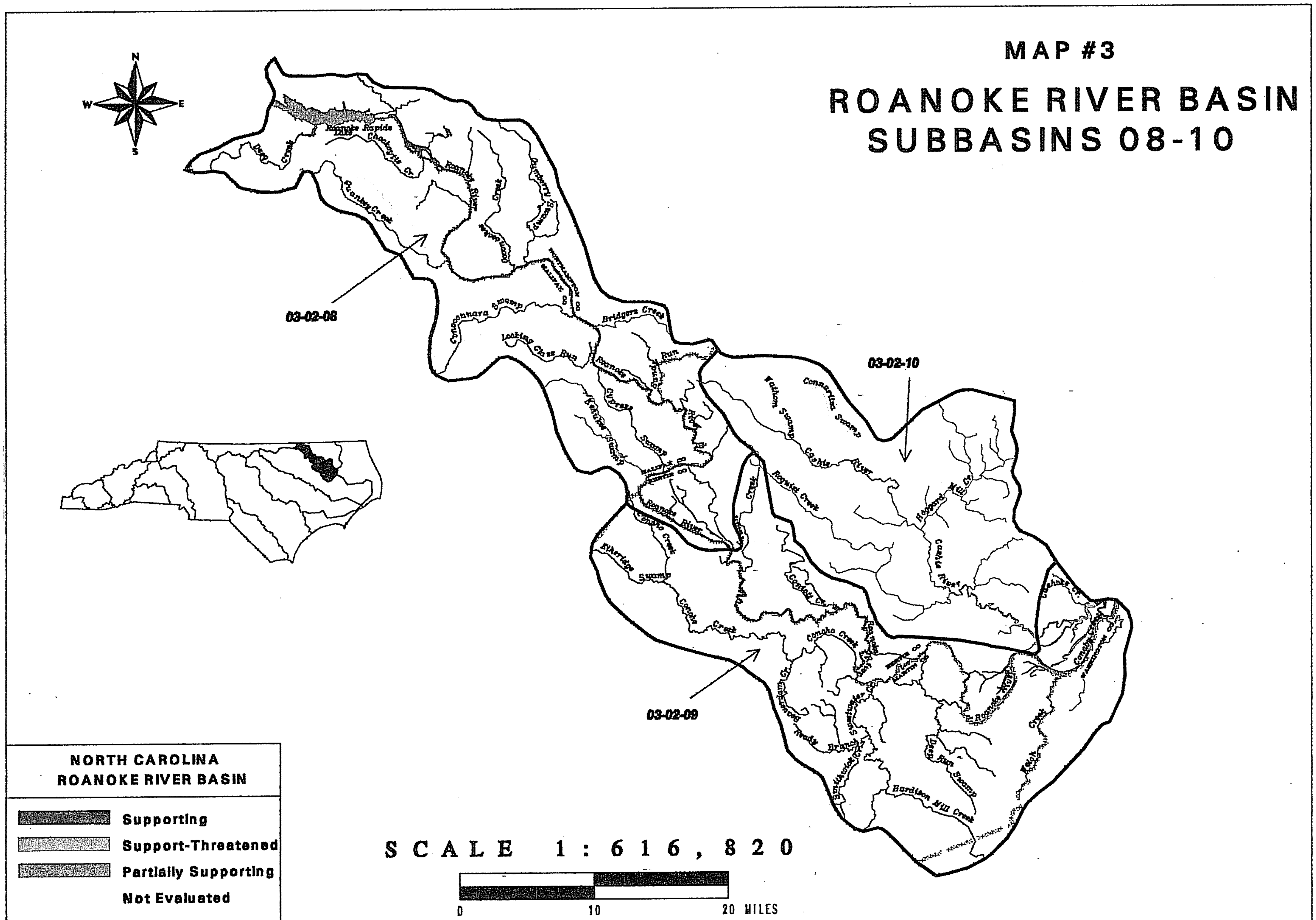


Figure 4.21c Use Support Map of the Lower Roanoke Basin (Subbasins 08 through 10)

Table 4.23 Water Quality and Use Support Ratings for Monitored Stream Segments (Sheet 1 of 2)

Station Number	Station Location	Classification	Index Number	Miles	Chem Rating 90-94	Prob. Param. 90-94	Biological Rating 90	91	92	93	94	Fish Comm.	OVERALL RATING Prob. Param.	Use Support	Potential Sources
SUBBASIN 30201															
02068500	Dan River NC 704 near Francisco, Stokes Co.	C Tr	22-(1)	19.7	NS	Turb(31)	E				G	G		S	NP
	Little Dan R off SR 1422, Stokes	C Tr	22-4	0.9								G-Ex 93		S	NP
	North Double Cr, SR 1504, Stokes	C	22-10	14.9							G-F			ST	NP
	Snow Cr. SR 1673, Stokes	WS-IV	22-20-(5.5)	6.5							G			S	NP
	Town Fork Cr, US 311 and SR 1917	WS-IV	22-25-(13.5)	4.8							G-F			ST	NP,P
	Cascade Cr, ab swimming lake, Stokes	B	22-12a	0.9			G	G		E				S	
	Cascade Cr at SR 2012 & SR 1001, Stokes Co.	B	22-12c	3.7			G	G						S	
	Indian Cr. ab & be hiking trail, & SR 1001, SR 1487 Stokes Co.	WS-III	22-13	3.1			G	E		E				S	
SUBBASIN 30202															
	Paw Paw Cr at SR 1360, Rockingham	WS-IV	22-30-6	5.1										S	NP
	Mayo R., NC 135, SR 2177, Rockingham	C	22-30-(10)	2.4							G			S	NP
02070500	Mayo River near Price, SR-1358	WS-IV	22-30-(1)a	0.8	PS	Fe(33)								S	
	Mayo River at NC 770 and 220 Bus. Rockingham Co.	WS-IV	22-30-(1)b	12.1										ST	
SUBBASIN 30203															
	Buffalo Cr SR 1515, Rockingham Co.	WS-IV	22-37	10.9								G-93		S	NP
	Dan River at NC 89, SR 1486, 1668, 1652, Stokes	WS-V	22-(8)	13.1								G 92/93		S	P
	Dan River SR 1695, Stokes	WS-IV	22-(19.5)	22.1							G			S	P
02071000	Dan River at SR 2150 nr Wentworth, Rockingham	WS-IV	22-(31.5)	14.6	NS	Fecal, Turb(13)								ST	
						Fe(61), Cu(13)									
02074000	Smith River at NC Hwy 14 at Eden	WS-IV	22-40-(1)	2.8	S	Cu (30)	G-F				G-F			ST	
	Wolf Island Creek NC 700 at Pelham, NC	C	22-48	22.9								G-Ex		S	
SUBBASIN 30204															
	Moon Cr at SR 1511, Casewell	C	22-51	19.0								G		S	NP
	Country Line Cr., NC 57 Caswell	C	22-56-(6)	25.2			G				G-F	G		S	NP,P
02074218	Dan River at SR 1761 nr Mayfield, Rockingham	C	22-(39)a	12.2	PS	Fecal, Turb(24)		E						ST	
						Cu(31),Fe(40)									
02075198	Dan River at Milton, NC-VA State Line	C	22-(39)b	31.2	PS	Turb(25)								S	
						Cu(36), Fe(50)									
	Cane Cr at SR 1527	C	22-54	0.7								G		S	
SUBBASIN 30205															
02077200	Hyco Creek near Leesburg, U.S. Hwy 158, Caswell	C	22-58-1	18.5	S	Cu(17), Fe(60)	G-F				*F			ST	NP
02077303	Hyco River near McGhees Mill, below Bay Dam	C	22-58-(9.5)	22.8	S	Cu(11),Fe(36)								S	NP
02077670	Mayo Creek at SR 1501 nr Bethel Hill	C	22-58-15	18.7	S									S	NP
02077348	Marlowe Creek SR 1322, near Woodsdale	C	22-58-12-6	2.7	NS	Cu(92),Fe(13)					F	F	Cu,Sed	PS	P,NP
SUBBASIN 30206															
	Anderson Creek at I-85, Vance Co.	WS-III&B	23-8-6-(1)	4.0			F							PS	NP
02079264	Nutbrush Creek near Henderson at NC 39, Vance Co.	C	23-8-(1)	2.0	ST	Cu(25)					F	G		PS	NP,P
	Grassy Cr at SR 1436, Granville	C	23-2-(1)	18.5								G		S	
	Island Cr SR 1445, Granville	C	23-4	8.2							G-F	G		ST	
SUBBASIN 30207															
02079717	Smith Creek, US 1, nr Paschal, Warren	C	23-10	11.6	NS	Fe(77)					F	G	Sed	PS	NP
	Sixpound Cr, SR 1306, Warren	C	23-13	7.6							F	G-F		ST	NP
SUBBASIN 30208															
	Conconnara Swamp at NC 561, Halifax Co.	C	23-33	17.8								F		PS	NP
02081000	Roanoke River at Scotland Neck, NC Hwy. 258	C	23-(26)b	28.3	S	Fe(30)					G			S	NP,P
02081054	Roanoke River at Williamston, U.S. Hwys. 13/17	C	23-(26)d	22.0	S	Fe(30)					G			S	NP,P
	Roanoke River be US 158 be Weldon Halifax	C	23-(26)a	5.2							G			S	NP

Table 4.23 Water Quality and Use Support Ratings for Monitored Stream Segments (Sheet 2 of 2)

Station Number	Station Location	Classification	Index Number	Miles	Chem Rating 90-94	Prob. Param. 90-94	<-----Biological Rating-----> 90	91	92	93	94	Fish Comm.	OVERALL RATING Prob. Param.	Use Support	Potential Sources
	Roanoke River fish advisory	C	23-(26)e	17.3									Fish Cons.	PS	NP,P
	Quankey Cr, ab & be WWTP Halifax, and at SR 1619	C	23-30	19.4					F			F		PS	NP,P
	Keehukee Cr at SR 1804, Halifax	C	23-42	14.0								G-F		ST	P
02080500	Roanoke River at Roanoke Rapids, NC Hwy. 48	WS-IV CA	23-(25.5)	0.6	S									S	
02081022	Roanoke R. nr Lewiston, NC11, & NC 125/903 be Hamilton	C	23-(26)c	39.4	S	Cu(10),Fe(46)					G			S	
	Deep Cr, US 158, Halifax	WS-IV	23-24-(1)	12.2							G-F	G		S	
SUBBASIN 30209															
	Welch Creek fish advisory	C Sw	23-55	13.6									Fish Cons.	PS	NP,P
02081135	Roanoke R. 1.3 mi upstream Welch Cr nr Plymouth	C Sw	23-(53)a	9.9	S	Cu(12), Fe(38)							Fish Cons.	PS	NP,P
02081141	Roanoke River at NC 45 near Sans Souci	C Sw	23-(53)b	8.4	S	Fe(30)	G-F		G-F		G-F		Fish Cons.	PS	NP,P
0208114330	Albemarle Sound (Batchelor Bay) nr Black Walnut	B Sw	24	3.4	S	Fe(36)								S	
SUBBASIN 30210															
02081101	Cashie R at SR 1257, Berti (Fish), ambient at SR 1219	C Sw	24-2-(1)a	24.3	NS	DO(63), Fe(93)						F	DO	PS	NP
	Cashie at SR 1500 Bertie	B Sw	24-2-(9)	2.3							G-F			ST	

Table 4.24 Use Support Status for Freshwater Streams in the Roanoke Basin

USE SUPPORT STATUS FOR FRESHWATER STREAMS (MILES) (1990-1994)						
Subbasin	S	ST	PS	NS	NE	Total Miles
30201	170.7	162	37.7	0	51.7	422.1
30202	88.7	38.9	0	0	0	127.6
30203	180.9	127.2	0	0	0	308.1
30204	190.3	12.2	0	0	3.9	206.4
30205	168.7	46.4	15.9	0	8.5	239.5
30206	92.5	55.1	31.6	0	37	216.2
30207	33.1	40	20.4	0	37.3	130.8
30208	229.4	26.5	54.5	0	20.5	330.9
30209	191.9	40.9	31.9	0	0	264.7
30210	0	93.9	24.3	0	25.4	143.6
TOTAL	1346.2	643.1	216.3	0	184.3	2389.9
PERCENTAGE	56	27	9	0	8	

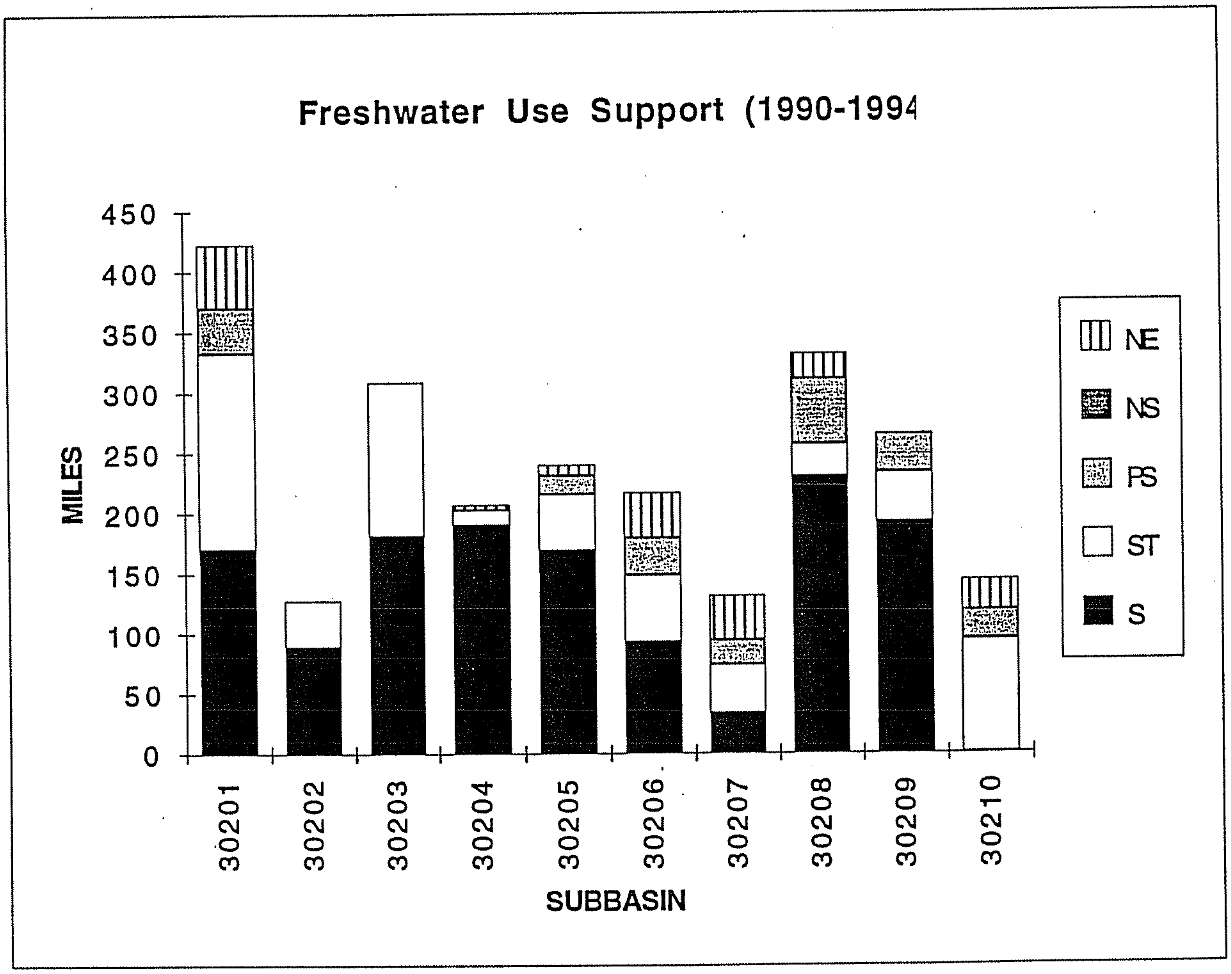


Figure 4.22 Bar Chart Showing Use Support Ratings by Subbasin

Table 4.25 Probable Sources of Use Support Impairment (Miles)

Subbasin	Nonpoint Source	Point Source	Agriculture	Forestry	Construction	Urban Runoff	Mining	Land Disposal	Hydromod	Unknown	Other
30201	27.9	0	35.7	20.1	0	0	0	7.8	0	0	9.8
30202	0	0	0	0	0	0	0	0	0	0	0
30203	0	0	0	0	0	0	0	0	0	0	0
30204	0	0	0	0	0	0	0	0	0	0	0
30205	2.7	2.7	0	0	0	0	0	0	0	0	3.3
30206	31.6	2	20.3	0	0	2	4	4	0	5.3	0
30207	11.6	0	11.6	0	0	0	0	0	0	0	0
30208	54.5	19.4	17.3	19.4	0	0	0	0	19.4	0	19.4
30209	13.6	49.2	0	0	0	13.6	0	13.6	0	0	0
30210	24.3	0	0	0	0	0	0	0	0	0	0
Total Miles	166.2	73.3	84.9	39.5	0	15.6	4	25.4	19.4	5.3	32.5
% of PS &\ NS	77	34	39	18	0	7	2	12	9	2	15

Note: PS (Partially Supporting) & NS (Nonsupporting) = 216.3 miles

Table 4.26 Probable Causes of Use Support Impairment (Miles)

Subbasin	Fish Adv.	Sediment	DO
30201	0	20.1	
30202	0	0	0
30203	0	0	0
30204	0	0	0
30205	0	6.2	0
30206	0	0	0
30207	0	11.6	0
30208	0	0	0
30209	49.2	0	0
30210	0	0	24.3
Total Miles	49.2	37.9	24.3
% of PS & NS	23	18	11

Table 4.27 Use Support Table for Lakes in the Roanoke River Basin

LAKE NAME	COUNTY NAME	SUB-BASIN	SIZE (acres)	CLASS	OVER-ALL USE	FISH CON-SUMP.	AQ. LIFE & SECONDARY CONTACT	SWIM-MING	DRINKING WATER	PROBLEM PARA-METERS
HANGING ROCK LAKE	Stokes	30201	12	B	S	S	S	S	n/a	
KERNERSVILLE RES.	Forsyth	30201	45	WS-IV CA	S	S	S	n/a	S	
BELEWS LAKE	Rockingham	30201	4030	WS-IV,B,C	PS	PS	S	S	n/a	Metals(4030)
FARMER LAKE	Caswell	30204	365	WS-II	S	S	S	n/a	S	
ROXBORO LAKE	Person	30205	212	WS-II CA	ST	S	S	n/a	S	Algal Blooms
MAYO RESERVOIR	Person	30205	2800	C	S	S	S	n/a	n/a	
LAKE ROXBORO	Caswell	30205	310	WS-II&B	S	S	S	n/a	S	
HYCO LAKE	Person	30205	3750	B	PS	PS	S	n/a	S	Metals (3750)
KERR RESERVOIR (Nutbush Creek)	Vance/Warren	30206	12400	WS-III,B,C	ST	S	S	S	n/a	Nutrients
LAKE GASTON (NC portion)	Halifax/Warren /Northampton	30207	13300	WS-IV,B	PS	S	PS	S	S	Aq. Weeds
ROANOKE RAPIDS L.	Northampton	30208	4893	WS-IV,B	PS	S	PS	S	S	Aq. Weeds
WHITE MILLPOND	Halifax	30208	151	C	ST	S	ST	S	n/a	

Table 4.28 Percent of Rivers in the Roanoke River Basin in Virginia - Use Support Categories (may not total 100% due to rounding).

Use	Percent Support				
	FS	ST	PS	NS	NA
Aquatic Life	52%	0%	4%	<1%	42%
Fish Cons	53%	0%	1%	<1%	44%
Swimming	54%	0%	<1%	<1%	44%
Drink. Water	54%	0%	<1%	<1%	44%

FS = Fully Supporting
ST = Support Threatened
PS = Partially Supporting
NS = Not Supporting
NA = Not Assessed

Table 4.29 Sources of Pollutant Impact in the Roanoke River Basin in Virginia. (Expressed as number of river miles impacted).

Pollutant	Major Impact	Moderate - Minor Impact
Municipal Point Sources	36	0
Agriculture	120	10
Urban Runoff/Storm Sewers	40	0
Hydromodification	6	0
Other	15	0
Unknown Source	20	0

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CHAPTER 5

EXISTING POINT AND NONPOINT SOURCE POLLUTION CONTROL PROGRAMS

5.1 INTRODUCTION

This chapter summarizes the point and nonpoint source control programs available for addressing water quality problems in the Roanoke River basin. **Sections 5.2 and 5.3**, respectively, describe existing point and nonpoint source pollution control programs. Application of these programs to specific water quality problems and water bodies is presented in Chapter 6. **Section 5.4** discusses integration of point and nonpoint source control management strategies and introduces the concept of *total maximum daily loads* (TMDLs).

5.2 NORTH CAROLINA'S POINT SOURCE CONTROL PROGRAM

5.2.1 Introduction

Point source discharges, which are also described in Section 3.3 in Chapter 3, are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the authority of North Carolina General Statute (NCGS) 143.215.1 and the National Pollutant Discharge Elimination System (NPDES) program which was delegated to North Carolina from the US Environmental Protection Agency (EPA). These permits serve as both state and federal permits. NPDES permits contain effluent limitations which establish the maximum level of various wastes, or pollutants, that may be discharged into surface waters. North Carolina has a very comprehensive NPDES program which includes the following major components:

1. NPDES Permit Review and Processing (Section 5.2.2),
2. Wasteload Allocation Modeling (Section 5.2.3),
3. Compliance Monitoring and Enforcement (Section 5.2.4),
4. Aquatic Toxicity Testing (Section 5.2.5),
5. Pretreatment (Section 5.2.6),
6. Operator Certification and Training (Section 5.2.7) and
7. Nondischarge and Regional Wastewater Treatment Alternatives (Section 5.2.8).

Below is a brief summary of key components of North Carolina's NPDES program

5.2.2 NPDES Permit Review and Processing

Under the basinwide approach, all discharge permits within a given basin are set to expire and be renewed at about the same time. In the Roanoke basin, for example, all of the existing permits will expire and be renewed between January 1997 and May 1997. The permitting schedule for the Roanoke Basin is presented in Chapter 1 for each subbasin. Permits are issued with an effective life of not more than five years, thus basin plans are renewed at five-year intervals. New discharge permits issued during an interim period between cycles will be given a shorter expiration period in order to coincide with the next basin permitting cycle.

DWQ will not process a permit application until the application is complete. Rules outlining the discharge permit application and processing requirements are contained in Administrative Code Section: 15A NCAC 2H .0100 - Wastewater Discharges to Surface Waters. Under this rule, all applications must include a summary of waste treatment and disposal options that were considered, and why the proposed system and point of discharge were selected. The summary should have sufficient detail to assure that the most environmentally sound alternative was selected from the reasonably cost effective options.

Also, applications for new discharges which propose to discharge wastewater in excess of 500,000 gallons per day or 10 million gallons per day (MGD) of cooling water or any other proposed discharge of 1 MGD or greater to surface waters must include an *assessment* report in addition to the normal permit application. The assessment is to provide sufficient information to describe the impact of the proposed action on the waters in the area. An Environmental Impact Statement or Environmental Assessment, under the NC Environmental Policy Act may also be required for certain publicly funded projects.

Once an application is considered complete, a staff review is initiated and a wasteload allocation is performed in order to establish permitted waste limits (described in the following section). The staff review includes a site inspection (which may actually be conducted prior to submittal of a complete application for existing facilities that are up for renewal). If the Division finds the application acceptable, then a public notice, called a Notice of Intent to Issue, is published in newspapers having wide circulation in the local area. The public is given a 30-day period in which to comment, and a public hearing may be held if there is sufficient interest. Under Basinwide Management, the Notice of Intent will include all of the permit applications for a particular subbasin (or subbasins) that will be issued within a given month. A public hearing would be scheduled for just those applications where sufficient interest is indicated. Copies of the Notice of Intent are also sent to a number of state and federal agencies for comment. For example, the Division of Environmental Health reviews the applications for their potential impact on surface water sources of drinking water. Once all comments are received and evaluated, a decision is made by the Director of DWQ on whether to issue the permit. The final permit will include recommended waste limits and other special conditions which may be necessary to ensure protection of water quality standards.

5.2.3 Establishing Discharge Permit Effluent Limitations/Wasteload Allocations

As noted above, effluent limitations, or waste limits as they are sometimes called, dictate the amounts of wastes (pollutants), that are allowed to be discharged into surface waters under an NPDES permit. Where a discharge permit is required, an evaluation is conducted to determine the projected impact of the discharge on the receiving waters. This determination, called a wasteload allocation (WLA), is often based on computer modeling which considers such factors as the rate of waste flow, the type of waste to be discharged, and characteristics of the receiving waters (e.g. rate and quantity of flow, waste assimilative capacity, channel configuration, rate of reaeration, water quality classification, etc.). Permit limits that are determined by models are called water quality-based limits. Permits may also be based on federal effluent guidelines established by the USEPA.

Wasteload allocations are performed by DWQ using models of varying scope and complexity, depending on the parameter (type of waste) of interest and the characteristics of the receiving waters. Model frameworks, which are discussed in more detail in Appendix IV, can range from simple mass balance analyses to 3-dimensional dynamic water quality models. Modeling fits into the basin plan by drawing on the current conditions within the basin and evaluating the effects of various management strategies. In general terms, modeling can be used to determine the fate and transport of pollutants, reduction goals for point and nonpoint sources of environmental contaminants, and to derive effluent limits for NPDES permits. More specifically, models can be used to predict concentrations of a parameter at a given site, such as instream DO or chlorophyll *a* in a lake, and can be used as a tool to determine what is needed to protect instream standards. Uncertainty analysis of water quality models expand the predictive capabilities and the confidence in results, and can produce probabilities that an event would occur under a certain set of circumstances. Waste limits may vary from summer to winter for some parameters, such as nutrients and ammonia, with winter limits being somewhat less stringent than summer limits due to higher instream flows during the winter months.

It should be noted that where point sources are responsible for water quality problems, WLAs offer a solution by yielding appropriate permit limits that offer adequate water quality protection. Where a sole discharge is responsible for the water quality impacts, a simple WLA can be performed and no other discharges need be affected. If the issues are not complex, and a standard WLA analysis was performed, the management practice is to establish limits in accordance with DWQ's Standard Operating Procedures (SOP) for Wasteload Allocations manual. The SOP manual has been developed to support State and Federal regulations and guidelines and has been approved by the EPA.

In considering a wasteload for an individual discharge facility, a critical factor is whether the receiving waters have a flow during 7Q10 or 30Q2 conditions. It is DWQ's policy not to allow new or expanded discharges into "no flow" streams having a 7Q10 and 30Q2 equal to zero. In addition, existing facilities on such streams will be targeted for removal unless it is determined that there are no reasonable alternatives. If that is the case, then the facility will be required to meet limits of 5 mg/l BOD_5 and 2 mg/l NH_3N in summer (and 10 mg/l BOD_5 and 4 mg/l NH_3N in winter).

If the water quality issues involve numerous discharges, the Environmental Management Commission, pursuant to NCGS 143-215.1(b)(2), is required to consider the cumulative impacts of all permits in order to prevent violations of water quality standards. Such areas are identified and discussed in Chapter 6. Generally, these are areas where the SOP alone does not provide adequate guidance. Since the SOP addresses mostly single discharge or relatively simple interaction of multiple discharges, WLA procedures outside the realm of the SOP represent the larger, basinwide strategy that DWQ is implementing.

5.2.4 Compliance Monitoring and Enforcement

Most dischargers are required to periodically sample the treated effluent from their discharge pipes. Also, many larger and more complex dischargers are required to sample points in the receiving waters both up and downstream from the discharge point. This process is called self-monitoring and it is typically required five days a week for some parameters (Monday through Friday) for major facilities. The sampling results (contained in a daily monitoring report or DMR) are then submitted each month to DWQ for compliance evaluations. If the limits are not being met, the state may issue a notice of violation, initiate enforcement action, place the facility on moratorium, and/or enter into a Special Order by Consent (SOC) to ensure compliance. An SOC is a legal commitment entered into by the state and the discharger that establishes a time schedule for bringing the wastewater treatment plant back into compliance. During this time period, interim waste limits may be assigned to the facility until the improvements can be made. These interim limits may be less stringent than those in the permit although they are still required to protect water quality in the receiving waters.

In addition to the DMR data, illegal or improperly treated discharges may be identified in other ways including through third party reports, routine DWQ site inspections, and water quality monitoring conducted by DWQ staff.

5.2.5 Aquatic Toxicity Testing

There are thousands of chemicals or compounds which may enter wastewater systems and be discharged to surface waters. Monitoring the concentration of these chemicals individually would be impossible due both to cost/time considerations as well as the inability of current analytical techniques to detect many of them. Even if the existence and potential effects of every constituent of a wastewater were known, the combined effects of these constituents could not be predicted.

North Carolina utilizes an integrated approach to address this problem which relies on chemical specific monitoring, assessment of resident aquatic populations, and analysis of whole effluent toxicity (WET) to control the potential effects of these chemicals and their interactions. Whole effluent toxicity limits allow protection against predicted impacts of toxicants through measurement of those impacts in the laboratory. It is from this same foundation of aquatic toxicity laboratory tests that chemical specific limits and criteria are derived for the majority of chemical toxicants.

Whole effluent toxicity limitations were implemented by North Carolina in February, 1987 through a policy to incorporate these limits in all major and complex minor permits. As of May of 1996, there were 566 permitted NPDES discharges in North Carolina required to perform whole effluent toxicity monitoring, and over 18,000 individual toxicity analyses had been performed across the state. These limitations are developed to protect aquatic life from the discharge of toxic substances in toxic amounts as prescribed by 15 NCAC 2B. 0208 (i.e. so as not to result in chronic toxicity at permitted discharge flow and 7Q10 receiving flow volumes). Since the inception of the aquatic toxicity program a shift in observed WET has been seen from a time when approximately 25% of the facilities tested would be predicted to have been acutely toxic instream to a point now where less than 10% would be considered chronically toxic.

Aquatic toxicity testing, no less than any other complex analytical technique, requires a great deal of quality assurance and control to achieve reliable results. In 1988, North Carolina adopted regulations that initiated a program which required all laboratories performing NPDES analyses in North Carolina to be certified by the state as a biological laboratory. As of May 1996, 23 commercial, municipal, and industrial laboratories had achieved this certification in either aquatic toxicity analyses and/or aquatic population survey. The NC Biological Laboratory Certification Program, much like WET permitting in North Carolina, is looked at as a national leader in its field.

5.2.6 Pretreatment Program

The goal of the pretreatment program is to protect municipal wastewater treatment plants, or publicly-owned treatment works (POTWs), and the environment from the adverse impacts that may occur when hazardous or toxic wastes are discharged into a public sewage system. The pretreatment program is designed to achieve this protection primarily by regulating non-domestic (e.g. industrial) users of POTWs that discharge toxic wastes under the Domestic Sewage Exclusion of the Resource Conservation and Recovery Act (RCRA). In essence, the program requires that businesses and other entities that use or produce toxic wastes pretreat their wastes prior to discharging their wastewater into the sewage collection system of POTW. State-approved pretreatment programs are typically administered by local governments that operate POTWs.

There are four major areas of concern addressed through implementation of a local pretreatment program: 1) interference with POTW operations, 2) pass-through of pollutants to a receiving stream, 3) municipal sludge contamination, and 4) exposure of workers to chemical hazards. Interference may involve any aspect of plant operation from physical obstruction to inhibition of biological activity. The process for developing technically based local pretreatment limits involves determining the maximum amount of each pollutant that can be accepted at the influent, or headworks, of the POTW and still protect the receiving water, the POTW itself, and the POTW's sludge disposal options.

5.2.7 Operator Certification and Training Program

Water pollution control systems must be operated by state-certified operators. These systems include: wastewater treatment plants, wastewater collection systems and "non-discharge" ground absorption systems, such as alternative on-site disposal technologies and spray irrigation facilities. Systems are classified based on system type and complexity and are required to have an appropriately trained and certified operator. The Certification Commission currently certifies operators in four grades of wastewater treatment, four grades of collection system operation, one grade of subsurface operation, and a variety of specialized conditional exams for other technologies. Training and certification programs are also being developed for land application of residuals and groundwater remediation.

Training is accomplished in cooperation with the state university and community college system as well as through the professional associations for operators and pollution control professionals. Specialty courses and seminars for operators are also offered by operators' associations and the NC Water Pollution Control Association/American Water Works Association (WPCA/AWWA).

Training and certification of operators is essential to the proper operation and maintenance of pollution control systems. Without proper operation and maintenance, even the most highly designed treatment system will not function efficiently. It is the goal of the Training and Certification Program to provide competent and conscientious professionals that will provide the best wastewater treatment and protect the environment and the public health.

5.2.8 Nondischarge and Regional Wastewater Treatment Alternatives

As discussed in section 5.2.2, discharge permit applicants are required to consider other forms or alternatives of wastewater treatment other than discharging into a stream. For some, there may be no other economically feasible alternatives. However, for others, particularly smaller dischargers, there are a number of potentially cost-effective and environmentally sound alternatives. There are several types of non-discharging wastewater treatment systems including spray irrigation, rapid infiltration, trickling systems and underground injection. Artificial wetlands wastewater systems are also being evaluated in this state. Permit requirements for nondischarging systems are presented in Administrative Code Section 15 NCAC 2H .0200 - Waste Not Discharged to Surface Waters.

Another alternative to a surface water discharge is to tie into an existing wastewater treatment system. Where possible, DWQ is encouraging smaller dischargers to connect to large established municipal systems. Regionalization, as this is called, has several advantages. First, large municipal facilities, unlike smaller package type plants, are manned most of the time thereby reducing the potential for plant malfunctions, and where malfunctions do occur, they can be caught and remedied more quickly. Second, these larger facilities can provide a higher level of treatment more economically and more consistently than can smaller plants. Third, the larger plants are monitored daily. And fourth, centralizing the discharges reduces the number of streams receiving effluent. In evaluating future permit expansion requests by regional facilities, DWQ will take into consideration the amount of flow accepted by them from the smaller discharges.

In addition to the nondischarging wastewater treatment systems mentioned above, nondischarge permits are also issued for the land application of residual solids (sludge) from wastewater treatment processes.

5.3 NONPOINT SOURCE CONTROL PROGRAMS

Land use control and technology-based best management practices (BMPs) are the two most widely used tools for controlling nonpoint source pollution and protecting designated uses of waterbodies. In developing areas, land use control through low density development has often been selected by municipalities as the preferred method of treatment for urban stormwater because it avoids potential problems with long-term BMP maintenance requirements. In situations where low density development is not feasible or where higher densities are preferred, stormwater control devices (BMPs) are available. These include, but are not limited to stormwater retention and wet detention ponds, vegetated buffer strips along streams, and designated infiltration areas.

Nonpoint source strategies for other categories of pollution (e.g., agriculture, construction, or mining) depend more on the installation of BMPs and waste reduction/management systems. The installation of these BMPs and management systems may be voluntary or required by a set of regulations, depending on the designated management agency. Examples of nonpoint source management approaches that combine land use controls and BMPs include the coastal stormwater regulations and the Water Supply Watershed Protection Program rules.

Once a management strategy is developed for each category of nonpoint source pollution, a schedule can be developed for implementing these strategies for specific geographic areas and waterbodies. It is important to emphasize that management strategies are developed for both highly valued resource waters where a potential for degradation exists and for areas already impacted by nonpoint source pollution.

Regulations or programs are in place which address most categories of nonpoint source pollution (Table 5.1). For example, discharges are not allowed into state waters without a discharge permit from DWQ. This includes discharges from septic systems and animal operations. In addition, water quality standards apply to all categories of land-use activities. In the case of the turbidity standard, it is assumed that the standard will be met if proper BMPs are in place, as determined by the appropriate lead nonpoint source agency.

After acceptable BMPs are established and geographic areas or waterbodies are targeted for implementation, steps must then be taken to assure that the chosen management strategies and BMPs are protecting water quality. DWQ utilizes both chemical and biological sampling procedures to test the effectiveness of BMPs.

In general, the goals of the nonpoint source management program include the following:

1) Continue to build and improve existing programs,
2) Develop new programs that control nonpoint sources of pollution not addressed by existing programs,
3) Continue to target geographic areas and waterbodies for protection,
4) Integrate the NPS Program with other state programs and management studies (e.g. Albemarle-Pamlico Estuarine Study), and
5) Monitor the effectiveness of BMPs and management strategies, both for surface and groundwater quality.

North Carolina has a variety of statewide programs which are used in the Roanoke River Basin and statewide to address nonpoint source pollution. Table 5.1 lists these programs by categories based on the type of activity. Below is a brief overview of existing nonpoint source control efforts for various categories of land use activities.

Table 5.1 Examples of Nonpoint Source Programs

PROGRAM	MANAGEMENT AGENCIES LOCAL	STATE	FEDERAL
AGRICULTURE			
Agriculture Cost Share Program	SWCD	SWCC, DSW	
N.C. Pesticide Law of 1971		NCDA	
Pesticide Disposal Program		NCDA	
Animal Waste Management	SWCD	DWQ, DSW, CES	NRCS
Laboratory Testing Services		NCDA	
Watershed Protection (PL-566)			NRCS
1985 and 1990 Farm Bills			USDA
- Conservation Reserve Program			
- Conservation Compliance			
- Sodbuster			
- Swampbuster			
- Conservation Easement			
- Wetland Reserve			
- Water Quality Incentive Program			
URBAN			
Water Supply Watershed Protection Program	city, county	DWQ	
Coastal Stormwater Program		DWQ	
ORW, HQW, NSW Management Strategies		DWQ	
Stormwater Control Program	city, county	DWQ	EPA
CONSTRUCTION			
Sedimentation and Erosion Control	ordinance	DLR, DOT	
Coastal Area Management Act	ordinance	DCM	
Coastal Stormwater Program		DWQ	
ON-SITE WASTEWATER DISPOSAL Sanitary Sewage Systems Program	county	DEH	
SOLID WASTE DISPOSAL			
Resource Conservation and Recovery Act			EPA
Solid Waste Management Act of 1989	city, county	DSWM	
FORESTRY			
Forest Practice Guidelines		DFR	
National Forest Management Act			NFS
Forest Stewardship Program		DFR	
MINING Mining Act of 1971		DLR	
HYDROLOGIC MODIFICATION			
Clean Water Act (Section 404)		DCM, DWQ	COE
Rivers and Harbors Act of 1899			COE
Dam Safety Permit		DLR	
WETLANDS			
Clean Water Act (Sections 401 and 404)		DWQ	COE
Wetland Reserve Program			USDA

(ABBREVIATIONS: **COE**, US Army Corps of Engineers; **DCM**, Div. of Coastal Mgmt.; **DWQ**, Div. of Water Quality; **DLR**, Div. of Land Resources; **DFR**, Div. of Forest Resources; **DOT**, Dept. of Transportation; **DSW**, Division of Soil and Water; **DSWM**, Div. of Solid Waste Mgmt.; **NCDA**, NC Dept. of Agric.; **NRCS**, Natural Resources Conservation Service; **SWCC**, Soil and Water Conservation Commission; **SWCD**, Soil and Water Conserv. District; **USDA**, US Dept. of Agric.)

5.3.1 Agricultural Nonpoint Source (NPS) Control Programs

Agricultural BMPs have been developed largely to control the five major agriculturally-related causes of pollution: nutrients, sediment, pesticides, oxygen-demanding substances and bacteria. BMPs vary from site to site and are dependent upon a particular pollutant but include practices such as grassed waterways and vegetated buffers, nondischarging animal waste lagoons, integrated crop and pest management and soil testing. BMPs may be administered through one or more of the agricultural programs described below. Common agricultural BMPs are listed in Appendix VI.

- **North Carolina Agriculture Cost Share Program**
  In 1984, the North Carolina General Assembly budgeted approximately $2 million to assist landowners in 16 counties within the "Nutrient Sensitive Water" (NSW) watersheds including the Upper Neuse River (Falls Lake) to implement BMPs for agricultural and silvicultural activities. These funds were increased in May 1987 to include 17 additional coastal counties by the passage of a General Statute formally creating the *Agriculture Cost Share Program for Nonpoint Source Pollution Control (NCACSP).* In 1989 the NCACSP became a statewide program. The NCACSP will pay a farmer 75 percent of the average cost of implementing approved BMPs and offer technical assistance to the landowners or users which would provide the greatest benefit for water quality protection. The primary purpose of this voluntary program is water quality protection.

  The local Soil and Water Conservation District Boards under the administration of the North Carolina Soil and Water Conservation Commission (SWCC) are responsible for identifying treatment areas, allocating resources, signing contractual agreements with landowners, providing technical assistance for the planning and implementation of BMPs and generally encouraging the use of appropriate BMPs to protect water quality. The criteria for allocating funds to the District is "based on the identified level of agricultural related nonpoint source pollution problems and the respective District's BMP installation goals and available technical services as demonstrated in the Districts annual strategy plan" (NC Administrative Code, Title 15, Chapter 6, Section 6E). This local participation is crucial to the success of the program.

  The DEHNR-Division of Soil and Water Conservation (DSWC) provides staff, administrative and technical support to the SWCC. The DSWC also coordinates the efforts of various associated Program committees and acts as the clearinghouse for District strategy plans, contracts, etc. A legislated Technical Review Committee meets quarterly "to review the progress of the Program" (G.S. 143-215.74B) and to make technical recommendations to the Commission.

  Technical assistance for the implementation of approved BMPs is provided to the Districts through a 50:50 cost share provision for technical positions to be filled at the District level. The USDA-Natural Resources Conservation Service also provides technical assistance.

  The current annual statewide budget to cost share BMPs (75% - NCACSP / 25% landowner) with landowners is approximately $ 6.7 million. The budget to share the cost of providing technical assistance with Districts is approximately $ 1.3 million. Additional support for administration and staff is provided by local governments. In Roanoke River Basin districts, approximately $4.9 million in BMP cost share dollars have been spent since the program was initiated. There is also federal assistance through ASCS for BMP implementation.

- **North Carolina Pesticide Law of 1971**
  In 1971 the General Assembly created and authorized the North Carolina Pesticide Board to regulate the use, application, sale, disposal and registration of pesticides for the protection of the health, safety, and welfare of the people and for the promotion of a healthy and safe environment. Some of the responsibilities of the Pesticide Board and the North Carolina Department of Agriculture include registering all pesticides prior to distribution and sale in North Carolina, sampling pesticides to insure that all products are up to guaranteed analysis and unadulterated by any other pesticide, sampling pesticides at time of application to insure that the applicator is following label instructions certifying the competency of applicators and dealers of restricted use pesticides.

  The Pesticide Section of the North Carolina Department of Agriculture conducts mandatory annual inspections of all aircraft used in pesticide application and conducts random inspections of ground application equipment and chemigation systems (application of pesticides through irrigation systems). These inspections are intended to encourage proper calibration and use of equipment in order to avoid excessive application rates and accidental spills from faulty systems. Stop use orders are issued for noncompliance with the regulations.

  Inspections are also required for bulk storage tanks prior to filling. All commercial pesticide storage facilities are required to have an approved Pre-fire Plan. In addition, each large commercial storage facility is required to develop and maintain an Emergency Contingency Plan. This plan describes the actions facility personnel shall take to respond to fires, explosions, spills, or any other sudden or gradual release of pesticides or pesticide contaminated materials to air, soil, or surface waters. The Contingency Plan is designed to minimize hazards to human health and the environment.

  Penalties are assessed to careless pesticide applicators. Enforcement of the law is based on where the pesticide is deposited rather than just where it is applied. For example, if a pesticide is found in a stream as a result of wind drift, the applicator is subject to legal action. The Raleigh Office staff of the NCDA Pesticide Section is comprised of 20 employees. There are 10 Inspectors who conduct field-level compliance monitoring and investigation services. The annual budget for pesticide control and analytical work is $1.4 million.

- **NCDA Pesticide Disposal Program**
  In 1976, the North Carolina Pesticide Board adopted regulations governing the disposal of pesticides. These regulations make it illegal in North Carolina to dispose of hazardous waste (which includes certain pesticides) in sanitary landfills. While households and farms which generate less than 220 pounds of hazardous waste and less than 2 pounds of acutely hazardous waste are exempt from federal disposal requirements, the regulations prohibiting the disposal of these wastes in sanitary landfills still applies to them. The option to use commercial hazardous waste disposal companies is too expensive and most companies will not pickup small quantities. As a result of this dilemma, the NCDA created the Pesticide Disposal Program in 1980 through appropriations from the General Assembly.

  The goal of the Program is to provide an available, affordable and environmentally acceptable mechanism in which any homeowner, farmer, or institution can dispose of unwanted or unusable pesticides. It is mandatory, however, that all pesticide products are labeled correctly before NCDA will pick them up. An EPA permitted hazardous waste treatment or disposal facility (TSD) requires proper identification before the products can be disposed.

The Food and Drug Division of the North Carolina Department of Agriculture administers the Pesticide Disposal Program. The same staff used for enforcing the North Carolina Pesticide Law of 1971 are used in the Disposal Program.

- **Animal Waste Management Regulations**

On December 10, 1992, the Environmental Management Commission adopted a rule modification (15A NCAC 2H .0217) to establish procedures for properly managing and reusing animal wastes from intensive livestock operations. The goal of the rule is for intensive animal operations to operate so that animal waste is not discharged to waters of the state. This means that if criteria are met and no waste is discharged to surface waters, then an individual permit from DWQ is not required. The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve more than or equal to the following animal populations: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds with a liquid waste system. These operations are deemed permitted if a signed registration and an approved waste management plan certification are submitted to DWQ by the appropriate deadlines.

The deadline for submittal of registrations to DWQ for existing facilities was December 31, 1993. There were 333 registered and 24 certified operations in the Roanoke Basin as of February of 1996. Facility plans must be certified by a technical specialist designated by the Soil and Water Conservation Commission and submitted to DWQ by December 31, 1997. The standards and specifications of the USDA Natural Resources Conservation Service are the minimum criteria used for plan approval by the local Soil and Water Conservation Districts.

In the past, DWQ inspected intensive animal operations mostly in response to third party complaints. However, with the passage of the above rules, plans are to be making more routine inspections to make sure that waste management systems are adequate and are being operated properly. Animal waste management systems that are determined to have an adverse impact on water quality may be required to obtain an approved animal waste management plan or to apply for and receive an individual nondischarge permit. Any animal operation found discharging is subject to a maximum fine of $10,000 per day.

The Swine Farm Siting Act, SB 1080, was adopted on July 11, 1995 to maximize the use and enjoyment of property adjoining concentrated animal operations. The Act specifies that a swine house or lagoon of a new farm sited on or after October 1, 1995 is required to be at least 1,500 feet from any occupied residence; at least 2,500 feet from any school, hospital, or church; and at least 100 feet from any property boundary. The Act restricts the application of lagoon effluent to land at least 50 feet from a residential property line and from any perennial stream or river, excluding irrigation ditches and canals. If written permission is given by the property owner and recorded with the Register of Deeds, a swine house or lagoon may locate closer to a residence, school, hospital, church, or property boundary.

Revised training requirements were set forth in Senate Bill 944 on July 29, 1995. Effective January 1, 1997, all owners of swine operations with more than 250 animals are required to be certified and have an animal waste management system in place. The North Carolina Cooperative Extension Service is to develop and administer a training and certification program that will supply the owner with six hours of instruction on the operation of an animal waste management system for swine. The Department of Environment, Health and Natural Resources is to issue a certificate to anyone who passes the appropriate examination and pays a ten dollar ($10.00) fee. Violators will be assessed a penalty up to one thousand ($1,000) and possible suspension or revocation of the certificate.

- **NC Cooperative Extension Service and Agricultural Research Service**
  Crop and animal production programs are administered under the research and education activities of the NC Agricultural Research Service (ARS) and the NC Cooperative Extension Service (CES). The research and education efforts are broad and include areas such as variety development, crop fertilizer requirements, soil testing, integrated pest management, animal housing, animal waste management, machinery development and irrigation. Guidelines for most agricultural enterprises have been developed and made available to farmers. A more intensified water quality emphasis is being incorporated in these areas and many other projects undertaken by ARS and CES. The local contact that county CES agents have with farmers and homeowners provides an excellent opportunity for dialogue and education in nonpoint source pollution control. This network of contacts can be used to inform people about BMPs and to provide some structure for a general NPS education program.

  The NC Agricultural Research Service and the NC Cooperative Extension Service conduct broad research and education efforts that include areas such as variety development, crop fertilizer requirements, soil testing, integrated pest management, animal housing, animal waste management, machinery development, and irrigation. County Cooperative Extension agents work closely with farmers and homeowners, providing an excellent opportunity for dialogue and education in nonpoint source pollution control. In addition, CES has begun assisting DWQ in holding a series of public workshops in each river basin prior to DWQ's preparation of the draft basin plan. The March 1995 workshops for this basin are discussed in the Executive Summary and in Appendix V.

- **Soil, Plant Tissue, and Animal Waste Testing Program**
  These services provide farmers with information necessary to improve crop production efficiency, to manage the soil properly and to protect environmental quality. The Soil, Plant Tissue and Animal Waste Testing Program is administered by the Agronomic Division of the North Carolina Department of Agriculture. Water and wastewater from lagoons is also tested for irrigation and fertilizer use.

- **Watershed Protection and Flood Prevention Program (PL 83-566)**
  The purpose of the Watershed Protection and Flood Prevention Program is to provide technical and financial assistance in planning, designing, and installing improvement projects for protection and development of small watersheds. The Program is administered by the USDA-Natural Resources Conservation Service in cooperation with the NC Division of Soil and Water Conservation, the State Soil and Water Conservation Commission, the U.S. Forest Service, Soil and Water Conservation Districts, and other project sponsors.

  The emphasis of the Program over the past three decades has been to provide flood control. However, legislation has shifted emphasis of PL-566 land treatment projects so that a project proposal must demonstrate off-site water quality benefits in order to have any chance of funding. In the Roanoke River Basin, there are two land treatment projects underway in the Piedmont physiographic region.

- **Food Security Act of 1985 (FSA) and the Food, Agriculture, Conservation and Trade Act of 1990 (FACTA)**
  There are several provisions authorized by the federal Food Security Act of 1985 (FSA) and re-authorized by the Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA) which offer excellent opportunities for the abatement of agricultural nonpoint source pollution. The FSA and FACTA make the goals of the USDA farm and conservation programs more consistent by encouraging the reduction of soil erosion and

production of surplus commodities and the retention of wetlands. At the same time, the provisions can serve as tools to remove from production those areas which critically degrade water quality by contributing to sedimentation. Important water quality-related provisions are known as the Conservation Reserve, Conservation Compliance, Sodbuster, Swampbuster, and Conservation Easement, Wetland Reserve, and Water Quality Incentive Program. These provisions are administered by the USDA.

Conservation Reserve Program

The Conservation Reserve Program (CRP) is administered by the USDA Agricultural Stabilization and Conservation Service (ASCS) and the USDA Natural Resources Conservation Service (NRCS). Other cooperating agencies include the NC CES, NC Division of Forest Resources and local Soil and Water Conservation Districts. The CRP was established to encourage removing highly erodible land from crop production and to promote planting long-term permanent grasses and tree cover. The ASCS will share up to half of the cost of establishing this protective cover. The intention of the program is to protect the long term ability of the US to produce food and fiber by reducing soil erosion, improving water quality and improving habitat for fish and wildlife. Additional objectives are to curb the production of surplus commodities and to provide farmers with income supports through rental payments over a 10 year contract period for land entered under the CRP.

Conservation Compliance

The Conservation Compliance provision of the FSA and FACTA discourages the production of crops on highly erodible cropland where the land is not carefully protected from erosion. Highly erodible land is defined as land where the potential erosion (erodibility index) is equal to eight times or greater than the rate at which the soil can maintain continued productivity. This rate is determined by the Natural Resources Conservation Service.

A farmer had until January 1, 1990 to develop and begin applying a conservation plan on highly erodible land. The plan must be operational by January 1, 1995. If a conservation plan is not developed and implemented, the farmer loses eligibility in price and income supports, crop insurance, FHA loans, Commodity Credit Corporation storage payments, farm storage facility loans, Conservation Reserve Program annual payments, and other programs under which USDA makes commodity-related payments. In other words, Conservation Compliance is an economic disincentive, quasi-regulatory program.

Sodbuster

The Sodbuster provision of the FSA and FACTA is aimed at discouraging the conversion of highly erodible land for agricultural production. It applies to highly erodible land that was not planted in annually tilled crops during the period 1981-85. As with the other provisions of the FSA, the Natural Resources Conservation Service determines if a field is highly erodible. If a highly erodible field is planted in an agricultural commodity without an approved conservation system, the landowner (or farmer) becomes ineligible for certain USDA program benefits.

Swampbuster

The purpose of Swampbuster is to discourage the conversion of wetlands to cropland use. Wetlands are defined as areas that have a predominance of hydric soils that are inundated or saturated by surface water or groundwater at a frequency or duration sufficient to support a prevalence of hydrophytic (water loving) vegetation. It is the responsibility of the Natural Resources Conservation Service to determine if an area is a wetland. Like the other provisions of the FSA and FACTA, a farmer will lose eligibility for certain USDA program benefits on all the land which is farmed if a wetland area is converted to cropland.

Conservation Easement
The Conservation Easement provision encourages producers whose FHA loans are in or near default to place their wetland, highly erodible land, and fragile land in conservation, recreation, or wildlife uses for periods of at least 50 years. The producer benefits by having the FHA loan partially canceled. The environment benefits by reducing the level of soil disturbing activities and the threat of agricultural pollutants.

Wetland Reserve
FACTA established a voluntary program for farmers to grant the federal government a 30-year or perpetual easement to wetlands. Eligible land includes farmed or converted wetlands which could be restored to their highest wetland function and value. The goal is to enroll one million acres by the end of 1995.

Water Quality Incentive Program
FACTA established this cost sharing program to help farmers control pollution problems associated with agricultural activities. A producer could receive up to $3,500 in cost share assistance to implement approved BMPs. The goal is to enroll 10 million acres by 1995.

5.3.2 NPS Programs for Urban and Developed Lands

- **Federal Urban Stormwater Discharge Program / NC NPDES Stormwater Program**

In 1987, Congress passed the Water Quality Act Amendments to the Clean Water Act requiring the U.S. Environmental Protection Agency (EPA) to develop regulations on permit application requirements for stormwater discharges associated with industrial activities as well as those associated with large and medium municipal separate storm sewer systems (population greater than 100,000). These regulations became effective in December 1990.

The goal of the stormwater discharge permitting regulations in North Carolina is to prevent pollution of the stormwater runoff by controlling the source(s) of pollutants. Defining the potential pollutant sources and establishing controls of the sources that will reduce and minimize pollutant availability will result in an improvement to the water quality of the receiving streams, consistent with the overall goal of the water quality program. Authority to administer these regulations has been delegated to the North Carolina Division of Water Quality (DWQ). The NPDES stormwater regulations require that facilities with stormwater point source discharges associated with industrial activity and municipalities defined as either large or medium municipal separate storm sewer systems be permitted.

The municipal permitting requirements are designed to lead to the formation of site-specific stormwater management programs for a municipal area Therefore, the permits issued to municipalities for their municipal separate storm sewer systems will be explicitly written for each individual municipality. Municipal permits of this type in North Carolina are currently required for Charlotte, Durham, Greensboro, Raleigh, Winston-Salem and Fayetteville/Cumberland County. The municipalities will develop and implement comprehensive stormwater quality management programs to reduce the discharge of pollutants in stormwater to the maximum extent practicable (MEP). MEP will be defined separately for each municipality required to be permitted. Industrial facilities discharging through a municipal separate storm sewer system are required to submit a permit application to the state and receive their own NPDES stormwater permit. Common best management practices to address urban runoff are listed in Appendix VI.

Industrial activities which require permitting are defined in eleven categories in the federal regulations ranging from sawmills and landfills to phosphate manufacturing plants and hazardous waste treatment, storage or disposal facilities. The regulations cover point source discharges that are related to manufacturing, processing, or material storage areas at an industrial facility. Stormwater discharges associated with industrial activities are required to be covered by permits which contain technology based controls based on Best Available Technology (BAT)/Best Conventional Pollutant Control Technology (BCT) considerations or water quality controls, if necessary. Through monitoring and regulating stormwater discharge quality, the goal of the NPDES stormwater program is to reduce the pollutant load in stormwater runoff.

The permitting requirements described here represent Phase I of the stormwater program. EPA and Congress are currently involved in studies to determine the scope of additional stormwater coverage under Phase II of the stormwater program. Further stormwater NPDES coverage could include additional industrial activities or additional municipal areas. If additional areas of coverage are added under the federal stormwater programs, DWQ will be responsible for the appropriate permitting of these areas within North Carolina.

- **Water Supply Protection Program**

Approximately 50 percent of North Carolina's population depends on surface water supplies for drinking, commercial, and industrial uses. Water supplies have become more important in recent years because of increased demand for water, concern over potential contamination by toxic substances, and protection of human health. As a result, the General Assembly passed the Water Supply Watershed Protection Act of 1989 (NCGS 143-214.5). This Act requires all local governments that have land-use jurisdiction within surface water supply watersheds, or a portion thereof, to be responsible for implementation and enforcement of nonpoint source management requirements related to urban development according to minimum standards adopted by the state. NPS control strategies are included in the rules for urban, agricultural, silvicultural, and Department of Transportation activities. The Water Supply Watershed Protection Rules were adopted by the Environmental Management Commission on February 13, 1992 and became effective on August 3, 1992. These rules were recently revised (effective August 1, 1995) to give local governments more flexibility in the implementation of water supply programs.

The purpose of the Water Supply Protection Program is to encourage communities to work with the state to provide enhanced protection for their water supply from pollution sources. There are five water supply classes that are defined according to existing land use and the amount and types of permitted point source discharges. (See Appendix I for a summary of the management requirements for the five water supply classifications.) By classifying a watershed as a water supply watershed, local governments having land use jurisdiction within the watershed will take steps to control nonpoint sources of pollution at their sources and thereby reduce the potential of pollutants contaminating their drinking water supply. In turn, the state limits the point source discharges that can locate within the watershed and thereby reduces the potential of contamination of the water supply.

This dual approach of state and local government action to preclude potential impacts from stormwater runoff and wastewater discharges is important since only a small fraction of the possible pollutants have water quality standards. As more is learned about the types and effects of pollutants in our drinking waters, the state will proceed to adopt additional water quality standards. One of the effects this would have is that water treatment facilities will be required to remove these pollutants. This could require additional technology and possibly more expensive treatment facilities or operation to ensure safe drinking water. It is therefore very important for the state and local governments to consider the important alternative of preventing pollution from entering their drinking water supplies.

The General Assembly extended the deadline for completing reclassification of existing surface water supply waters to July 1, 1992 in House Bill 873. The bill also established a schedule for local governments' submittal of water supply protection ordinances as follows:

1) July 1, 1993 for municipalities with populations of 5,000 or more,
2) October 1, 1993 for municipalities with smaller populations, and
3) January 1, 1994 for counties.

As of January 1995, 100% of the 20 local governments in the Roanoke River basin required to submit a water supply protection ordinance for approval have done so. Statewide, the compliance rate for submittals is also 100%.

The Water Supply Protection Program is administered by staff in the Operations Branch of the Water Quality Section in DWQ. These staff coordinate with the Division of Community Assistance (NCDCA) who helps local governments develop land-use ordinances, the Division of Environmental Health, which certifies that a proposed reclassification is suitable for a drinking water supply, and DWQ staff in NCDEHNR regional offices who are responsible for water quality sampling in the proposed water supply.

- **ORW and HQW Stream Classifications**
  Outstanding Resource Waters (ORW) and High Quality Waters (HQW) have management strategies that address handling of urban stormwater. Controls for urban stormwater, either through development density limitations or stormwater treatment systems, are required by DWQ. Some of these controls are outlined in Appendix I. Other NPS management agencies are expected to place priority on protecting these waters as well. For example, the NC Department of Transportation and the NC Division of Land Resources require more stringent sediment control on construction sites in ORW and HQW areas. There are currently no waters in the Roanoke River Basin supplementally classified as HQW or ORW.

- **CAMA Land Use Plans**
  The Coastal Area Management Act (CAMA), passed in 1974, requires the development of land use plans by each of the 20 coastal counties that fall within the coastal area. These plans must be consistent with state guidelines and address a wide range of issues, including resource protection and conservation, hazards mitigation, economic development and public participation. Land use plans must be updated every five years. 1995 revisions to the land use planning guidelines strengthened the connection between land use planning and surface water quality. Future land use plan updates must consider water quality use classifications, watershed planning and problems identified in basinwide plans. Of the 91 jurisdictions that have prepared and adopted CAMA land use plans, two CAMA counties and two municipalities fall wholly or partially in the Roanoke River basin.

  A land use plan is a "blueprint" used by local leaders to help guide their decisions that affect their community. Through land use planning, local jurisdictions can influence how that growth will affect surface water quality by adopting policies, supported by local ordinances, promoting better sedimentation and erosion control standards, stream buffers and lower levels of impervious surface cover. Although land use plans are required only in the state's coastal area, these land use planning tools for the protection of water quality are available to any jurisdiction which chooses to implement them.

- **Water Resources Development Project Grant Program**
  The Division of Water Resources administers a grant program for a variety of activities associated with water resources. Cost-share monies appropriated by the General Assembly are available for land acquisition and facility development for water-based recreation sites operated by local governments and stream restoration projects. These activities may create buffers or basins that retard stormwater runoff, reduce flood peaks and stabilize channels.

5.3.3 Construction - Sedimentation and Erosion Control NPS Program

In 1973, the North Carolina General Assembly enacted the Sedimentation Pollution Control Act. The Act authorized the establishment of a sediment control program to prevent accelerated erosion and off-site sedimentation caused by land-disturbing activities other than agriculture, forestry, and mining. The Land Quality Section of the Division of Land Resources is responsible for administration and enforcement of the requirements of the Act under the authority of the NC Sedimentation Control Commission.

The sediment control program requires, prior to construction, the submission and approval of erosion control plans on all projects disturbing one or more acres. On-site inspections are conducted to determine compliance with the plan and to evaluate the effectiveness of the BMPs (see examples listed in Appendix VI) which are used. The intent is to prevent sedimentation damage to downstream properties and the waters of the state. If voluntary compliance with the approved plan is not achieved and violations occur, the Land Quality Section will pursue enforcement through civil penalties and injunctive relief. House Bill 448, passed in 1991, authorized the issuance of stop-work orders for violations of the SPCA. This additional enforcement mechanism will help improve the overall performance of the program.

Sedimentation control rules are more stringent for areas draining to waters supplementally classified as Trout or High Quality Waters.

There is one local county erosion and sedimentation control program with part of its jurisdiction in the Roanoke River Basin (Forsyth County). Local programs are reviewed annually for compliance with the requirements of the Sedimentation Pollution Control Act. The Land Quality Section also conducts educational programs directed toward state and local government officials in order to strengthen the local programs. Persons engaged in land-disturbing activities and interested citizen groups are included in the educational effort.

The Sedimentation Control Commission has delegated to the Division of Highways of the North Carolina Department of Transportation (DOT) the authority to approve erosion and sedimentation control plans for land-disturbing activity conducted by that agency or by other persons under highway contracts with that agency. The DOT sedimentation control program has been reviewed by the Division of Land Resources under the authority of the Sedimentation Control Commission. DOT uses more stringent sedimentation controls in areas adjacent to High Quality Waters and Outstanding Resource Waters. The NC Department of Environment, Health, and Natural Resources (NCDEHNR) has established a position to evaluate environmental aspects of DOT highway projects and programs. DOT, in cooperation with DWQ, has developed and adopted formal BMPs for protection of surface waters. These BMPs and other efforts are significant improvements in developing a proactive system at DOT toward environmental issues.

5.3.4 On-Site Wastewater Disposal - Sanitary Sewage Systems NPS Program

Septic tank soil absorption systems are the most widely used method of on-site domestic wastewater disposal in North Carolina. More than 52 percent of all housing units in the state are served by septic tank systems or other systems besides public or community sewage systems. A conventional septic system consists of a septic tank, a distribution box or equivalent branching lines, and a series of subsurface absorption lines consisting of tile or perforated pipes laid in a bed of gravel. All subsurface sanitary sewage systems are under the jurisdiction of the Commission for Health Services (CHS) of the Department of Environment, Health, and Natural Resources. The CHS establishes the rules for on-site sewage systems which are administered by the Division to Environmental Health. BMPs for onsite sewage systems are listed in Appendix VI.

According to GS 130A-335(e) and (f), the rules of the CHS and the rules of the local board of health shall address at least the following: sewage characteristics; design unit; design capacity; design volume; criteria for the design, installation, operation, maintenance, and performance of sanitary sewage collection, treatment, and disposal systems; soil morphology and drainage; topography and landscape position; depth to seasonally high water table, rock, and water impeding formations; proximity to water supply wells, shellfish waters, estuaries, marshes, wetlands, areas subject to frequent flooding, streams, lakes, swamps, and other bodies of surface or groundwaters; density of sanitary sewage collection, treatment, and disposal systems in a geographical area; requirements for issuance, suspension, and revocation of permits; and other factors which affect the effective operation in performance of sanitary sewage collection treatment and disposal systems.

The rules also must provide construction requirements, standards for operation, and ownership requirements for each classification of sanitary systems of sewage collection, treatment, and disposal in order to prevent, as far as reasonably possible, any contamination of the land, groundwater, and surface waters. There exists a strict permitting procedure which regulates site selection, system design, and installation of on-site sewage systems. Privately owned subsurface sewage discharging systems are governed by NCDEHNR through local county health departments. Authorized local sanitariums serve as agents of NCDEHNR and assist in implementing the state sewage rules. Local boards of health may adopt by reference the state rules and append to those rules more stringent laws and local criteria which they desire. These amendments, however, must be approved by the state. Only nine counties in the state currently operate under local rules. The 1983 amendments of the state public health laws eliminated the co-mingling of state rules with local rules except by state approval.

5.3.5 Solid Waste Disposal NPS Programs

- **Federal Program**
  The major federal legislation in the area of solid waste management is the Resource Conservation and Recovery Act (RCRA) administered by the U.S. Environmental Protection Agency (EPA). RCRA deals almost entirely with hazardous waste management but it does require that states meet minimum standards for solid waste facilities. EPA does not have permitting authority over solid waste management facilities.

- **State Program**
  States are accorded a major role in solid waste management by RCRA. North Carolina now operates under revisions by the General Assembly to Chapter 130A of the General Statutes. The Division of Solid Waste Management (DSWM) in the Department of Environment Health and Natural Resources is authorized as the single state agency for the management of solid waste. DSWM is responsible for the development of the state's solid waste management plan, has permitting authority over all solid waste management facility siting and operation, inspects permitted facilities, provides technical assistance, investigates complaints, responds to emergencies, monitors ground water quality at facilities, promotes the state's recycling effort, and closes non-conforming sites.

  The Solid Waste Management Act of 1989 established the policies and goals of the state to recycle at least 25 percent of the total waste stream by January 1, 1993. This Act created a Solid Waste Management Trust Fund to promote waste reduction and fund research and demonstration projects to manage solid waste. In 1991, the Solid Waste Management Act of 1989 was amended to broaden the goal to reduce the solid waste stream by 40 percent through source reduction, reuse, recycling, and composting by June 30, 2001.

The state adopted solid waste management rules, effective February 1, 1991, requiring liner, leachate collection, and final cover systems at all new landfills, lateral expansions of existing landfills, and at all active landfills by January 1, 1998. Septage rules and regulations also have been adopted and are administered through a permit program.

- **Local Program**
  Solid waste collection and disposal has long been a municipal function. The operation of solid waste collection and disposal facilities is among the enterprises which municipalities are expressly authorized by statute to operate (G.S. 160A-311 through 160A-321). Municipalities are also authorized to regulate the disposal of solid waste within their corporate limits. Such regulations may specify the location and type of receptacles to be used for collection (G.S. 160A-192).

  Outside municipal limits, counties are authorized to operate solid waste collection and disposal facilities either as a function of county government or through establishment of a special service district (G.S. 153A-292 and 301). Since 1970, county governments have increasingly accepted responsibility for solid waste disposal activities and most disposal facilities in the state are now operated by counties or with county financial assistance.

5.3.6 Forestry NPS Programs

- **Forest Practice Guidelines Related to Water Quality**
  In 1989 the Sedimentation Pollution Control Act (SPCA) was amended to limit the forestry exemption to those operations that adhere to forest practice guidelines. The forestry amendment to the SPCA required the Division of Forest Resources to develop performance standards known as the Forest Practices Guidelines Related to Water Quality.

  Guidelines consist of nine performance standards for activities such as maintaining streamside management zones and applying fertilizer and pesticide applications. These Guidelines are used to determine if a forestry operation will fall under the jurisdiction of the Division of Land Resources which enforces the SPCA. The Guidelines were developed in October 1989 and were put into effect on January 1, 1990. A Memorandum of Agreement was also signed between the Division of Forest Resources and the Division of Land Resources to coordinate their respective activities in the sedimentation control program. DLR has also signed an MOA with DWQ.

  Site-disturbing forestry activities are being inspected by local DFR personnel as part of a training, mitigation, and monitoring program. Site inspections are conducted when a problem or potential problem is suspected to exist. Sites not brought into compliance within a reasonable time schedule are referred by DFR to DLR or DWQ for appropriate enforcement action. Commonly used forestry BMPs are listed in Appendix VI.

- **National Forest Management Act (NFMA)**
  The National Forest Management Act was passed in 1976 and applies to all lands owned or administered by the National Forest System. The Act stipulates that land management plans be prepared which consider economic and environmental aspects of forest resources. The Act further states that timber will be harvested from National Forest lands only where soil, slope, or other watershed conditions will not be irreversibly damaged; and where protection is provided for streams, streambanks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of

watercourses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat.

- **Forest Stewardship Program**
  The Division of Forest Resources initiated the Forest Stewardship Program in 1991 along with the cooperation and support of several other natural resource and conservation agencies. This program encourages landowners with ten or more acres of forestland to become involved and committed to the wise development, protection and use of all natural forest resources they own or control.

5.3.7 Mining NPS Program

In 1971 the North Carolina General Assembly passed the Mining Act to ensure that the usefulness, productivity, and scenic values of all land and waters involved in mining will receive the greatest practical degree of protection and restoration. The Mining Commission is the rule-making body for the Act and has designated authority to administer and enforce the rules and regulations of the Act to the Mining Program within the Land Quality Section of the NCDEHNR Division of Land Resources.

The Mining program has four major areas of responsibility. First, the Program requires submission and approval of a mining permit application prior to initiating land disturbing activity if the mining operation is one (1) or more acres in surface area. The mining permit application must have a reclamation plan for these operations. Second, the Program conducts on-site inspections to determine compliance with the approved application and whether or not the plan is effective in protecting land and water quality. Third, the program pursues enforcement action through civil penalties, injunctive relief, and/or bond forfeiture to gain compliance when voluntary compliance is not achieved. Finally, the Mining Program conducts educational efforts for mine operators. Common BMPs for mining activities are listed in Appendix VI.

5.3.8 Wetlands Regulatory NPS Programs

There are numerous reasons for preserving wetlands, but of special interest within the context of basinwide planning is their role in protecting water quality. Because of their intrinsic characteristics and location within the landscape, wetlands function to protect water quality in a number of ways. These functions include the retention and removal of pollutants, stabilization of shorelines, and storage of flood waters.

Numerous authors have studied the effectiveness of riparian wetland forests for nutrient retention and transformation (Jones et al. 1976; Yates and Sheridan 1983; Brinson et al. 1984; Lowrance et al. 1984; Peterjohn and Correll 1984; Jacobs and Gilliam 1985; Budd et al. 1987; and Groffman et al. 1991). The location of riparian wetlands allows them the opportunity to receive nutrients from the surrounding landscape as well as through overbank flooding. In addition to the storage of nutrients in wetland vegetation, the microbial and chemical processes within wetland soils may function to completely remove nutrients from the system.

Headwater riparian wetlands are the most important wetland in terms of sediment and associated nutrient and toxicant retention. Since small streams comprise most of the total stream length within a watershed (Leopold 1974), these areas intercept the greatest proportion of eroded sediments and associated substances from uplands before these pollutant reach waters downstream. Novitzki (1978) found that approximately 80% of the sediments entering a stream were retained in headwater wetlands.

Wetlands adjacent to streams, rivers and lakes stabilize shorelines and help protect these bodies of water from erosive forces. This function is particularly important in urbanized watersheds where the prevalence of impervious surfaces contributes to greater peak storm flows. Wetland vegetation serves to dissipate erosive forces and anchors the shoreline in place preventing sediments and associated pollutants from entering waterways. Wetlands by their very nature of being "wet" are also vital for water storage. Those wetlands adjacent to surface waters, that have the opportunity to receive flood waters and surface runoff, are most important to water storage. Wetlands located in headwaters generally desynchronize peaks in tributaries and main channels, and lakes and wetlands with restricted outlets hold back flood waters and attenuate flood peaks (Carter et al. 1978).

Several important state and federal wetland protection programs are described below. In addition to the following wetlands programs, provisions of the 1985 and 1990 Farm Bills, discussed in Section 5.3.1, should also help reduce wetlands impacts. Agriculture conversions should be reduced by the "swampbuster" provision of the 1985 Farm Bill, which encourages farmers not to convert wetlands for agriculture in order not to lose their USDA subsidies, loans, and price supports. Silviculture is exempted from the swampbuster provision and therefore, conversion of wetlands for intensive or managed forestry will not receive the benefits of this incentive device. A Wetland Reserve Program was established by the 1990 Farm Bill with the goal of allowing one million acres of prior-converted wetlands to revert back to wetlands by 1995.

- **Section 10 of the Rivers and Harbors Act of 1899**
  This act, administered by the US Army Corps of Engineers, provides the basis for regulating dredge and fill activities in navigable waters of the United States. Originally, this Act was administered to protect navigation and the navigation capacity of the nation's waters. In 1968, due to growing environmental concerns, the review of permit applications was changed to include factors other than navigation including fish and wildlife conservation, pollution, aesthetics, ecology, and general public interest. Activities which may be covered under the Act include dredging and filling, piers, dams, dikes, marinas, bulkheads, bank stabilization and others.

- **Section 404 of the Clean Water Act**
  The U.S. Army Corps of Engineers administers a national regulatory program under Section 404 of the Clean Water Act aimed at controlling the discharge of dredged or fill material into waters of the United States. Section 404 applies to just the discharge of dredged or fill materials into waters of the United States and does not apply to dredging activities. Waters of the United States refers to navigable waters, their tributaries, and adjacent wetlands. Activities covered under Section 404 include dams, dikes, marinas, bulkheads, utility and power transmission lines and bank stabilization. Although the 404 program does not fully protect wetlands, it is nonetheless the only federal tool at this time for regulating wetland development statewide. State legislation has not been adopted to protect inland freshwater wetlands in North Carolina, as has been done for coastal wetlands, but DWQ is in the process of drafting rules which will formalize the wetlands protection measures associated with the 401 Water Quality Certification review process.

- **Section 401 Water Quality Certification (from CWA)**
  The Division of Water Quality is responsible for the issuance of 401 Water Quality Certifications. Section 401 of the federal Clean Water Act provides that no federal agency can issue any license or permit to conduct any activity which may result in a new discharge to the navigable waters, or the alteration of an existing discharge, unless the state has certified that the activity will comply with all state water quality or related standards. Thus, a 401 certification is required for, among other things, a discharge into surface waters or wetlands for projects that require a section 404 permit. A federal permit cannot be issued if the state denies a 401 certification. The 401 certification process is coordinated with the 404 and CAMA processes in the 20 counties of CAMA jurisdiction.

- **North Carolina Dredge and Fill Act (1969)**
  This act requires permits for "excavation or filling begun in any estuarine waters, tidelands, marshlands, or state-owned lake". This law is currently administered with North Carolina's Coastal Area Management Act (CAMA) (1974).

5.3.9 Hydrologic Modification

Hydrologic modification is defined as channelization, dredging, dam construction, flow regulation and modification, bridge construction, removal of riparian vegetation, streambank modification/destabilization, and dam collapse. By its very nature hydrologic modification is closely tied to wetland issues. It is not surprising then that the U.S. Army Corps of Engineers (Corps) is the agency most involved in issuing permits for land-disturbing activities in wetlands. These permits are issued through Section 404 and the Rivers and Harbors Act discussed above.

In addition to wetland issues, dam construction and the lack of low flow releases into streams can severely impact downstream aquatic resources. Dam construction, repair, modification, and removal are regulated by the NC Division of Land Resources under the Dam Safety Law of 1967. A dam safety permit is required for any dam which is 15 feet or greater in height (from top of dam to lowest point on downstream toe) and the impoundment capacity is 10-acre-feet or greater at the top of the dam. Low-flow release requirements to maintain adequate instream flows are established in permits where appropriate. Instream flows are recommended by the NC Division of Water Resources.

There are several other programs which can affect hydrologic modification. The Forest Practice Guidelines Related to Water Quality requires streamside management zones to be maintained during logging operations. The Water Supply Watershed Protection Program also has requirements to maintain buffers for certain activities. The Conservation Reserve Program encourages the establishment of vegetative filter strips (66-99 feet wide) for farming operations. A significant number of local governments have established greenway programs within urban settings in order to maintain and protect riparian areas.

5.3.10 Water Supply Legislation in North Carolina

- **Water Supply Planning Law**
  The Water Supply Planning law (G.S. 143-355 (l) and (m)) was adopted in 1989 and amended in 1993. It requires all local governments that supply or plan to supply water to prepare a local water supply plan. In their plans, local governments are to include present and projected population, industrial development and water use within the service area, present and future water supplies, an estimate of technical assistance needs and other information that may be required by the Department. All local plans are to be approved and submitted to DWR by January 1, 1995. Information in those local plans is to be included in a State Water Supply Plan. The State Plan will also investigate the extent to which the various local plans are compatible.

- **Registration of Water Withdrawals and Transfers Law**
  The Registration of Water Withdrawals and Transfers law (G.S. 143-215.22H) requires any person who withdraws or transfers 1 MGD or more of surface water or groundwater to register the average daily and maximum daily withdrawal or transfer with the Environmental Management Commission (EMC). The law also provides that if a local government has an approved local water supply plan on file with DWR, it does not have to register that withdrawal, thereby reducing duplication of effort by local governments that otherwise would be subject to both laws. In addition, the law includes a 5-year renewal requirement, which will ensure that the data is regularly updated.

A related provision (G.S. 143-215.22A) notes the public policy of the state that a surface water withdrawal should not cause the natural flow of a river or portion of a reservoir to be reversed if a substantial portion of the water is not returned to the river system.

- **Regulation of Surface Water Transfers Act**
  In 1993, the legislature adopted the Regulation of Surface Water Transfers Act (G.S. 143-215.22I et seq.). This law was designed to regulate large surface water transfers by requiring a certificate from the EMC and by repealing several other laws that had previously affected interbasin transfers. The law applies to anyone initiating a transfer of 2 MGD from one river basin to another and to anyone increasing an existing transfer by 25 percent or more if the total transfer is 2 MGD or more. Applicants for certificates must petition the EMC and include a description of the transfer facilities, the proposed water uses, water conservation measures to assure efficient use and any other information desired by the EMC. A certificate will be granted for the transfer if the Commission concludes that the overall benefits of the transfer outweigh its detriments. The Commission may grant the petition in whole or in part, or deny it, and it may require mitigation measures to minimize detrimental effects. The law also provides for a $10,000 civil penalty for violating various statutes.

- **Capacity Use Act**
  DWR administers the Capacity Use Act (G.S. 143-215.11 et seq.), which allows the EMC to establish a Capacity Use Area where it finds that the use of ground water, surface water or both requires coordination and limited regulation. If after an investigation and public hearings a Capacity Use Area is designated, the EMC may adopt regulations within the area, including issuance of permits for water users. In the near future, DWR plans to review the rules for implementation of the Capacity Use statute and develop a model of the aquifer system, in coordination with the Groundwater Section of DWQ, for Capacity Use Area 1, which was created to regulate surface water and ground water withdrawals in an area surrounding Texasgulf, Inc. in Aurora, N.C. A new ground water flow model will be used to simulate Capacity Use Area 1 as a basis for permitting withdrawals.

- **Dam Safety law**
  The Dam Safety law (G.S. 143-215.24) was amended in 1993, and rules are being developed for implementation of these amendments. Among the changes, the amendment defines "minimum stream flow" as a quantity and quality sufficient in the judgment of the Department of Environment, Health and Natural Resources (DEHNR) to meet and maintain stream classifications and water quality standards established by DEHNR and to maintain aquatic habitat in the affected stream length.

  The Dam Safety Law applies to dams that are 15 feet or more high or with impoundment capacity of 10 acre feet or more. The law requires that the EMC adopt rules specifying minimum stream flow in the length of the stream affected by a dam and sets specific parameters for minimum stream flow for dams operated by small power producers that divert water from 4,000 feet or less of a natural stream bed and return the water to the same stream.

- **Roanoke River Basin Water Allocation Law**
  G.S. 143-215.22B reserves and allocates to the State all rights in the water located in Kerr Lake and Lake Gaston that are in the State. These rights are allocated to the State as protector of the public interest in the waters.

5.4 ALBEMARLE-PAMLICO ESTUARINE STUDY

5.4.1 Introduction

By authority of the Clean Water Act, the Governor of North Carolina and the U.S. Environmental Protection Agency (EPA) designated the Albemarle and Pamlico sounds as an "estuary of national significance" because of the diversity and importance of the region's natural resources. The area was selected for inclusion in EPA's National Estuary Program (NEP) in 1987. Through a cooperative agreement between the NC Department of Environment, Health and Natural Resources and the EPA, the Albemarle-Pamlico Estuarine Study (APES) was created to study the environmental conditions in over 23,000 square miles of watershed in North Carolina and Virginia.

Four committees consisting of 95 members have guided its work. These committees, known as the APES Management Conference, represented nearly every group with an interest in the region: farmers, foresters, fishermen, environmentalists, developers, business and industry leaders, university researchers, government agencies, and local government officials. Their goals were to identify problems in the estuarine system, generate research where gaps in knowledge existed, increase public awareness of environmental issues, and find solutions to address those issues.

5.4.2 Comprehensive Conservation and Management Plan (CCMP)

As a result of the APES program, more is known about the Albemarle-Pamlico estuary than ever before. The culmination of this six-year collaboration is the APES Comprehensive Conservation and Management Plan (CCMP). The CCMP addresses three main environmental concerns - water quality, vital habitats, and fisheries - as well as the need for public involvement and education. This document, which proposed management strategies designed to protect the region's natural resources and allow for responsible economic growth, was officially endorsed by Governor James B. Hunt and the EPA in November of 1994. Currently, several key objectives of the CCMP are being implemented through the Division of Water Quality's Water Quality Section.

5.4.3 Regional Councils

The CCMP recommends the establishment of a Regional Council for each of the five river basins in the Albemarle-Pamlico watershed. membership to the Regional Councils consists of citizens and local government officials, representing every county and interest group in the region. The Regional Councils, which have no regulatory authority, are to advise and consult with local, state, and federal governments, as well as the general public and different interest groups within the basin, on the implementation of environmental management programs in the river basins. To date, one Regional Council has been formed. That one is for the Neuse River and their first meeting was held on November 27, 1995. For other river basins in the APES region, including the Roanoke, councils may be formed sometime in 1996.

5.5 INTEGRATING POINT AND NONPOINT SOURCE POLLUTION CONTROLS STRATEGIES

Integrating point and nonpoint source pollution controls and determining the amount and location of the remaining assimilative capacity in a basin are key long-term objectives of basinwide management. The information can be used for a number of purposes including determining if and where new or expanded municipal or industrial wastewater treatment facilities can be allowed; setting the recommended treatment level at these facilities; and identifying where point and nonpoint source pollution controls must be implemented to restore capacity and maintain water quality standards.

The U.S. Environmental Protection Agency (USEPA) has developed a means to help accomplish these objectives called *total maximum daily loads (TMDL).* The TMDL approach, which is being required by the United States Environmental Protection Agency (USEPA) pursuant to Section 303(d) of the Clean Water Act, is based on the concept of determining the total waste (pollutant) loading, from point and nonpoint sources, that a water body (such as a stream, lake or estuary) can assimilate while still maintaining its designated uses.

A TMDL is a strategy for establishing water quality-based controls on point and nonpoint sources of a given pollutant identified as contributing to a waterbody's impairment. In the Cape Fear basin, biochemical oxygen demand (BOD) and nutrients are the primary pollutants for which TMDLs are being developed. The TMDL can reflect quantifiable limits to be placed on specific pollution sources or it can be comprised of programmatic strategies (e.g., implementation of nonpoint source best management practices) established to reduce pollutant loadings, in general, throughout the targeted waterbody. The overall goal in establishing the TMDL is to set forth a course of management actions necessary for a waterbody to meet water quality standards.

It should be noted that a targeted water body does not necessarily refer to an entire basin. In the Cape Fear River Basin, for example, there are several major drainage areas (e.g., Deep River, Haw River and Cape Fear River) for which individual TMDLs are being recommended. TMDLs for smaller streams may also serve as important elements in a TMDL covering a larger portion of the basin. Nesting of TMDLs in this fashion constitutes a flexible yet comprehensive management approach that allows for specific strategies to be developed for smaller problem areas and yet offers the means to address the large scale problems as well.

As DWQ's abilities to quantify and predict the impacts of point and nonpoint source pollution become more sophisticated, the basinwide approach will make more innovative management strategies possible. Possible strategies that might be considered in future Cape Fear Basinwide Plans or in the plans for basins that come up later in this first five-year cycle include agency banking, pollution trading among permitted dischargers, industrial recruitment mapping and consolidation of wastewater discharges.

Agency banking refers to the concept of holding assimilative capacity in reserve by DWQ for future growth and development in the basin. *Pollution trading* involves trading of waste loading and stream assimilative capacity among permitted dischargers, or between point and nonpoint sources, adding flexibility to the permitting system and also using the free market system as an aid to identifying the most cost effective solution to water quality protection. *Industrial recruitment mapping* involves providing specific recommendations on the types of industry and land development best suited to the basin's long-term water quality goals and also an individual basin's ability to assimilate a particular type or quantity of discharge or nonpoint source pollutants. *Consolidation of wastewater discharges*, also referred to as regionalization, entails combining several dischargers into one facility. Input from local authorities, regulated industries, landowners, and other interested parties will be needed to develop these strategies. By accommodating, to the degree possible, local needs and preferences, the probability of the plan's long-term success can be increased.

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CHAPTER 6

BASINWIDE GOALS, MAJOR WATER QUALITY CONCERNS AND RECOMMENDED MANAGEMENT STRATEGIES FOR THE ROANOKE BASIN

6.1 BASINWIDE MANAGEMENT GOALS

It has been documented in Chapter 4 that the majority of waters in the Roanoke River basin are presently unimpaired. However, there are waterbodies where impairment exists and which need to be restored. In addition, continued population growth and development as well as increases in agricultural, industrial and silvicultural uses of land promise to amplify these problems unless effective long-term strategies are developed to meet these challenges.

The long-range goal of basinwide management is to provide a framework for DWQ and others to mitigate impacts to the system and thereby allow for development and economic growth while protecting and/or restoring the quality and intended uses of the Roanoke River Basin's surface waters. To that end, this document proposed various strategies for alleviating the effects of current and foreseeable sources of pollution.

In striving towards the long-range goal stated above, DWQ's highest priority near-term goals will be as follows:

- o identify and restore the most serious water quality problems in the basin (**Section 6.2.1**)
- o protect those waters known to be of the highest quality or supporting biological communities of special importance (**Section 6.2.2**) and
- o manage problem pollutants, particularly biochemical oxygen demand, nutrients, sedimentation and toxics in order to correct existing water quality problems and to ensure protection of those waters currently supporting their uses (**Sections 6.2.3 and 6.3 through 6.9**).

6.2 MAJOR WATER QUALITY CONCERNS AND PRIORITY ISSUES

6.2.1 Identifying and Restoring Impaired Waters

For the purposes of this chapter, impaired waters are those identified as being rated partially supporting their designated uses based on monitored data (see Section 4.5) in Table 4.23 and in Figure 4.21 of Chapter 4. A list of those impaired waters in the Roanoke River Basin is presented in Table 6.1. Waterbodies listed in this table include those which have been rated based on biological or chemical monitoring data between 1990 and 1994. Table 6.1 also includes the current and planned water quality management strategies for these waters.

Depending on the cause and source of impairment, the strategies in Table 6.1 may rely on limiting point source pollution discharges through the NPDES permitting program, on implementation of nonpoint source pollution control measures, or a combination of both. Where water quality problems have been identified but the source(s) is not evident, investigation of the source(s) will be necessary before any specific actions can be outlined. Water quality monitoring will be an

Table 6.1 List of Monitored Impaired Waterbodies and Recommended Management Strategies

Subbasin	Waterbody Name	Use Rating	Source	Management Strategy	Chapter 6 Reference Section	NPS Priority
01	Belews Lake	PS	P	Selenium source to lake eliminated. Recovery being monitored.	6.5.2	N/A
05	Marlowe Creek	PS	NP, P	Consider need for improvements to Roxboro WWTP and/or ID	6.3.1	M
				and implement NPS controls to restore water quality.		
05	Hyco Lake	PS	P	Selenium source to lake eliminated. Recovery being monitored.	6.5.3	N/A
06	Anderson Creek	PS	NP	ID and correct sedimentation problems	6.6	M
06	Nutbush Creek	PS	NP, P	Monitor improvements to Henderson WWTP and investigate NPS measure	6.4.2, 6.5.6	M
07	Smith Creek	PS	NP	ID and correct sedimentation problems (SECP needed)	6.6	M
07	Lake Gaston	PS	NPS	Assess need for NPS nutrient mgmt plan to address aquatic weed problems	6.4.2	M
08	Conconnara Swamp	PS	NP	Evaluate contribution of ag runoff and implement BMPs as needed	6.3.2	M
08	Roanoke Rapids Res.	PS	NP	Assess need for NPS nutrient mgmt plan to address aquatic weed problems	6.4.2	M
08/09	Roanoke R. (below	PS	NP, P	Dioxin source to river eliminated. Recovery being monitored.	6.5.4	M
	Williamston)					
08	Quankey Creek	PS	NP, P	Evaluate impacts from highway reststop.	6.7	M
09	Welch Creek	PS	NP, P	Dioxin source to creek eliminated. Recovery being monitored.	6.5.4	M
10	Cashie River	PS	NP	Evaluate contribution of ag runoff and implement BMPs as needed	6.3.2	M

DEFINITIONS	
PS	Partially Supporting classified uses
NS	Not Supporting classified uses
NP	Impairment due to Nonpoint Source pollution, though specific sources may not be known
P	Impairment attributed to Point source pollution
SECP	Sediment Erosion Control Plan
NPDES	NPDES permit limits or compliance program
Use Rating	Use support rating - See Section 4.5 and Appendix IV for explanation

important component of this strategy. Where more detailed information is known about a waterbody listed in Table 6.1, summaries of the water quality problem and management strategies are presented in sections 6.3 through 6.7. It is of note that several streams and lakes, which have been impaired by discharges from point sources in the past, have seen improvements and are now being monitored for recovery. These include Hyco and Belews Lakes (Selenium discharges from fly ash ponds have been eliminated), Welch Creek and the lower Roanoke River below Williamston (dioxin discharges from Weyerhaueser have been eliminated) and wastewater treatment plant improvements by Henderson (Nutbush Creek).

Federal Funding Priorities for Restoring Nonpoint Source Impaired Streams and for Protecting Highly Valued Resource Waters

Federal grant funding is made available to the state for both restoring waters impaired by nonpoint source pollution and for protecting unusually sensitive highly valued resource waters from nonpoint source degradation. Figures 6.1a and 6.1b depict those waters in the Roanoke River Basin targeted for priority nonpoint source management. The funds are provided by the US Environmental Protection Agency pursuant to Section 319 of the Clean Water Act. Grants are awarded on a competitive basis across the state.

The NPS Priority column of Table 6.1 indicates DWQ's recommended priority rating for awarding of grant funding to address restoration of nonpoint source impaired waters in the Roanoke Basin. The rating is based on a schedule of priority from high to medium, presented below. Because the use support ratings for all of those streams in the Roanoke that are impaired by nonpoint source pollution is *partially supporting* (as opposed to *not supporting*), these waterbodies have been assigned a medium priority rating. It should be noted that there is a provision under the High priority waters for a partially supporting stream such at Nutbush Creek or Marlowe Creek to be considered High priority if there is predicted loading of one or more pollutants that is high.

Table 6.2 lists those highly valued resource waters in the basin that qualify for a High priority rating. These ratings are based on the classifications of the waters which in this basin include WS-II, and the critical areas (CA) of WS-III, IV and V waters. These classification are discussed in Section 2.7 of Chapter 2 and in Appendix I.

High priority waters:

- monitored waters that have an overall use support rating of "nonsupporting,"
- monitored waters that have a "partial support" rating but have a predicted loading of one or more pollutants that is high,
- highly valued resource waters as documented by special studies
  - High Quality Waters (None in Roanoke Basin)
  - Outstanding Resource Waters (None in Roanoke Basin)
  - Water Supply I; Water Supply II; Critical Areas of WS-II, WS-III, WS-IV (in the Roanoke Basin)
  - Shellfish Waters (Class SA) closed due to pollutants that have a Significant Shellfish Resource (SSR) as identified by the Division of Environmental Health. (None in Roanoke Basin)

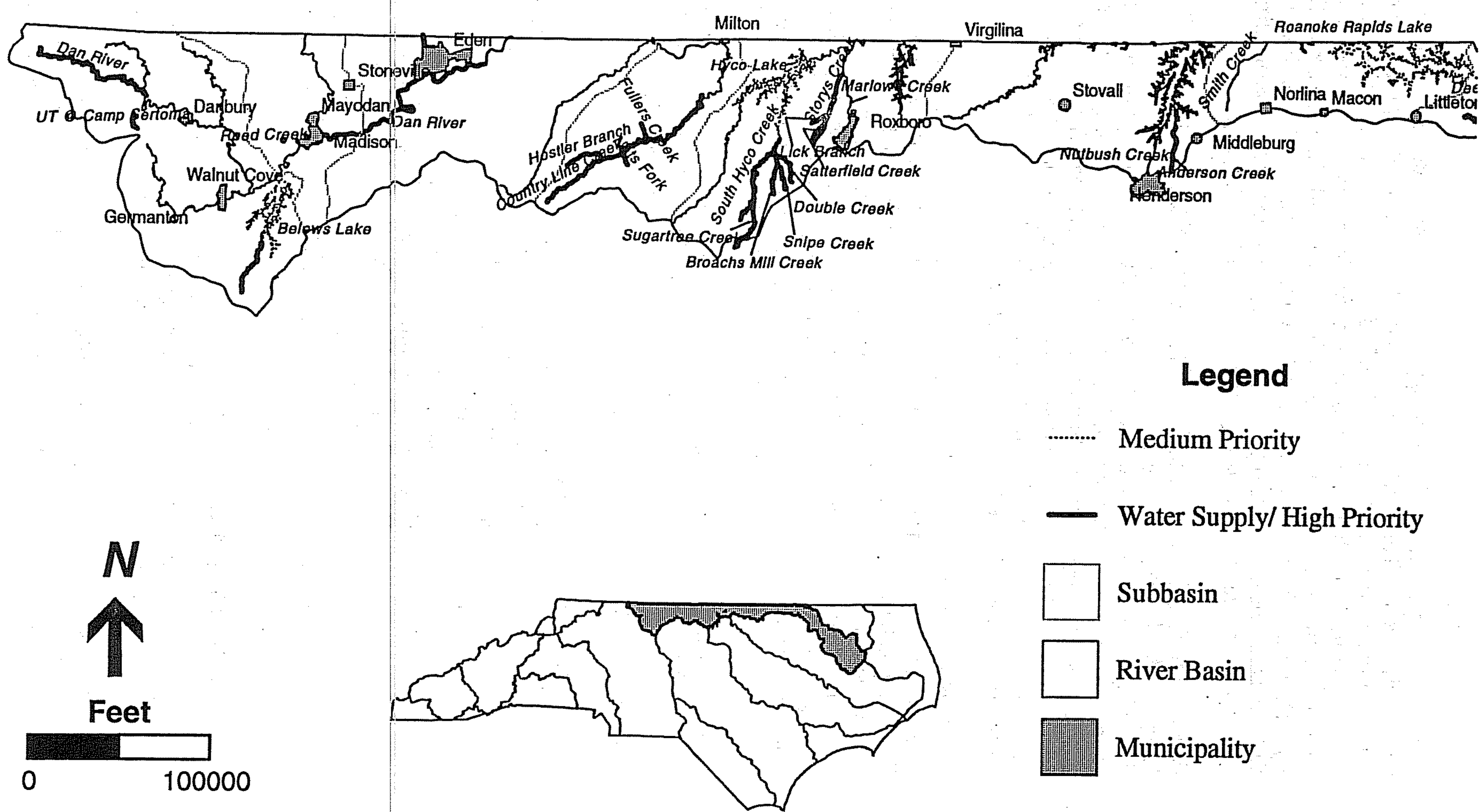
Medium priority waters:

- Monitored waters that have an overall use support rating of "partially supporting."
- Shellfish Waters (Class SA) that are closed due to pollutants and that do not have a SSR are also considered medium priority streams. (None in Roanoke Basin)

In addition to establishing a priority rating system for awarding of 319 funds, it is hoped that these ratings can be used by other state, local and federal agencies involved in addressing nonpoint source pollution problems by helping to target some of their resources and activities. This could

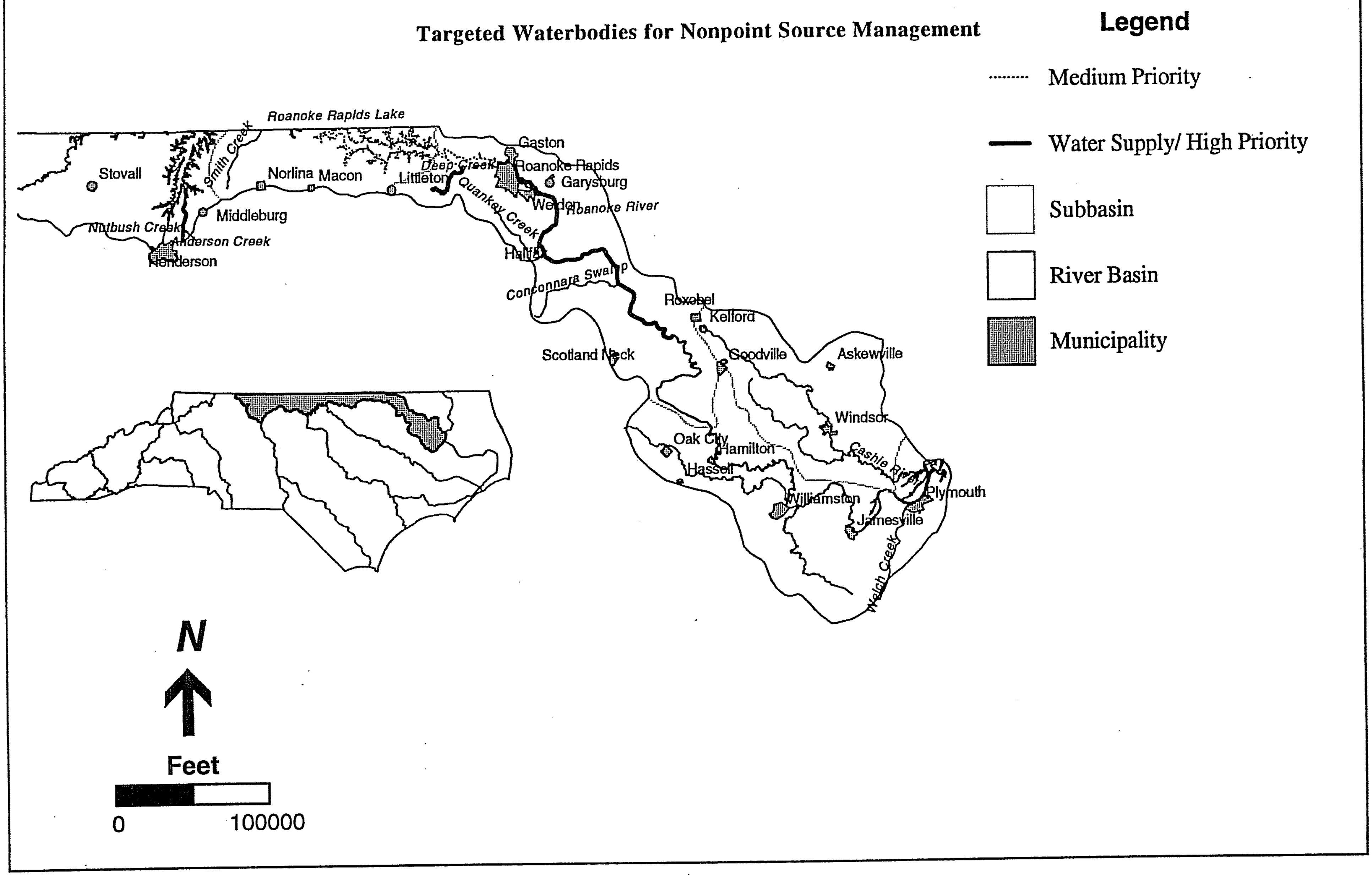
Upper Roanoke Basin

Targeted Waterbodies for Nonpoint Source Management



Lower Roanoke Basin

Targeted Waterbodies for Nonpoint Source Management



include such agencies as the NC Agriculture Cost Share Program, the Division of Forest Resource's (through the Forest Practice Guidelines Related to Water Quality), Cooperative Extension Service, Natural Resources Conservation Service, local governments and many others.

Table 6.2 Nonpoint Source Priority Ratings for Protection of High Resource Value Waters in the Roanoke River Basin

Name of Stream	Index #	Miles	Reason for Priority*	NPS Priority
Unnamed Tributary at Camp Sertoma	22-11-1-2-(1.5)	0.5	WS-II CA	High
Belews Creek	22-27-(1.5)	1.2	WS-IV CA	High
Dan River above water intake	22-(27.5)	0.6	WS-IV CA	High
Reed Creek	22-28-(2)	0.3	WS-IV CA	High
Mayo River	22-30-(9.5)	0.5	WS-IV CA	High
Dan River above water intake	22-(38.5)	0.5	WS-IV CA	High
Smith River	22-40-(2)	0.5	WS-IV CA	High
Country Line Creek	22-56-(1)	12.9	WS-II	High
Hostler Branch	22-56-2	6.4	WS-II	High
Nats Fork	22-56-3	3.0	WS-II	High
Country Line Creek	22-56-(3.5)	4.3	WS-II CA	High
Fullers Creek	22-56-4-(1)	0.9	WS-II	High
Fullers Creek	22-56-4-(2)	0.8	WS-II CA	High
South Hyco Creek	22-58-4-(0.5)	7.3	WS-II	High
Sugartree Creek	22-58-4-1	4.4	WS-II	High
South Hyco Creek (Lake)	22-58-4-(1.4)	3.5	WS-II & B	High
South Hyco Creek	22-58-4-(1.7)	4.1	WS-II	High
Double Creek	22-58-4-2	5.8	WS-II	High
Broachs Mill Creek	22-58-4-2-1	5.7	WS-II	High
Snipe Creek	22-58-4-2-1-1	4.0	WS-II	High
South Hyco Creek	22-58-4-(3)	0.6	WS-II CA	High
Storys Creek	22-58-12-(1)	3.1	WS-II	High
Storys Creek [Roxboro City]	22-58-12-(1.5)	2.2	WS-III CA	High
Satterfield Creek	22-58-12-2-(1)	3.5	WS-II	High
Satterfield Creek	22-58-12-2-(2)	0.5	WS-II CA	High
Lick Branch	22-58-12-3-(1)	0.8	WS-II	High
Lick Branch	22-58-12-3-(2)	0.6	WS-II CA	High
Anderson Swamp Creek	23-8-6-(1.5)	2.6	WS-III&B CA	High
Deep Creek	23-24-(2)	0.5	WS-IV CA	High
Roanoke River above water intake	23-(25.5)	0.6	WS-IV CA	High
***REASON FOR PRIORITY**				
CA	Water Supply Watershed Critical Area			
WS-II, III or IV	Water Supply Watershed			

6.2.2 Identification and Protection of Highly Valued Resource Waters

Waters considered to be biologically sensitive or of high resource value may be afforded protection through 1) reclassification to HQW (high quality waters), ORW (outstanding resource waters) or WS (water supply), 2) through more stringent NPDES permit conditions or 3) through implementation of localized watershed protection efforts (state, local, federal or private).

Reclassification

Waters eligible for reclassification to HQW or ORW (see Appendix I) may include those approved for commercial shellfish harvesting (SA), designated primary nursery areas, designated critical habitats for threatened or endangered species (as designated by the NC Wildlife Resources Commission), waters having excellent water quality or those used for domestic water supply purposes (WS I and II). The HQW, ORW and WS classifications generally require more stringent point and nonpoint source pollution controls than do basic water quality classifications such as C (Appendix I).

There are two streams in the Roanoke River basin that are currently being studied for ORW designation. These are Cascade and Indian Creeks which are located in Hanging Rock State Park. If water quality in these streams is determined to be excellent based on benthic macroinvertebrate sampling, the Division will pursue reclassification.

In addition to these streams, Town Fork Creek is being considered for the supplemental FWS classification or future water supply. The waters' current classification is C and the proposed classification is WS-III FWS. This is the first surface water to be considered for the new FWS classification which was established to identify and protect future water supplies. A public hearing for this proposed reclassification was held on September 28, 1995 and the public comment period ended on October 30. The Environmental Management Commission is expected to consider the issue in the fall of 1996.

Two lakes in the Roanoke River Basin, Hyco and Mayo, are currently being studied to determine if they should be classified as WS-V water supplies. These studies were initiated by the Division's Raleigh Regional Office.

In addition to the above pending reclassifications, there is another one that could be considered within this basin plan's five year cycle. As has been mentioned elsewhere in this document, the Roanoke River below Roanoke Rapids dam is an important spawning area for anadromous fish. If the NC Wildlife Resources Commission or the Marine Fisheries Commission designates this area as a functional nursery area or primary nursery area, then the Division of Water Quality and the Environmental Management Commission can consider this area for High Quality Waters designation. During such consideration, DWQ would work closely with the WRC to develop an appropriate management strategy for the protection of this resource. Considering the WRC's and DMF's concern for the protection of this habitat, it is recommended that they consider its designation as a functional nursery area or primary nursery area.

NPDES Permitting

Where waters are known to support state or federally listed endangered or threatened species or species of concern, but where water quality is less than Excellent and where no critical habitat has been designated, consideration will be given during NPDES permitting to minimize impacts to these habitat areas consistent with the requirements of the federal Endangered Species Act and North Carolina's endangered species statutes. Possible protection measures may include dechlorination or alternative disinfection, tertiary or advanced tertiary treatment, outfall relocation, backup power provisions to minimize accidental plant spills, and others. The need for special provisions will be determined on a case-by-case basis during review of individual permit applications and take into account the degree of impact and the costs of protection.

NPS Targeting

Table 6.2, above, lists those highly-valued resource waters in the Roanoke River basin that have received a High priority rating for federal grant funding pursuant to Section 319 of the Federal Clean Water Act. The priority ratings and funding are discussed in Section 6.2.1, above. Funding can be used to implement best management practices intended to protect these sensitive resource waters from nonpoint source pollution. Those waters in the Roanoke River basin qualifying for high priority include those classified as WS II and the critical areas of waters classified WS III, IV, and V.

6.2.3 Managing Problem Pollutants in Order to Protect Unimpaired Waters

In addition to restoring impaired waters, protection of waters which currently meet their standards and are considered supporting their uses is a basic responsibility of the State's water quality program. The basinwide management approach facilitates this goal through more efficient use and analysis of monitoring data and through predictive computer modeling. Careful analysis of water quality data on a basin by basin approach allows for improved identification of threatened waters. Where water quality appears to be degrading, more concentrated monitoring efforts can be initiated and the information can be brought to the attention of local interests and other resource agencies as needed. As noted in Section 4.6, a large number of the freshwater streams in the Roanoke Basin rated as supporting their uses are considered threatened.

In addition to monitoring, basinwide management provides a framework for predicting water quality impairment through computer modeling, and then recommending measures that can be undertaken to avoid these impacts. This is most clearly seen through the Division's use of predictive computer modeling to determine the waste assimilative capacity of streams for various types of pollutants. Where capacities can be identified, strategies can be developed to help ensure that water quality standards can be met. This type of approach is used extensively in Sections 6.3, 6.4 and 6.5 in addressing potential impacts of oxygen-demanding wastes (BOD), nutrients and toxicants from wastewater treatment plants on receiving water quality.

The management strategies outlined in the following sections are the result of comprehensive evaluations of data summarized in this plan. They incorporate the effects of interaction between impacts of point and nonpoint sources of pollution. It is the intention of DWQ that the following recommendations serve the public of North Carolina for long-term planning purposes. The management strategies are comprised of two major components: recommendations for point and nonpoint source control. General nonpoint source management strategies are discussed thoroughly in Chapter 5. Appendix V contains a listing of agencies involved with the control and management of nonpoint sources of pollution and provides contacts that can be used to obtain technical assistance to implement measures to manage input from those sources. Point source controls are implemented through limiting wastewater parameters in NPDES permits.

6.2.4 Protecting, Enhancing, and Restoring NPS Pollution Abatement Functions of Wetlands

Wetlands perform a wide variety of functions including nutrient transformation, water storage, and sediment and nutrient retention. Those functions that are perceived as essential or important for protection by laws and regulations are referred to as values. Wetland values include water quality improvement, flood control, wildlife habitat, nursery areas for fisheries, and recreation. Water quality values are of special interest for basinwide planning purposes.

The nonpoint source pollution abatement functions of wetlands can provide another mechanism to protecting state waters from degradation. Extensive work has been done on vegetated buffers and streamside management zones as a means of protecting the quality of rivers, streams, and lakes from nonpoint source sediments (Trimble 1957; Bud et al. 1987; Cooper et al. 1987; Howard and Allen 1988; Nutter and Gaskin 1989; Nieswand et al. 1990). Numerous authors have studied the effectiveness of riparian forested wetlands for nutrient retention and transformation (Jones et al. 1976; Yates and Sheridan 1983; Brinson et al. 1984; Lowrance et al. 1984; Peterjohn and Correll 1984; Jacobs and Gilliam 1985; Budd et al. 1987; Groffman et al. 1991). Bastian and Benforado (1988) note that natural and constructed wetlands under the right conditions have achieved high removal efficiencies for BOD, suspended solids, heavy metals, and trace organics.

However, nonpoint source loadings cannot be processed satisfactorily if the system is overloaded. With excessive nutrient and sediment loadings, the removal efficiencies of wetlands decline. Sufficient riparian and other wetland areas must be maintained to prevent a decrease or loss of the NPS pollution abatement functions of wetlands.

Current Management Strategies

Several programs are in place that utilize the nonpoint source pollution abatement functions of wetlands.

- The Agricultural Cost-Share Program (ACP) administered by the NC Division of Soil and Water Conservation is a voluntary program that provides financial and technical assistance to farmers to install soil-saving practices to address point and nonpoint source pollution. ACP approved practices include the construction of wetland systems to treat wastewater derived from livestock, poultry, or aquaculture and the restoration or establishment of riparian buffers to remove nutrients, sediment, pesticides, and organic matter.

- The Natural Resources Conservation Service through the Watershed Protection and Flood Prevention Program (PL 83-566) assists local communities in developing watershed protection. NRCS can assist state, local, and non-profit organizations with water control and conservation projects, including projects to restore wetlands and stream characteristics throughout a small watershed to improve water quality.

Future Management Strategies

Future management strategies will be targeted at protecting and maintaining the water quality functions of wetlands and encouraging their use for nonpoint source pollution abatement. This will include the promotion of wetland acquisition and restoration by state, federal, and local government agencies and national, regional, and local land trusts.

The implementation of the Wetland Restoration, Enhancement, and Protection Program (WREP) currently being developed by the Division of Water Quality is an important part of future wetland management strategies. The objectives of the WREP include increasing the net wetland acres, functions, and values in each river basin and fostering a comprehensive approach to environmental protection by coordinating planned wetland restoration with basinwide water quality planning, coastal management, watershed improvement planning, and local land use planning. The goal of these restoration efforts will be to restore wetlands within a watershed context that is consistent with the goals of the basinwide planning initiatives. The incorporation of wetland restoration and management plans into the basinwide planning process may reduce the need for more expensive methods of controlling point and nonpoint sources of pollution.

Additionally, the Division of Coastal Management is currently undertaking an initiative to map the wetlands of the lower Roanoke River basin in Bertie, Washington and Beaufort counties. The Division of Coastal Management's GIS maps will enable DWQ to target restoration sites in the Roanoke and other coastal river basins to meet the goals of the basinwide planning initiatives.

6.3 RECOMMENDED MANAGEMENT STRATEGIES FOR OXYGEN-CONSUMING WASTES

Maintenance of dissolved oxygen (DO) is critical to the survival of aquatic life and to the general health of North Carolina's surface waters. The daily average dissolved oxygen standard for most waters in the state, except for waters classified as trout and swamp waters, is 5.0 mg/l. Waters classified as swamp waters may have naturally lower dissolved oxygen and these are prevalent in lower portion of the basin. The appropriate level of dissolved oxygen for swamp waters will vary from stream to stream. Trout waters have a daily average dissolved oxygen standard of 6.0 mg/l and there are several trout streams in the headwaters of the basin.

Biochemical oxygen demand (BOD) and ammonia nitrogen (NH_3-N) associated with wastewater treatment plants are generally the types of oxygen-consuming wastes of greatest concern. During summertime conditions, when temperature is high and streamflow is low, point source BOD and NH_3-N have the greatest impact on instream dissolved oxygen concentrations. Under these conditions, nonpoint source pollution input, which typically occurs as a result of rainfall events, has a minor impact. Therefore, NPDES permits for wastewater facilities generally limit BOD_5 (or $CBOD_5$) and NH_3-N in point source discharge effluents to control the effects of oxygen depletion in receiving waters. Where residual BOD is significant, management of nonpoint sources to reduce loading is recommended by implementation of best management practices. Additionally, constructed wetlands can be strategically engineered and positioned in the landscape to reduce the input of oxygen demanding wastes. Constructed wetland treatment systems can remove between 50% and 90% of the BOD_5 from primary effluent (Bastian and Benforado 1988).

The coastal floodplain forests of North Carolina have demonstrated ability to remove and process wastewater nitrogen by sedimentation, ammonification, nitrification and denitrification, and decrease concentrations downstream, if the system is not overloaded (Kuenzler 1988). However, for the Roanoke River forested floodplain wetlands to effectively remove oxygen demanding wastes, it is important that the flow regime remain be properly manipulated. If the seasonal flooding regime is improperly manipulated, the nutrient transformation processes will be impacted which could result in the draining of anoxic swamp waters into the river and a net export of nitrogen.

BOD/DO models are used by DWQ to determine oxygen-consuming waste limits in NPDES permits. The choice of model, North Carolina's desktop empirical model (Level B) or the field calibrated, QUAL2E model, is determined by the amount of data available for a given stream reach (Appendix III-A). Modeling is not conducted in some instances, such as for discharges into swamp-like systems, zero flow streams, and HQW stream segments where NPDES permit limitations are determined by special procedures and regulations.

6.3.1 Discharges to Low Flow Streams

Due to the preponderance of low flow streams across the state, the Division developed regulations for evaluating discharges to low flow streams. In 1980 studies were performed on zero flow streams (7Q10 and 30Q2 = 0 cfs) to determine the effect of wastewater discharges. The data concluded that:

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

As a result of the study, regulations 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 facilities built new treatment plants to meet advanced tertiary limits for BOD_5 and NH_3-N. Facilities that currently discharge to a zero flow stream but which have not yet been evaluated will receive the following language in their NPDES permit:

> *Removal of the discharge will be required if a more environmentally sound and economically achievable alternative is available. An engineering report evaluating alternatives to discharge is due 180 days prior to permit expiration along with the permit renewal application. As part of the report, the cost of constructing a treatment facility to meet limits of 5 mg/l BOD_5, 2 mg/l NH_3-N, 6 mg/l dissolved oxygen and 17 ug/l chlorine must also be included if there are no alternatives to a surface water discharge. Upon review of the results of the engineering report, the Division may reopen and modify this NPDES permit to require removal of the discharge, modified treatment designs, and/or revised effluent limitations within a specified time schedule.*

This policy typically covers small discharges, i.e., schools, mobile home parks, rest homes, subdivisions, etc. which discharge to zero flow streams in headwater areas. While these discharges may not cause severe water quality problems in mainstem reaches of the Roanoke River Basin they can cause localized problems in their low flow receiving streams.

The results of the 1980 study were extrapolated for facilities discharging to low flow streams with a 7Q10 = 0 and a 30Q2 > 0 since similar adverse impacts are expected in the receiving streams. Regulations were developed to set effluent limitations for new and expanded discharges of oxygen consuming waste at 5 mg/l BOD5, 2 mg/l NH3-N, and 6 mg/l DO, unless it is determined that these limitations will not protect water quality standards. The following Marlowe Creek example illustrates the problem with facilities discharging into low flow streams.

Marlowe Creek (Subbasin 05)

Roxboro WWTP discharges 5 MGD of treated effluent (equal to 7.74 cubic feet per second (cfs)) into Marlowe Creek. According to USGS flow statistics, Marlowe Creek has a summer 7Q10 = 0 and a 30Q2 = 0.1 cfs. This results in the WWTP effluent dominating the receiving stream. The Roxboro WWTP NPDES permit was originally issued prior to the low flow regulations. The stream also receives stormwater run-off from the City of Roxboro.

In 1994, DWQ conducted benthic macroinvertebrate and fish community structure studies at SR 1322, located 3.4 miles downstream from the Roxboro WWTP outfall. The study results indicate the stream is impaired. These studies were not designed to determine the cause of the impairment; however, DWQ believes that the documented impact is due in part to the effluent dominated nature of the system. The Marlowe Creek watershed has been prioritized for the investigation and implementation of non-point pollution management strategies. DWQ will conduct additional investigations prior to the next Roanoke River Basinwide Plan of 2001. Future studies will be designed to determined the cause of the impairment. The results will be used to determine if more stringent NPDES permit limitations should apply to the Roxboro WWTP and/or, if urban stormwater management measures should be implemented.

6.3.2 Discharges to Swamp Waters

Many of the streams in the Roanoke River Basin are classified as swamp waters. DWQ does not have a good tool to evaluate the ability of these waters to assimilate oxygen-consuming wastes as our desktop dissolved oxygen model assumes a steady-state, one-dimensional flow, and these conditions may not exist in swamp waters. In addition, data analyses from a previously studied system in the Lumber River Basin indicated that critical conditions in a swamp system are not necessarily limited to low flow conditions. Inadequate flow and water quality data prevent verification of the relationship between flow and dissolved oxygen in many of the tributaries classified as swamp waters.

Given the difficulty of determining assimilative capacity in these waters, DWQ has identified the need to develop a better tool to evaluate a swamp system's ability to assimilate waste flow. Since many swamp systems are very slow moving and naturally have low dissolved oxygen concentrations, the criteria to determine impact is currently being reevaluated. A work group has been formed in the Water Quality Section to determine wastewater impacts given various treatment capabilities and flow conditions in a swamp. Instream data above and below several facilities will be used as part of the study. The focus of the study is to evaluate discharge impacts during various hydrologic regimes within the swamps in question. Emphasis will be placed on data collected during high, low and medium flows and during a falling hydrograph event when swamp backwaters drain to the mainstem carrying potentially lower dissolved oxygen concentrations.

Until these studies are completed, new discharges will not be permitted at limits no less stringent than 15 mg/l BOD_5 and 4 mg/l NH_3-N (NH_3-N may be lower if dilution is lower). More stringent limits may be needed on a case-by-case basis if data or conditions suggest that adverse impacts will occur. Existing facilities will receive current permit limits unless they expand or site specific information is available which indicates more stringent limits are needed. Upon expansion, they will receive existing loading (mass basis).

The following are swamp-designated systems which have been listed as impaired:

Conoconnara Swamp (Subbasin 08)

Biological data indicates this stream is impaired. However, assigning water quality ratings to this system and other swamp systems is complicated by natural conditions of a swamp which may indicate impairment when compared to criteria in a free flowing stream. In Conoconnara Swamp, a stagnant low-flowing stream, significant hydrogen sulfide releases from the bottom sediments have been observed. Hydrogen sulfide and other gases from bottom sediments is a common indicator of the breakdown of organic material in very slow streams.

Therefore, the impairment is partially attributed to natural conditions, including low DO concentrations, of this swamp-like system. However, agricultural run-off further impairs the water quality of the system. The Conoconnara Swamp watershed has been targeted for non-point pollution controls. DWQ will continue to monitor this system and will re-evaluate this impairment prior to the next basin plan.

Cashie River (Subbasin 10)

This river is typical of many large, slow-moving lower coastal plain rivers. Biological data indicate the stream is impaired. However, significant improvement in the last two miles of the downstream section of the river has been documented. The impairment is partially attributed to natural conditions. However, extensive farming occurs in areas of the Cashie River watershed suggesting agricultural run-off being a significant contributor of the impairment. The Cashie River watershed should be targeted for implementation of non-point pollution control strategies by DWQ and by agricultural and forestry agencies. DWQ will continue to monitor this system and will re-evaluate this impairment prior to the next basin plan.

6.3.3 Dissolved Oxygen Mainstem Models

Roanoke River from Roanoke Rapids to Hamilton (Subbasins 08 and 09)
In North Carolina, the Roanoke River begins at the Roanoke Rapids Lake dam and extends for 137 miles to the Albemarle Sound. This section of the river is referred to as the lower Roanoke River.

Several dissolved oxygen models have been developed for the lower Roanoke River. These include a model developed by the Research Triangle Institute (RTI) in 1986 and a model developed by Roy F Weston, Inc. in 1990. These models helped DWQ to better understand the Roanoke River system, but the models could not be used by DWQ to determine the assimilative capacity of the stream due to model development and calibration concerns. Also, DWQ developed a model using the North Carolina's desktop Level B procedure to determine the oxygen consuming waste assimilative of the river. However, this model was not field calibrated but developed empirically with methods and assumptions not specific to a large system like the Roanoke River which results in a considerable degree of model uncertainty.

In light of the above, in 1995 DWQ developed a field calibrated dissolved oxygen model (QUAL2E) for 74 stream miles of the mainstem of the Roanoke River, from the Roanoke Rapids dam to Hamilton (Figure 6.2). The QUAL2E model was used to determine the oxygen-consuming waste assimilative capacity of the lower Roanoke River. As can be seen in Figure 6.2, at existing permitted loads during low flow conditions, the predicted minimum dissolved oxygen level is approximately 6 mg/l. DWQ will continue to use this model to allocate oxygen-consuming permit limitations in the Roanoke River mainstem from Roanoke Rapids to Hamilton. In tidal waters, management strategies will be developed on a case-by-case basis using all available flow and water quality information to assess discharge impacts. More detailed information can be found in DWQ's modeling report (DWQ, 1996).

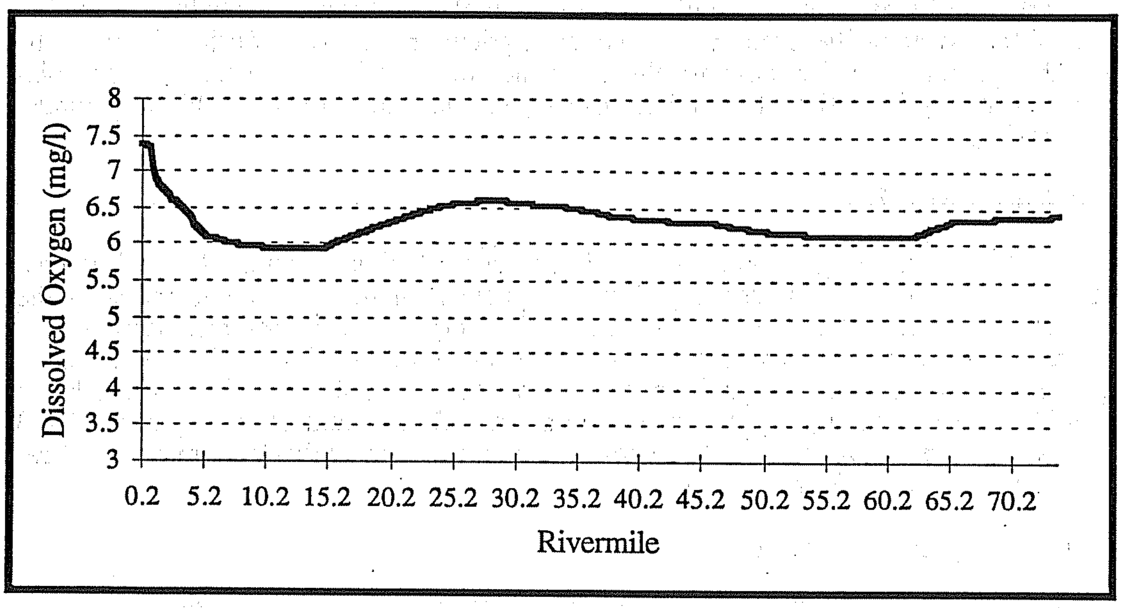


Figure 6.2 Predicted Dissolved Oxygen Concentrations in the Lower Roanoke River From Roanoke Rapids (left) to Hamilton (right) Based on a QUAL2E Model of Discharges of Existing Permitted Loads During Summer Low-Flow Conditions

Dan River from NC 220 to North Carolina-Virginia State Line

The North Carolina's desktop Level B model was applied to the mainstem of the Dan River from NC 220 to the North Carolina-Virginia state line. This model included a few significant tributaries to the Dan River such as Mayo River, Buffalo Creek, Rockhouse Creek and Hogan Creek. The model will continue to be used by DWQ to allocate oxygen-consuming waste limitations in NPDES permits. Although the model does not predict substandard DO concentrations at existing permitted loads, the results should be interpreted with caution since the empirical equations contained in the Level B procedure may not apply to the Dan River. Instream DO data collected from 1990 to 1994 does not indicate a need for further modeling at this time. However, DWQ will continue to monitor the instream DO concentrations and will analyze the data for trends. The instream data will be used to determine if a field calibrated model is necessary in the future.

6.4 MANAGEMENT STRATEGIES FOR NUTRIENTS

Control of nutrients is necessary to limit algal growth potential, to assure protection of the instream chlorophyll *a* standard, and to avoid the development of nuisance conditions in the state's waterways. Point source controls are typically NPDES permit limitations on total phosphorus (TP) and total nitrogen (TN). Nonpoint controls of nutrients generally include best management practices (BMPs) to control nutrient loading from areas such as agricultural land and urban areas.

6.4.1 Assimilative Capacity

The nutrient assimilative capacity in a system is compromised when eutrophic conditions (algal blooms) develop. Although a system may have not been determined to be eutrophic, the development of macrophytes (aquatic weeds) may compromise the intended use of the waterbody. The Roanoke River Basin has some areas where eutrophication problems exist such as Roxboro Lake, Lake Roxboro, Farmer Lake (near Yanceyville) and White Millpond in eastern Halifax County. In the past, eutrophication has been documented in the Nutbush Arm of Kerr Lake (it is currently rated as mesotrophic).

Excessive macrophyte growth has been documented in Kernersville Reservoir, Mayo Reservoir, Lake Gaston and Roanoke Rapids Lake. Further evaluation of the sources of nutrients and appropriate control strategies need to be developed. The N.C. Division of Water Resources and the N.C. Aquatic Weed Control Council have been working in controlling macrophytes in Lake Gaston. The U.S. Army Corps of Engineers is controlling macrophytes in Kerr Lake through chemical treatment. Carolina Power and Light has been treating macrophytes in the Mayo Reservoir.

6.4.2 Management of Specific Waterbodies

Roxboro Lake and Lake Roxboro (Subbasin 05)
These two lakes are water supply reservoirs near the Town of Roxboro. Although these lakes currently support all of their uses, 1994 sampling indicated the lakes are eutrophic. The watersheds for both lakes are comprised of agricultural, forest and pasture lands, and residential areas. Implementation of nonpoint source nutrient reduction best management practices will be needed in order to prevent further water quality degradation and loss of uses. The lakes will continue to be monitored and reevaluated prior to the next basin plan.

Nutbush Arm of Kerr Lake (Subbasin 06)
Conditions at the headwaters of the Nutbush Creek Arm have in the past been nearly hypereutrophic. During low flow conditions, Nutbush Creek is dominated by the effluent of the Henderson WWTP. A study conducted in 1988 by DWQ indicated that the Henderson WWTP was a major contributor of nutrients to Nutbush Creek.

Since the mid 1980's, DWQ has been working with the City of Henderson to resolve this problem including the implementation of a phosphorus limitation in its NPDES permit. The Henderson WWTP has undergone a number of upgrades, including phosphorus removal capabilities. Significant water quality improvements have been realized from the City's efforts as indicated in Figures 6.3 and 6.4.

Data collected by DWQ in 1994 ranked the lake as being mesotrophic. The lake's new ranking may indicate improvement due to the WWTP's upgrades. DWQ will continue to monitor the Nutbush Arm of Kerr Lake.

Lake Gaston (Subbasin 07)

Lake Gaston is located between Kerr Lake and Roanoke Rapids Lake. This body of water is impaired due to the infestation of exotic plants such as hydrilla (Hydrilla verticillata), Brazilian Elodea (Egeria densa), Eurasian watermilfoil (Myriophyllum spicatum) and Brittle Naiad. These plants are estimated to cover about 3,100 acres, or 15% of the lake's surface. The NC Division of Water Resources has been applying herbicides to the plants in the lake since 1991. The herbicide treatments increased every year from 1991 to 1994. In 1995, the pesticides were cut back as grass carp were introduced to the lake to control the plants. Additional treatments of the plants are planned for 1996 but will take into account the effects of the grass carp. The need for nutrient controls to the lake should be examined prior to completion of the next basin plan.

Roanoke Rapids Reservoir (Subbasin 08)
Roanoke Rapids Reservoir is located immediately below Lake Gaston. This body of water is also impaired due to the infestation of exotic weeds such as hydrilla (Hydrilla verticillata), Brazilian Elodea (Egeria densa), and Eurasian watermilfoil (Myriophyllum spicatum). The lake was rated mesotrophic in 1994 and nutrient values have remained low to moderate since 1983. North Carolina Power and the N.C. Division of Water Resources have considered options for controlling these aquatic weeds although no specific actions are planned in the near future. The watershed is being targeted for NPS pollution controls.

6.4.3 Nonpoint Source Control Strategies for Meeting Nutrient Goals through Wetlands Protection

Protection and/or restoration of wetlands may prove to be a cost-effective tool in controlling nutrients. Numerous authors have studied the effectiveness of riparian wetland forests for nutrient retention and transformation. The location of riparian wetlands allows them the opportunity to receive nutrients from the surrounding landscape and through overbank flooding. In addition to the storage of nutrients in wetland vegetation, the microbial and chemical processes within wetland soils may function to completely remove nutrients from the system. Kuenzler and Craig (1986) found that the riparian systems along the Chowan River removed 64% of the total nitrogen and 43% of the total phosphorus from upland, predominantly nonpoint, sources.

Headwater riparian wetlands are the most important wetlands in terms of sediment and associated nutrient and toxicant retention. Since small streams comprise most of the total stream length within a watershed, these areas intercept the greatest portion of eroded sediments and associated substances before these pollutants reach waters downstream. One study found that approximately 80% of the sediments entering a stream were retained in headwater wetlands.

The Roanoke River basin contains large expanses of bottomland hardwood forests and cypress-tupelo swamps. The river and floodplain wetlands form one of the most biologically significant sites in the coastal plain of the south Atlantic states. The water flow of the river along the coastal plain is unobstructed by reservoirs, creating some of the nation's best examples of bottomland

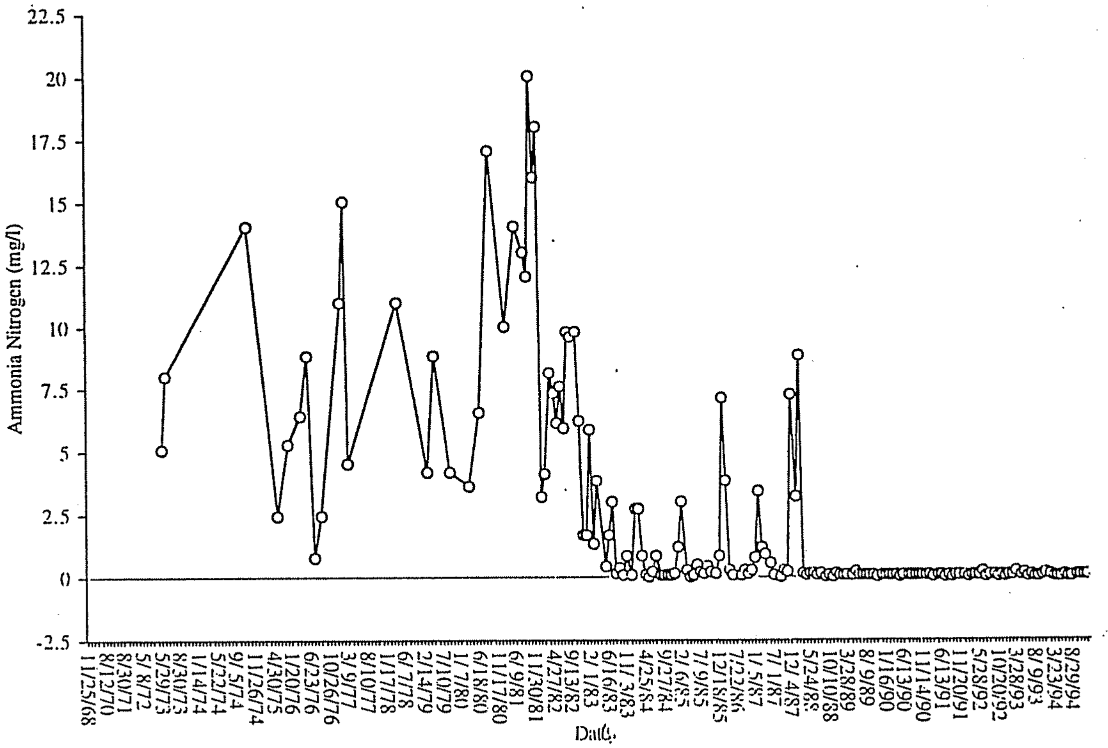


Figure 6.3 Long-term Ammonia Nitrogen Concentrations in Nutbush Creek at State Road 1317 Downstream of the City of Henderson's Wastewater Treatment Plant

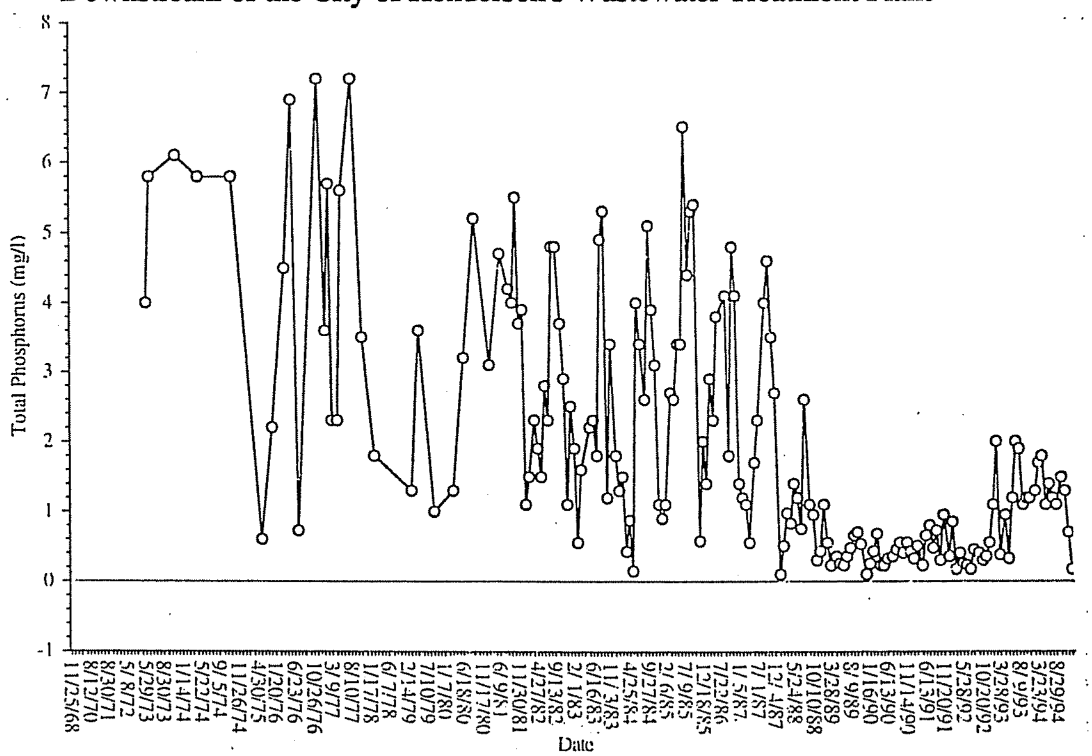


Figure 6.4 Long-term Total Phosphorus Concentrations in Nutbush Creek at State Road 1317 Downstream of the City of Henderson's Wastewater Treatment Plant

hardwood forests (Frost et al. 1990). Protection of these significant bottomland hardwoods will protect the nutrient and sediment removal benefits provided by the adjacent floodplain. Currently, portions of the floodplain forests are protected by The Nature Conservancy, the North Carolina Wildlife Resources Commission, and the U.S. Fish and Wildlife Service (Frost et al. 1990).

Nonpoint source reduction measures should capitalize on and protect the nutrient removal and transformation function of these important floodplain wetlands. This can be accomplished through the following initiatives.

- Continue acquisition and restoration efforts to protect bottomland hardwood forests in the coastal plain of the basin. Section 319(h) funds can be used to acquire and restore riparian wetlands that are important to preventing and controlling NPS pollution in the Roanoke. Additionally, the Roanoke River National Wildlife Refuge is continuing efforts to acquire land through voluntary contributions or acquisition.

- Encourage the use of riparian buffers in areas of intensive agriculture. Riparian buffers can be restored and established along cropland, pasture, hayland, or rangeland to remove nutrients, sediments, organic matter and pesticides. Close to a third (20,000 acres) of the basin's acreage is agricultural (APES 1993).

- Utilize forestry incentives programs to reduce sediment and nutrient inputs from forestry practices along the Roanoke River. The Forest Stewardship Incentives Program administered by the Division of Forest Resources and the U.S Forest Service provides cost-share funds for implementing Forest Stewardship Plans. Cooperative initiatives between industry and conservation organizations, such as The Nature Conservancy and Georgia-Pacific, will further protection of these water quality functions. The limited partnership between the North Carolina Chapter of The Nature Conservancy and Georgia-Pacific was instrumental in reducing the extent of forested wetland logged by Georgia-Pacific as well as encouraging the use of environmentally sound logging.

6.5 MANAGEMENT STRATEGIES TO CONTROL TOXIC SUBSTANCES

Toxic substances routinely regulated by DWQ include metals, organics, chlorine and ammonia. Section 3.2.3 of the basin plan describes toxic substances.

6.5.1 Assimilative Capacity

Chlorine has widespread use as a disinfectant and is often left in residual amounts that may prove toxic instream under critical low flow conditions. DWQ is currently requiring residual chlorine limits in all new or expanding discharges where chlorine is used for disinfection. All facilities located in trout waters will receive chlorine limits based on the standard.

Letters addressing chlorine toxicity were sent in 1993 to all facilities who are monitoring for total residual chlorine. These letters encourage permittees to examine the chlorine levels in their effluent and note that a chlorine limit may be implemented in the future. Currently, DWQ is not assigning new chlorine limits to existing (built) facilities.

Whole effluent toxicity limits are also assigned to all major discharges and any discharger of complex wastewater (those containing or potentially containing toxics).

Finally, DWQ recognizes that toxics from nonpoint sources typically enter a waterbody during storm events. Toxic pollution from both point and nonpoint sources is a growing issue of concern in this country. However, DWQ has not documented any surface waters in the Roanoke River Basin as impaired due to toxic run-off.

DWQ has identified problems in Belews Lake and Hyco Lake due to bioaccumulation of selenium in fish tissue, in the lower reaches of the mainstem Roanoke River and Welch Creek due to bioaccumulation of dioxin in fish tissue, and in Nutbush Creek due to failure of the City of Henderson WWTP to comply with the whole effluent toxicity test. The following management strategies have been applied to these surface waters.

6.5.2 Belews Lake (Subbasin 01)

In 1975, Duke Power Company began operating a coal burning power plant at Belews Lake. Water was used to sluice the ash residue and routed to a settling pond which in turn discharged to Belews Lake. In 1978 it was determined that this practice resulted in an unexpected concentration of selenium by the aquatic food chain organisms in the lake. Selenium bioaccumulation blocked reproduction in warm water fish species indigenous to the Belews Creek/Belews Lake system.

Since the late 70's, DWQ has worked with Duke Power to resolve this problem. In 1984, the power plant was converted from a wet ash sluicing system to a damp disposal system which offers the advantage of having no excess water to be treated and discharged. Thus, the ash basin effluent was removed from the reservoir. Bottom ash sluice which offers little or no chemical leaching was routed directly to the Dan River with a selenium NPDES permit limitation. As part of the conversion process, DWQ required Duke Power to extensively monitor the Dan River to assess the impact the new discharge may have on water quality and selected biota.

DWQ and Duke Power continue to monitor Belews Lake and the Dan River. Selenium concentrations in the water column of these streams are well below the 5 ug/l standard. Selenium concentrations in Belews Lake fish have exhibited a decreasing trend in recent years. The 1988 fish consumption advisory was recently revised from all species to include only common carp, redear sunfish and crappie. Belews Lake is currently considered in "recovery status." In the Dan River, data indicate that selenium concentrations are well below levels which result reproductive failure, and well below levels considered safe for human consumption. Benthic macroinvertebrate sampling conducted by Duke Power indicate no effect of the discharge to the macroinvertebrate community of the Dan River. DWQ considers Belews Lake as an *impaired* stream until such time the fish consumption advisory is lifted, but it is not included on the 303(d) list (Appendix VI) since a management strategy is in place.

6.5.3 Hyco Lake (Subbasin 05)

Carolina Power & Light Company (CP & L) built the Hyco Reservoir in 1965 and started operating the Roxboro Steam Electric Plant in 1966. The original wet fly ash sluicing system discharged to the reservoir. After a decline in the sport fishery, studies were conducted in the late 1970's which documented bioaccumulation of selenium in the lake's food chain.

In 1985, the North Carolina water quality standard for selenium was reduced from 10 ug/l to 5 ug/l. In light of this, DWQ developed a model to determine a new selenium NPDES permit limitation that would protect the selenium water quality standard in the reservoir. The analysis resulted in a more stringent permit limitation for selenium. In 1986 CP&L began conversion of the plant to a dry fly ash system to reduce selenium concentrations at the effluent. The new system has been operational since January 1990.

CP&L is required by the NPDES permit to provide long-term chemical and biological monitoring of the lake and to assess trends in selenium concentrations in the water, sediment, and tissue of aquatic organisms. DWQ also collects biological and chemical data in the reservoir. Selenium concentrations in the water column have remained below the State water quality standard since 1990 and selenium levels in fish tissue continue to decline. In May 1995, a partial lifting of the consumption advisory was issued. Common carp, white catfish and green sunfish remain in the fish consumption advisory. DWQ considers Hyco Lake as an *impaired* stream until such time the fish consumption advisory is completely lifted, but is is not included on the 303(d) list (Appendix VI) since a management strategy is in place.

6.5.4 Roanoke River (from Williamston to Batchelor Bay) and Welch Creek (Subbasins 08 and 09)

Weyerhaeuser Paper Company operates a paper mill near Plymouth. The outfall originally discharged to Welch Creek until 1988 when it was relocated to the Roanoke River. In the 1980's it was recognized that dioxin, a carcinogen byproduct of the chlorine paper bleaching process, was accumulating in fish tissue in the receiving stream. The EPA mandated all states to include a dioxin limitation in NPDES permits for bleach kraft paper mills by mid 1993. In light of this, Weyerhaeuser implemented measures to drastically reduce dioxin concentrations in its effluent. In 1993, a dioxin limitation was added to the NPDES permit. Weyerhaeuser dioxin reduction efforts culminated in 1994 with a complete modernization of the paper mill in which chlorine is not used in the process.

Weyerhaeuser is required by the NPDES permit to provide extensive water quality and biological monitoring of the area of impact. The data indicate that dioxin levels in fish are gradually decreasing since the company started its dioxin reduction programs. However, the State fish consumption advisory remains in effect from Williamston to the mouth at Albemarle Sound for all species except for herring and shad. This section of the Roanoke River and Welch Creek will remain listed as *impaired* streams until such time the fish consumption advisory is completely lifted, but it is not included on the 303(d) list (Appendix VI) since a management strategy is in place.

6.5.5 Nutbush Creek (Subbasin 06)

This stream is impacted by the City of Henderson WWTP and urban run-off. The City of Henderson WWTP effluent dominates the stream flow with an instream waste concentration of 97%. Benthic macroinvertebrate sampling conducted in August and October 1994 indicate that water quality has improved since the previous benthic macroinvertebrate sampling of 1988. However, the abundance and taxa richness values are still considered "fair."

DWQ is currently working with the City of Henderson, and compliance with the whole effluent toxicity test is expected in 1996.

6.6 MANAGEMENT STRATEGIES FOR CONTROLLING SEDIMENTATION

Sedimentation is a concern in the Roanoke Basin (see section 3.2.4 of Chapter 3). Although there are only 14.3 miles of monitored streams in the basin considered impaired due to sedimentation, DWQ staff who conducted sampling in the upper basin noted evidence of sedimentation even though biological ratings were high enough to be ranked as unimpaired. It is important to address this issue before it worsens and the biological communities suffer.

Sedimentation is essentially a widespread nonpoint source-related water quality problem which results from land-disturbing activities. The most significant of these activities include agriculture and land development (e.g., highways, shopping centers, and residential subdivisions). For each of these major types of land-disturbing activities, there are programs being implemented by various government agencies at the state, federal and/or local level to minimize soil loss and protect water quality.

DWQ's role in sediment control is to work cooperatively with those agencies that administer the erosion and sediment control programs in order to maximize the effectiveness of the programs and protect water quality. Where programs are not effective, as evidenced by violation of instream water quality standards (section 3.2.4), and where DWQ can identify a source, then appropriate enforcement action can be taken. Generally, this would entail requiring the land owner or responsible party to install acceptable best management practices (BMPs). BMPs vary with the type of activity, but they are generally aimed at minimizing the area of land-disturbing activity and the amount of time the land remains unstabilized; setting up barriers, filters or sediment traps (such as temporary ponds or silt fences) to reduce the amount of sediment reaching surface waters; and recommending land management approaches that minimize soil loss, especially for agriculture.

Some control measures, principally for construction or land development activities of 1 acre or more, are required by law under the state's Sedimentation and Erosion Control Act administered by the NC Division of Land Resources. For activities not subject to the act such as agriculture, erosion and sediment controls are carried out on a voluntary basis through programs administered by several different agencies. The NC Agricultural Cost Share Program administered by the NC Division of Soil and Water Conservation provides incentives to farmers to install best management practices (BMPs) by offering to pay up to 75% of the average cost of approved BMPs. A federal Farm Bill program administered by the Natural Resource Conservation Service provides an incentive not to farm on highly erodible land (HEL) by taking away federal subsidies to a farmer that fails to comply with the provision.

The NC Agricultural Cost Share Program funding totals for 1985 through 1994 are presented in Table 6.14. Table 6.14 presents expenditures by subbasin within the Roanoke basin. The cost share figures include a wide array of BMPs including conservation tillage, terraces, diversions, critical area plan, sod-based rotation, crop conservation grass, crop conservation trees, filter strip, field border, grass waterway, water control structure and livestock exclusion.

Table 6.3 NC Agricultural Cost Share Program Statistics for Erosion Control in the Roanoke River Basin (Cumulative totals 1985 -1994)

SUBBASIN	ACRES AFFECTED	TONS OF SOIL SAVED	TOTAL CONTRACT AMT
03-02-01	1,870	34,778	$406,551
02	1,215	31,631	$145,126
03	3,724	31,558	$404,011
04	3,830	17,377	$284,995
05	11,569	95,796	$1,062,544
06	2,349	26,212	$196,062
07	4,998	18,291	$279,963
08	7,400	33,234	$310,979
09	8,340	906	$375,959
10	8,675	11,032	$271,543
TOTALS	53,970	300,815	$3,737,733

No sediment control measures are 100% effective so some level of sedimentation is expected as long as land-disturbing activities occur. But there are still additional improvements that can be made as listed below. Education and promotion of stewardship are keys to improvement along with judicious strengthening of regulations and enforcement.

Finally the sediment and soil stabilizing functions of wetlands cannot be ignored when developing an NPS pollution control strategy. The same characteristics important for nutrient removal and transformation are important for physical removal of sediments. Nutrient and sediment removal functions of wetlands are interrelated; and, therefore, the previous discussion on nutrient removal and transformation in Section 6.4 also addresses strategies for controlling sediment.

The role of the floodplain wetlands along the Roanoke River in sediment removal is based on their opportunity and ability to receive and retain sediment, respectively. Approximately 59% of the Roanoke River use-impaired stream miles are impacted by agriculture. Wetlands in predominantly agricultural watersheds have more opportunity to receive runoff and, therefore play an essential role controlling sedimentation. Headwater wetlands and broad floodplain wetlands are ideally located in the watershed to perform sediment retention functions. In the Roanoke River basin, the expansive bottomland hardwood forests in the coastal plain retain sediments, not held by headwater wetlands, through overbank flow. The preservation of the bottomland hardwood forest through acquisition or conservation easements is critical to control sedimentation in the Roanoke River.

In addition to conservation of wetlands for NPS pollution abatement, the creation and restoration of forested wetland buffer strips should continue to be encouraged through existing sedimentation control programs, both voluntary and regulatory. These programs include the Agricultural Conservation Program, Watershed Protection and Flood Prevention Program, and the Sedimentation and Erosion Control Program. In a non-sensitive watershed, a forested wetland buffer strip of 25 ft on each side of an intermittent stream would provide a reasonable level of protection from sedimentation. For perennial streams, a forested wetland buffer of 50 ft would provide sufficient safeguards. In sensitive watersheds, additional protection, such as doubling the width of the buffer strips, would be required to provide sufficient sedimentation control (DEM 1993).

Recommendations for Improving Erosion and Sediment Control

- Continue to promote effective implementation and maintenance of erosion and sediment control measures by contractors, developers, farmers and other land owners. Even the best-designed plans will not work if those responsible for maintaining silt fences, ground cover, settling ponds, grassed waterways, etc. are not carrying out those responsibilities either due to lack of understanding or carelessness.
- Evaluate effectiveness of enforcement of existing sediment control programs.
- Encourage more widespread adoption of erosion and sediment control programs by local governments, especially in rapidly developing areas. Coastal counties can include recommendations to address erosion and sedimentation in development of land use plans under the Coastal Area Management Act. Other city and county governments that have not adopted programs can be still become involved through local education efforts, maintaining publicly-owned lands, and coordinating with other agencies such as local soil and water conservation districts and NC Division of Land Resources to identify and correct problems.
- Promote public education at the state and local level on the impacts of sedimentation and the need for improved sediment control. The cumulative effects of a number of small projects can significantly degrade water quality and habitat downstream.
- Evaluate existing sedimentation and erosion control rules and statutes for possible strengthening at the state and local level. Examples include limiting the area of disturbed land on a given site and reducing the time period for reestablishing vegetation on denuded areas.
- Maintaining vegetated stream buffers along fields and in urban areas is an excellent means of controlling sedimentation and other nonpoint source pollution.

Appendix V provides a list of agencies and corresponding contacts that can be used to obtain technical assistance to implement the above recommendations.

6.7 MANAGEMENT STRATEGIES FOR URBAN STORMWATER CONTROL

6.7.1 NPDES Stormwater Management

There are no municipalities in the Roanoke River Basin that are required to obtain permits requiring the management of stormwater runoff within their jurisdiction.

Throughout the Roanoke Basin, various types of industrial activities with point source discharges of stormwater are required to be permitted under the NPDES stormwater program. These include activities related to manufacturing, processing, materials storage areas and construction activities with greater than five acres of disturbance. All of those areas requiring coverage must develop Stormwater Pollution Prevention Plans (SWPPP) to minimize and control pollutants discharged from their stormwater systems. These SWPPPs are subject to review and modification by the permitted facilities and DWQ to assure that management measures are appropriate.

6.7.3 Recommendations for Controlling Stormwater Impacts by Local Governments Not Subject to NPDES Stormwater Requirements

For local governments that are not required to develop stormwater programs but where urban stormwater impacts have been identified and/or where urban water quality is of concern to local citizens, there are several basic steps, listed below, that could be undertaken at relatively low cost to help control urban stormwater pollution.

- o Mapping of municipal storm sewer systems and outfall points, and developing procedures to update this information.
- o Evaluating existing land uses in the local government's jurisdictional area to determine where sources of stormwater pollution may exist. In addition, local government activities and programs could be evaluated to determine where existing activities address stormwater management in some way, or could be modified to do so.
- o Developing educational programs to inform citizens of activities that may contribute pollutants to stormwater runoff (dumping oil, paint or chemicals down storm drains) and offering ways of carrying out such activities in an environmentally sound manner. Storm drain stenciling is a good example of a low cost educational tool.
- o Developing programs to locate and remove illicit connections (illegal discharge of non-stormwater materials) to the storm sewer system. These often occur in the form of floor drains and similar connections. In practice, stormwater management programs represent an area where local governments can develop their own ideas and activities for controlling sources of pollution.
- o Reviewing local ordinances pertaining to parking, curb and gutter and open space requirements. Many of these local ordinances could be modified to enhance water quality protection from urban stormwater runoff impacts. Maintaining riparian buffer strips along streams is an example.

Wetlands can be created along streams in urbanized areas of the watershed to receive stormwater runoff. Natural wetlands already serve as water treatment systems for agricultural and urban runoff. Virtually every water quality parameter can be affected by passage through a wetland. This includes nutrients, heavy metals, pesticides, organics, and other chemical constituents (Bastion and Benforado, 1988). When transported into a wetland, pollutants can be removed by burial, chemical breakdown, and/or assimilation into plant tissue.

DWQ's urban stormwater staff have recently completed a series of stormwater workshops across the state for the benefit of local governments and others on addressing urban stormwater pollution. DWQ can provide additional information to interested local governments or can provide references of other local governments in the state that are undertaking programs on their own. Below is a list of available literature prepared by the NC Cooperative Extension Service and the Land-of-Sky Regional Council under federal grants administered by DWQ. The last item is a document prepared by DWQ that should be available this year.

- *Stormwater Management Guidance Manual,* 1993, Cooperative Extension Service (NCSU)
- *Stormwater Management in North Carolina: A Guide for Local Officials*, 1994, Land-of-Sky Regional Council, Asheville, NC (Eaker, 1994)
- Stormwater Fact Sheets by Land-of-Sky Regional Council, 1994
    1) *Stormwater Problems and Impacts: Why all the Fuss?*
    2) *Stormwater Control Principles and Practices*
    3) *Stormwater Management Roles and Regulations*
    4) *Local Stormwater Program Elements and Funding Alternatives*
- *Stormwater Best Management Practices*, 1995, NC Division of Environmental Management

6.8 MANAGEMENT STRATEGIES FOR CONTROLLING COLOR

The discharge of color is to be regulated such that only such amounts as will not render the waters injurious to public health, secondary recreation, or to aquatic life and the wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses. However, the practical application of this regulation must take into account the various ways in which color is perceived in the environment. Color in natural waters is rarely the result of one specific chemical, rather a mixture of many dissolved and/or suspended constituents contribute to color. Also, the stream bed and sediments may contribute to color. Because color is perceived differently by different people and in different lighting conditions, no general definition of color impairment can be specified by a simple set of criteria.

DWQ is presently working to develop a color monitoring protocol that will allow specific analyses of color in waters of the State. Because textile industries are a significant source of color to waters of the North Carolina including the Roanoke River Basin, DWQ is currently working with the North Carolina Textile Manufacturing Association to develop appropriate monitoring and compliance methodologies for color. Two subbasins that make up the South Fork Catawba River watershed have been targeted in a pilot study to address color. Once this pilot study is complete, monitoring and or color limits may be required for facilities with significant colored discharges. In the Roanoke River Basin the City of Roxboro WWTP has been identified for possible participation in future color monitoring.

6.9 MANAGEMENT STRATEGIES FOR CONTROLLING FECAL COLIFORM

Fecal coliforms are bacteria typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of disease-causing bacteria and viruses. They enter surface waters from a number of sources including failing onsite wastewater systems, broken sewer lines, improperly treated discharges of domestic wastewater, pump station overflows, and runoff carrying livestock and wildlife wastes.

There are two water bodies where the geometric mean of the fecal coliform data exceed the standard of 200/100 ml. This information was derived from Table 4.4 in Chapter 4.

1) Dan River at SR 2150 near Wentworth (43%)
2) Dan River at SR 1716 near Mayfield (40%)

Each of these stream segments has been rated as support-threatened as biological data indicate good water quality. Several general recommendations for addressing fecal coliform contamination in both fresh and estuarine waters include:

- Proper maintenance of onsite waste disposal systems (such as septic tanks).
- Maintenance and repair of sanitary sewer lines by WWTP authorities.
- Elimination of direct unpermitted discharges of domestic sewage wastes (also known as "straight pipes") from homes and businesses to streams or stormwater systems.
- Proper management of livestock to keep wastes from reaching surface waters.
- Encouragement of local health departments to routinely monitor waters known to be used for body contact recreation (e.g., swimming and tubing). There are 144 miles of streams in the Roanoke River Basin classified for swimming (Class B).

6.10 MANAGING WATER FLOW IN THE BASIN FOR WATER QUALITY PROTECTION

Variations in flow can greatly affect the water quality of a river system. Any attempts to protect water quality must take these variations into account. In addition, the operations of Kerr, Gaston and Roanoke Rapids Reservoirs are interconnected and managed by four independent entities under normal operations. The reservoirs are used for power generation and flood control. Flows downstream of them are highly regulated and their management can effect water quality and habitat in downstream areas.

Several potential occurrences have the capacity to alter the flow conditions in the basin, especially in the Roanoke River. For example, the pipeline proposed by the City of Virginia Beach may consume up to 60 MGD. Other local governments already are turning to the Roanoke River as a water supply source, and more will in the future. A study by the NC Division of Water Resources estimated that consumptive water use in the Roanoke Basin will increase approximately 240% from 1980 to 2010. In 2001, FERC will relicense the Gaston-Roanoke Rapids project. FERC will reevaluate the entire operation of that project and may impose a significantly different flow regime. The precise effects of these contingent actions cannot be reliably predicted. This reinforces the need to develop more fully models of the lower basin, and to plan for the most efficient use of this resource so as not to compromise water quality.

DWQ recognizes the need to establish and implement an appropriate flow regime. To date, DWQ has not studied this aspect of the Roanoke River Basin sufficiently to enable it to recommend a comprehensive flow regime. The United States Fish and Wildlife Service has proposed a year round flow regime based on the preimpoundment hydrograph. The Service suggests that such a regime is important to protect instream uses, such as fish spawning. DWQ hopes that the water quality modeling being undertaken as part of the relicensing of the Gaston and Roanoke Rapids hydroelectric projects will be used by the US Army Corps of Engineers to develop a water quality model that will allow DWQ and others to evaluate the merits of this and other suggested regimes, and promote an appropriate plan.

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CHAPTER 7

FUTURE INITIATIVES

7.1 OVERVIEW OF ROANOKE BASINWIDE GOALS AND OBJECTIVES

Near-term objectives, or those achievable at least in part during the next five years, include implementing the strategies, or TMDLs (total maximum daily loads) outlined in Chapter 6 to reduce point and nonpoint source loadings of BOD, nutrients and other pollutants. These steps are necessary to progress towards restoring impaired waters, protecting high resource value and biologically sensitive waters and maintaining the quality of other waters currently supporting their uses.

The long-term goal of basinwide management is to protect the water quality standards and uses of the basin's surface waters 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 parts of all involved. However, with the needed support and cooperation, NCDWQ believes that these goals are attainable through the basinwide water quality management approach.

7.2 FUTURE ACTIVITIES IN THE ROANOKE RIVER BASIN

7.2.1 Specific Areas in Need of Management Strategies

Lower Roanoke Instream Flow Studies

The license granted by the Federal Energy Regulatory Commission (FERC) for the Roanoke Rapids and Gaston Hydropower project on the Roanoke River expires on January 31, 2001. North Carolina Power owns and operates this hydropower project and intends to submit an application for a new FERC license by the beginning of 1999. The Department of Environment, Health, and Natural Resources will be involved in the development and review of the license application. DWQ is currently working with NC Power on the water quality study plans to be addressed during the relicensing process.

DWQ has also attended a series of meetings with NC Power and the US Army Corps of Engineers (COE) in response to a major fish kill on the Roanoke River in late July and early August, 1995. A "Lower Roanoke River Environmental Betterment Plan" was developed by NC Power in response to these meetings. The proposed steps of the plan include:

1) NC Power will initiate an agreement with the US Army COE to mitigate the impact of the lower Roanoke River hypoxic swamp water drainage into the main stem of the river. DWQ has requested to be involved in any interim agreement that may be established, prior to the completion of water quality studies to be conducted as part of the relicensing process.

2) NC Power will promote and participate in Lower Roanoke River basin water quality modeling studies. DWQ is currently working with NC Power on proposed water quality modeling study plans as part of the relicensing process. In addition, the Army COE is looking at securing funding for a comprehensive basinwide study on the Roanoke River and the Division of Water Resources is discussing cost-share options with the Army COE for

this study. The study will use the NC Power flow model to develop a water quality model that will simulate the impacts of floodplain inundation during high flow releases and the subsequent return of water stored in overbank areas to the main channel during low flow releases. The results of this complex modeling analysis will provide a more accurate assessment of the BOD assimilative capacity of the system and will update the preliminary estimates provided by the DWQ DO model.

3) Encourage the establishment of a lower Roanoke River environmental monitoring and communications network. DWQ supports the use of a monitoring association of NPDES discharges as a means to produce better, more coordinated monitoring information. DWQ is interested in interacting with VA Power on the development of such an association. Potential partners include US Geological Survey, US COE, Weyerhaeuser Corp., Champion International, US Fish and Wildlife Service, and The Nature Conservancy.

4) Increase Roanoke Rapids dam minimum flow releases from 2000 cfs to 3000 cfs during "critical" summer conditions. Implementation of this proposal would be based on data received from the monitoring network and consultation with network participants. The minimum flow release will also be addressed during the relicensing process.

5) Extend the striped bass spawning flow regime to include the June 16-30 period through year 2000. Maintain flow variations from Roanoke Rapids dam at less than the 1,500 cfs per hour limit. The NC Wildlife Resources Commission supports the commitment to implement the extended flow regime through the year 2000. DWQ agrees this would be a positive action.

6) Participate in a partnership to promote an annual publication on the Roanoke River. Such a publication could be easily tied into information gathered by a monitoring organization discussed in #3 above. In the future, this publication could be very valuable for updating the Roanoke River Basinwide Water Quality Management Plan.

7.2.2 Other NPDES Program Initiatives

In the next five years, efforts will be continued to:

- improve compliance with permitted limits;
- improve pretreatment of industrial wastes to municipal wastewater treatment plants so as to reduce the toxicity in effluent wastes;
- encourage pollution prevention at industrial facilities in order to reduce the need for pollution control;
- require dechlorination of chlorinated effluents or use of alternative disinfectants; (At this time NC requires dechlorination for new and expanding dischargers with a domestic component to their waste. In the future, other types of dischargers could be affected if it were determined that their chlorinated effluent was causing toxicity in stream.)
- require multiple treatment trains at wastewater facilities; and
- require plants to begin plans for enlargement well before they reach capacity.

Longer-term objectives will include refining overall management strategies after obtaining feedback on current management efforts during the next round of water quality monitoring. Long-term point source control efforts will stress reduction of wastes entering wastewater treatment plants, seeking more efficient and creative ways of recycling byproducts of the treatment process (including nonpotable reuse of treated wastewater), and keeping abreast of and recommending the most advanced wastewater treatment technologies.

7.2.3 Nonpoint Source Control Strategies and Priorities/Nutrient Reduction Efforts

Improving our knowledge of and controlling nonpoint source pollution will be a high priority over the next five years. Nonpoint source pollution, as noted in Section 4.5 in Chapter 4, accounts for the majority of impaired waters in the Roanoke River Basin. Sediment and nutrients are the most widespread cause of nonpoint source impairment in freshwater streams and lakes. There are several initiatives underway to address the protection of surface waters from nonpoint sources of pollution. Three of these are discussed below.

- Establishment of nonpoint source basin teams in each basin. DWQ has begun setting up nonpoint source teams in each of the state's 17 major river basins. These teams will have representatives from agriculture, urban stormwater, construction, mining, on-site wastewater disposal, forestry, solid waste, wetlands, groundwater, the League of Municipalities and wildlife organizations. These teams will provide descriptions of NPS activities within a basin, conduct assessments of NPS controls in targeted watersheds, identify future monitoring sites, develop five-year action plans for NPS pollutants, and develop Section 319 project proposals for targeted watersheds.
- Promote wetlands protection. Future management strategies will be targeted at protecting and maintaining the water quality functions of wetlands and encouraging their use for nonpoint source pollution abatement. This will include the promotion of wetland acquisition and restoration by state, federal, and local government agencies and national, regional, and local land trusts.
- Interagency Water Quality Monitoring. DWQ has begun the process of coordinating with other natural resource agencies on the idea of interagency water quality monitoring across the state. There is a need for more widespread monitoring data in order to better assess water quality, identify trends, improve water quality modeling capabilities and assure an ample supply of high quality water for aquatic life support, water supply and recreation.

7.2.4 Future Monitoring Priorities

Monitoring of the chemical and biological status of receiving waters will provide critical feedback on the success of the basin management strategy. As discussed in Chapter 4, monitoring data will be collected from (1) ambient water chemistry, (2) sediment chemistry, (3) biological communities, (4) contaminant concentrations in fish and other biota, (5) ambient toxicity, and (6) facility self-monitoring data. The specific parameters measured will relate directly to the long-term water quality goals and objectives defined within the basinwide management strategy.

7.3 FUTURE PROGRAMMATIC INITIATIVES

7.3.1 Further Evaluation of Swamp Systems

Many of the waterbodies in the eastern third of the State, including the Roanoke River Basin, are classified as swamp waters. It is difficult to evaluate monitoring data in these systems to determine if a waterbody is impaired. For example, a swamp may have low dissolved oxygen concentrations, but these may be due to natural background concentrations rather than from impacts from point and nonpoint sources. DWQ will continue its efforts to evaluate these systems using chemical and biological data.

DWQ does not have a good tool to evaluate the ability of these waters to assimilate oxygen-consuming wastes as our desktop dissolved oxygen model assumes a steady-state, one-dimensional flow, and these conditions may not exist in swamp waters. In addition, data analyses from a previously studied system in the Lumber River Basin indicated that critical conditions in a swamp system are not necessarily during low flow conditions. Inadequate flow and water quality data prevent verification of the relationship between flow and dissolved oxygen in many of the tributaries classified as swamp waters.

Given the difficulty of determining assimilative capacity in these waters, DWQ has identified the need to develop a better tool to evaluate a swamp system's ability to assimilate waste flow. Since many swamp systems are very slow moving and naturally have low dissolved oxygen concentrations, the criteria by which impact is determined is currently being reevaluated. A work group has been formed in the Water Quality Section to determine wastewater impacts given various treatment capabilities and flow conditions in a swamp. Instream data above and below several facilities will be used as part of the study. The focus of the study is to evaluate discharge impacts during various hydrologic regimes within the swamps in question. Emphasis will be placed on data collected during high, low and medium flows and during a falling hydrograph event when swamp backwaters drain to the mainstem carrying potentially lower dissolved oxygen concentrations.

7.3.1 Improved Monitoring Coverage: Citizen Monitoring and Coordination with Other Agencies

DWQ and other environmental agencies have been discussing the potential for coordination of field resources. This includes the Wildlife Resources Commission, Division of Marine Fisheries, Division of Water Resources and the Division of Coastal Management. If individuals from another environmental agency are visiting certain waterbodies to investigate fish populations or wetland areas, they could also collect water quality data from these areas. The coordination of these activities should help to better blend the activities of the various agencies.

Hopes for a statewide citizen monitoring program were lost when the General Assembly failed to approve funding for coordinator positions and supplies for volunteers.

7.3.2 Use of Discharger Self-Monitoring Data

NCDWQ will explore the pros and cons of using discharger self-monitoring data to a greater degree to augment the data it collects through the programs described in Chapter 4. Quality assurance, timing and consistency of data from plant to plant would have to be addressed. Also, a system would need to be developed to enter the data into a computerized database for later analysis. One method of data collection that is currently being explored includes developing a comprehensive list of monitoring sites for the basin that would be monitored by an Association of NPDES dischargers with data input to STORET. A basinwide sampling program has been established for dischargers in the Neuse River Basin and to date appears to be successful.

7.3.3 Promotion of Non-Discharge Alternatives/Regionalization

NCDWQ requires all new and expanding dischargers to submit an alternatives analysis as part of its NPDES permit application. Non-discharge alternatives, including tying on 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 recommend denial of the NPDES permit.

7.3.4 Coordinating Basinwide Management With the Construction Grants and Loans Program

The potential exists to use the basinwide planning process as a means of identifying and prioritizing wastewater treatment plants in need of funding through NCDWQ's Construction Grants and Loan Program. Completed basin documents are provided to this office for their use.

7.3.5 Improved Data Management and Expanded Use of Geographic Information System (GIS) Computer Capabilities

NCDWQ 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, and so on, will be put in a central data center which will then be made accessible to most staff at desktop computer stations. Much of this information is also being entered into the state's GIS computer system (Center for Geographic Information and Analysis or CGIA). As this and other information is made available to the GIS system, including land use data from satellite or air photo interpretation, and as the system becomes more user friendly, the potential to graphically display the results of water quality data analysis will be tremendous.

Research Triangle Institute performed a pilot study in the Tar-Pamlico River Basin in which high priority waterbodies for nonpoint source control programs were mapped. These maps were used by the various nonpoint source agencies for planning purposes. As resources become available, this tool will be developed for other basins.

APPENDIX I

Summary of North Carolina's Water Quality Classifications and Standards

Antidegradation Policy

High Quality Waters

Outstanding Resource Waters

Classifications and Water Quality Standards Assigned to the Waters of the Roanoke River Basin

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STANDARDS

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
Freshwater:				
Class C (standards apply to all fresh waters, unless preempted by more stringent standard for more protective classification)	Secondary recreation (including swimming on an unorganized or infrequent basis); fish and other aquatic life propagation and survival; agriculture and other uses, except for primary recreation, water supply or other food-related uses	See attached Table 1.; WATER QUALITY STANDARDS FOR FRESHWATER CLASSES; standards listed under "Standards For All Freshwaters" column (aquatic life and human health sections) apply to Class C waters, unless preempted by more protective standard.	Stormwater Disposal Rules apply in the 20 coastal counties as described in 15A NCAC 2H .1000	
Class B	Primary recreation (swimming on an organized or frequent basis) and all uses specified for Class C (and not water supply or other food-related uses)	Same as for Class C	Same as for Class C	Wastewater treatment reliability requirements (dual train design; backup power capability) may apply to protect swimming uses (15A NCAC 2H .0124)
WS-I Water Supply NOTE: Revised water supply classifications and standards effective as of 8/3/92	Water supplies in natural and undeveloped watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; no point sources except groundwater remediation when no alternative exists	Not applicable since watershed is undeveloped	No landfills, sludge/residual or petroleum contaminated soils application allowed in watershed
WS-II Water supply	Water supplies in predominantly undeveloped watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; only general permit wastewater discharges allowed in watershed and groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(d): 2-acre lots or 6% built-upon area in critical area; 1-acre lots or 12% built-upon area outside of critical area; up to 24% in the critical area and 30% built upon area outside of the critical area allowed with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area and no new discharging landfills outside of critical area; no new sludge/ residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required; spill containment structures required for new industries in the critical area using, storing or manufacturing hazardous materials

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STANDARDS (continued)

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
WS-III Water Supply	Water supplies in low to moderately developed watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; general permits allowed throughout watershed, domestic and non-process industrial outside of the critical area, groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(e): 1-acre lots or 12% built-upon area in critical area; 1/2 acre lots or 24% built-upon outside of critical area; up to 30% in critical area and 50% built-upon area outside critical area allowed with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area and no new discharging landfills outside of the critical area; no new sludge/ residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required; spill containment structures required for new industries in the critical area using, storing or manufacturing hazardous materials
WS-IV Water Supply	Water supplies in moderately to highly developed watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; general permits, domestic and industrial discharges allowed throughout water supply [2]; groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(f): 1/2 acre lots or 24% built-upon area in critical area and protected area [3,4]; up to 50% in critical area and 70% built-upon area outside critical area with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area; no new sludge/ residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required
WS-V Water Supply	River segment	No categorical restrictions on development or wastewater dischargers. Instream water quality standards for water supply waters are applicable.		

NOTE: Please refer to 15A NCAC 2B .0101, .0104, .0202, .0211 and .0301 for more specific requirements for surface water supply protection.

1 If the high density development option is utilized, then wet detention basins are required and local governments will assume ultimate responsibility for the operation and maintenance of these engineered stormwater control structures.
2 New industrial process wastewater discharges in the critical area are allowed but must meet additional treatment requirements.
3 Applies to projects requiring an Erosion/Sedimentation Control Plan.
4 1/3 acre or 36% built-upon area is allowed for projects without a curb and gutter street system in the protected area.

- Critical area is 1/2 mile and draining to water supplies from normal pool elevation of reservoirs, or 1/2 mile and draining to a river intake.
- Protected area is 5 miles and draining to water supplies from normal pool elevation of reservoirs, or 10 miles upstream of and draining to a river intake.
- Agricultural activities are subject to provisions of the Food Security Act of 1985 and the Food, Agriculture, Conservation and Trade Act of 1990. In WS-I watersheds and critical areas of WS-II, WS-III and WS-IV areas, agricultural activities must maintain a 10 foot vegetated buffer or equivalent control, and animal operations >100 animal units must use BMPs as determined by the Soil and Water Conservation Commission.
- Silviculture activities are subject to the provisions of the Forest Practices Guidelines Related to Water Quality (15A NCAC 1I .0101-.0209).
- The Department of Transportation must use BMPs as described in their document, "Best Management Practices for Protection of Surface Waters".

Supplemental Classifications are added to the primary classifications as appropriate (Examples include Class C-NSW, Class SA-ORW, Class B-Trout, etc.) and impose additional requirements.

SUPPLEMENTAL CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
High Quality Waters (HQW) (categories: (1) waters rated as Excellent by DEM; (2) Primary Nursey Areas; (3) Native or Special Native Trout Waters; (4) Critical Habitat Areas; (5) WS-I and WS-II water supplies; (6) SA waters)	Waters with quality higher than the standards (EPA's Tier II waters; the minimum standards for Class C and SC define Tier I); see Standards and Stream Classifications Rules (15A NCAC 2B .0100) for detailed description (15A NCAC 2B .0101(e)(5))	For new or expanded discharges, advanced treatment requirements are: BOD_5=5 mg/l; NH_3-N= 2 mg/l; DO=6 mg/l	Projects requiring Erosion/ Sedimentation Control Plan and are within 1 mile and draining to HQW waters: 1-acre lots or 12% built-upon area, or higher density with engineered structural controls (wet detention ponds); WS-I, WS-II and 20 coastal counties exempt since stormwater control requirements already apply	Other treatment requirements may apply, dependent upon type of discharge and characteristics of receiving waters (see pp. 1 and 2 of Section .0200 Rules: 15A: NCAC 2B .0201(d) of Antidegradation Policy)
Outstanding Resource Waters (ORW)	Unique and special waters having exceptional water quality and being of exceptional state or national ecological or recreational significance; must meet other certain conditions and have 1 or more of 5 outstanding resource value criteria as described in Rule 2B .0216	Water quality must clearly maintain and protect uses, including outstanding resource values; management strategies must include at a minimum: no new or expanded discharges to freshwater ORWs; some discharges may be allowed in coastal areas	Same as for High Quality Waters for Freshwater ORWs; for Saltwater ORWs, development activities within a 575' buffer must comply with the low density option of Stormwater Disposal Rules (generally, 25% built-upon area around SA waters and 30% around other waters)	Other management strategy components as described in Rule .0216
Trout Waters (Tr)	Protected for natural trout propagation and survival of stocked trout;	More protective standards for cadmium, total residual chlorine, chlorophyll-a, dissolved oxygen, turbidity and toluene to protect these sensitive species (see Table 1. under "Trout" heading)		
Nutrient Sensitive Waters (NSW)	Waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation	No increase of nutrients over background levels		Nutrient management strategies developed on a case-by-case basis
Swamp Waters (Sw)	Waters with low velocities and other characteristics different from other waterbodies (generally, low pH, DO, high organic content)	pH as low as 4.3 and DO less than 5 mg/l allowed if due to natural conditions		

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Water Quality Standards for Freshwater Classifications

Parameters	Standards for All Freshwater: Aquatic life	Standards for All Freshwater: Human health	More Stringent Standards to Support Additional Uses: Water supply classes	More Stringent Standards to Support Additional Uses: Trout waters
Arsenic (µg/l)	50			
Barium (mg/l)			1.0	
Benzene (µg/l)		71.4	1.19	
Beryllium (ng/l)		117.0	6.8	
Cadmium (µg/l)	2.0			0.4
Carbon tetrachloride (µg/l)		4.42	0.254	
Chloride (mg/l)	230 (AL)		250	
Chlorinated benzenes (µg/l)			488	
Chlorine, total residual (µg/l)	17 (AL)			17
Chlorophyll *a*, corrected (µg/l)	40 (N)			15 (N)
Chromium, total (µg/l)	50			
Coliform, total (MFTCC/100ml)			50 (N) (2)	
Coliform, fecal (MFTCC/100ml)		200 (N)		
Copper (µg/l)	7 (AL)			
Cyanide (µg/l)	5.0			
Dioxin (ng/l)		0.000014	0.000013	
Dissolved gases	(N)			
Dissolved oxygen (mg/l)	5.0 (Sw) (1)			6.0
Fluoride (mg/l)	1.8			
Hardness, total (mg/l)			100	
Hexachlorobutadiene (µg/l)		49.7	0.445	
Iron (mg/l)	1.0 (AL)			
Lead (µg/l)	25 (N)			
Manganese (µg/l)			200	
MBAS (Methylene-Blue-Active Substances) (µg/l)	500			
Mercury (µg/l)	0.012			
Nickel (µg/l)	88		25	
Nitrate nitrogen (mg/l)			10	
Pesticides				
Aldrin (ng/l)	2.0	0.136	0.127	
Chlordane (ng/l)	4.0	0.588	0.575	
DDT (ng/l)	1.0	0.591	0.588	
Demeton (ng/l)	100			
Dieldrin (ng/l)	2.0	0.144	0.135	
Endosulfan (ng/l)	50			
Endrin (ng/l)	2.0			
Guthion (ng/l)	10			
Heptachlor (ng/l)	4.0	0.214	0.208	
Lindane (ng/l)	10			
Methoxychlor (ng/l)	30			
Mirex (ng/l)	1.0			
Parathion (ng/l)	13			
Toxaphene (ng/l)	0.2			
2,4-D (µg/l)			100	
2,4,5-TP (Silvex) (µg/l)			10	
pH (units)	6.0-9.0 (Sw)			
Phenolic compounds (µg/l)		(N)	1.0 (N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079		
Polynuclear aromatic hydrocarbons (ng/l)		31.1	2.8	
Radioactive substances		(N)		
Selenium (µg/l)	5			
Silver (µg/l)	0.06 (AL)			
Solids, total dissolved (mg/l)			500	
Solids, suspended	(N)			
Sulfates (mg/l)			250	

Water Quality Standards for Freshwater Classifications (continued)

Parameters	Standards for All Freshwater: Aquatic life	Standards for All Freshwater: Human health	More Stringent Standards to Support Additional Uses: Water supply classes	More Stringent Standards to Support Additional Uses: Trout waters
Temperature	(N)			
Tetrachloroethane (1,1,2,2) (µg/l)		10.8	0.172	
Tetrachloroethylene (µg/l)			0.8	
Toluene (µg/l)	11			0.36
Toxic substances	(N)			
Trialkyltin (µg/l)	0.008			
Trichloroethylene (µg/l)		92.4	3.08	
Turbidity (NTU)	50; 25 (N)			10 (N)
Vinyl chloride (µg/l)		525.0	2.0	
Zinc (µg/l)	50 (AL)			

NOTE:
- (N) See 2B .0211 (b), (c), (d), or (e) for narrative description of limits.
- (AL) Values represent action levels as specified in .0211 (b) (4)
- (Sw) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.
- (1) An instantaneous reading may be as low as 4.0 µg/l, but the daily average must be 5.0 µg/l or more.
- (2) Applies only to unfiltered water supplies

Water Quality Standards for Tidal Saltwater Classifications

Parameters	Standards for All Tidal Saltwaters: Aquatic life	Standards for All Tidal Saltwaters: Human health	More Stringent Standards to Support Additional Uses: Class SA
Arsenic (µg/l)	50		
Benzene (µg/l)		71.4	
Beryllium (ng/l)		117	
Cadmium (µg/l)	5.0		
Carbon tetrachloride (µg/l)		4.42	
Chlorophyll *a* (µg/l)	40 (N)		
Chromium, total (µg/l)	20		
Coliform, fecal (MFTCC/100ml)		200 (N)	14 (N)
Copper (µg/l)	3 (AL)		
Cyanide (µg/l)	1.0		
Dioxin (ng/l)		0.000014	
Dissolved gases	(N)		
Dissolved oxygen (mg/l)	5.0 (1)		
Hexachlorobutadiene (µg/l)		49.7	
Lead (µg/l)	25 (N)		
Mercury (µg/l)	0.025		
Nickel (µg/l)	8.3		
Phenolic compounds (µg/l)		(N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079	
Polynuclear aromatic hydrocarbons (ng/l)		31.1	
Pesticides			
Aldrin (ng/l)	3.0	0.136	
Chlordane (ng/l)	4.0	0.588	
DDT (ng/l)	1.0	0.591	
Demeton (ng/l)	100		
Dieldrin (ng/l)	2.0	0.144	
Endosulfan (ng/l)	9.0		
Endrin (ng/l)	2.0		
Guthion (ng/l)	10		
Heptachlor (ng/l)	4.0	0.214	
Lindane (ng/l)	4.0		
Methoxychlor (ng/l)	30		
Mirex (ng/l)	1.0		
Parathion (ng/l)	178		
Toxaphene (ng/l)	0.2		
pH (units)	6.8-8.5 (1)		
Radioactive substances		(N)	
Salinity	(N)		
Selenium (µg/l)	71		
Silver (µg/l)	0.1 (AL)		
Solids, suspended	(N)		
Temperature	(N)		
Tetrachloroethane (1,1,2,2) (µg/l)		10.8	
Toxic substances	(N)		
Trialkyltin (µg/l)	0.002		
Trichloroethylene (µg/l)		92.4	
Turbidity (NTU)	25 (N)		
Vinyl chloride (µg/l)		525	
Zinc (µg/l)	86 (AL)		

NOTE:
- (N) See 2B .0212 (b), (c), (d), or (e) for narrative description of limits.
- (AL) Values represent action levels as specified in .0212 (b) (4)
- (1) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.

.0201 ANTIDEGRADATION POLICY

(a) It is the policy of the Environmental Management Commission to maintain, protect, and enhance water quality within the State of North Carolina. Pursuant to this policy, the requirements of 40 CFR 131.12 are hereby incorporated by reference including any subsequent amendments and editions. This material is available for inspection at the Department of Environment, Health, and Natural Resources, Division of Environmental Management, Water Quality Planning Branch, 512 North Salisbury Street, Raleigh, North Carolina. Copies may be obtained from the U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402-9325 at a cost of thirteen dollars ($13.00). These requirements will be implemented in North Carolina as set forth in Paragraphs (b), (c) and (d) of this Rule.

(b) Existing uses, as defined by Rule .0202 of this Section, and the water quality to protect such uses shall be protected by properly classifying surface waters and having standards sufficient to protect these uses. In cases where the Commission or its designee determines that an existing use is not included in the classification of waters, a project which will affect these waters will not be permitted unless the existing uses are protected.

(c) The Commission shall consider the present and anticipated usage of waters with quality higher than the standards, including any uses not specified by the assigned classification (such as outstanding national resource waters or waters of exceptional water quality) and will not allow degradation of the quality of waters with quality higher than the standards below the water quality necessary to maintain existing and anticipated uses of those waters. Waters with quality higher than the standards are defined by Rule .0202 of this Section. The following procedures will be implemented in order to meet these requirements:

(1) Each applicant for an NPDES permit or NPDES permit expansion to discharge treated waste will document an effort to consider non-discharge alternatives pursuant to 15A NCAC 2H .0105(c)(2).

(2) Public Notices for NPDES permits will list parameters that would be water quality limited and state whether or not the discharge will use the entire available load capacity of the receiving waters and may cause more stringent water quality based effluent limitations to be established for dischargers downstream.

(3) The Division may require supplemental documentation from the affected local government that a proposed project or parts of the project are necessary for important economic and social development.

(4) The Commission and Division will work with local governments on a voluntary basis to identify and develop appropriate management strategies or classifications for waters with unused pollutant loading capacity to accommodate future economic growth.

Waters with quality higher than the standards will be identified by the Division on a case-by-case basis through the NPDES permitting and waste load allocation processes (pursuant to the provisions of 15A NCAC 2H .0100). Dischargers affected by the requirements of Paragraphs (c)(1) through (c)(4) of this Rule and the public at large will be notified according to the provisions described herein, and all other appropriate provisions pursuant to 15A NCAC 2H .0109. If an applicant objects to the requirements to protect waters with quality higher than the standards and believes degradation is necessary to accommodate important social and economic development, the applicant can contest these requirements according to the provisions of General Statute 143-215.1(e) and 150B-23.

(d) The Commission shall consider the present and anticipated usage of High Quality Waters (HQW), including any uses not specified by the assigned classification (such as outstanding national resource waters or waters of exceptional water quality) and will not allow degradation of the quality of High Quality Waters below the water quality necessary to maintain existing and anticipated uses of those waters. High Quality Waters are a subset of waters with quality higher than the standards and are as described by 15A NCAC 2B .0101(e)(5). The procedures described in Rule .0224 of this Section will be implemented in order to meet the requirements of this part.

(e) Outstanding Resource Waters (ORW) are a special subset of High Quality Waters with unique and special characteristics as described in Rule .0225 of this Section. The water quality of waters classified as ORW shall be maintained such that existing uses, including the outstanding resource values of said Outstanding Resource Waters, will be maintained and protected.

History Note: Authority G.S. 143-214.1; 143-215.1; 143-215.3(a)(1);
Eff. February 1, 1976;
Amended Eff. October 1, 1995; February 1, 1993; April 1, 1991; August 1, 1990.

To become effective April 1, 1996.

15A NCAC 2B.0225 has been amended with changes as published in 10:16B NCR 1842-1846 as follows:

.0225 OUTSTANDING RESOURCE WATERS

(a) General. In addition to the existing classifications, the Commission may classify certain unique and special surface waters of the state as outstanding resource waters (ORW) upon finding that such waters are of exceptional state or national recreational or ecological significance and that the waters have exceptional water quality while meeting the following conditions:

(1) there are no significant impacts from pollution with the water quality rated as excellent based on physical, chemical or biological information;

(2) the characteristics which make these waters unique and special may not be protected by the assigned narrative and numerical water quality standards.

(b) Outstanding Resource Values. In order to be classified as ORW, a water body must exhibit one or more of the following values or uses to demonstrate it is of exceptional state or national recreational or ecological significance:

(1) there are outstanding fish (or commercially important aquatic species) habitat and fisheries;

(2) there is an unusually high level of water-based recreation or the potential for such recreation;

(3) the waters have already received some special designation such as a North Carolina or National Wild and Scenic River, Native or Special Native Trout Waters, National Wildlife Refuge, etc, which do not provide any water quality protection;

(4) the waters represent an important component of a state or national park or forest; or

(5) the waters are of special ecological or scientific significance such as habitat for rare or endangered species or as areas for research and education.

(c) Quality Standards for ORW.

(1) Freshwater: Water quality conditions shall clearly maintain and protect the outstanding resource values of waters classified ORW. Management strategies to protect resource values shall be developed on a site specific basis during the proceedings to classify waters as ORW. At a minimum, no new discharges or expansions of existing discharges shall be permitted, and stormwater controls for all new development activities requiring an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or an appropriate local erosion and sedimentation control program shall be required to ~~control stormwater runoff as follows:~~ follow the stormwater provisions as specified in 15A NCAC 2H .1000. Specific stormwater requirements for ORW areas are described in 15A NCAC 2H .1007.

~~(A) Low Density Option: Developments which limit single family developments to one acre lots and other type developments to 12 percent built-upon area, have no stormwater collection system as defined in 15A NCAC 2H .1002(13), and have built-upon areas at least 30 feet from surface water areas shall be deemed to comply with this requirement, unless it is determined that additional runoff control measures are required to protect the water quality of Outstanding Resource Waters necessary to maintain existing and anticipated uses of those waters, in which case such additional stormwater runoff control measures may be required on a case-by-case basis.~~

~~(B) High Density Development: Higher density developments shall be allowed if stormwater control systems utilizing wet detention ponds as described in 15A NCAC 2H .1003(i), (k) and (l) are installed, operated and maintained which control the runoff from all built-upon areas generated from one inch of rainfall, unless it is determined that additional runoff control measures are required to protect the water quality of Outstanding Resource Waters necessary to maintain existing and anticipated uses of those waters, in which case such additional stormwater runoff control measures may be required on a case-by-case basis. The size of the control system must take into account the runoff from any pervious surfaces draining to the system.~~

(2) Saltwater: Water quality conditions shall clearly maintain and protect the outstanding resource

values of waters classified ORW. Management strategies to protect resource values shall be developed on a site-specific basis during the proceedings to classify waters as ORW. At a minimum, new development shall comply with the ~~low density options as specified in the Stormwater Runoff Disposal rules [15A NCAC 2H .1003 (a)(2)] within 575 feet of the mean high water line of the designated ORW area.~~ <u>stormwater provisions as specified in 15A NCAC 2H .1000. Specific stormwater management requirements for saltwater ORWs are described in 15A NCAC 2H .1007.</u> New non-discharge permits shall be required to meet reduced loading rates and increased buffer zones, to be determined on a case-by-case basis. No dredge or fill activities shall be allowed where significant shellfish or submerged aquatic vegetation bed resources occur, except for maintenance dredging, such as that required to maintain access to existing channels and facilities located within the designated areas or maintenance dredging for activities such as agriculture. A public hearing is mandatory for any proposed permits to discharge to waters classified as ORW.

Additional actions to protect resource values shall be considered on a site specific basis during the proceedings to classify waters as ORW and shall be specified in Paragraph (e) of this Rule. These actions may include anything within the powers of the commission. The commission shall also consider local actions which have been taken to protect a water body in determining the appropriate state protection options. Descriptions of boundaries of waters classified as ORW are included in Paragraph (e) of this Rule and in the Schedule of Classifications (15A NCAC 2B .0302 through .0317) as specified for the appropriate river basin and shall also be described on maps maintained by the Division of Environmental Management.

(d) Petition Process. Any person may petition the Commission to classify a surface water of the state as an ORW. The petition shall identify the exceptional resource value to be protected, address how the water body meets the general criteria in Paragraph (a) of this Rule, and the suggested actions to protect the resource values. The Commission may request additional supporting information from the petitioner. The Commission or its designee shall initiate public proceedings to classify waters as ORW or shall inform the petitioner that the waters do not meet the criteria for ORW with an explanation of the basis for this decision. The petition shall be sent to:

Director
DEHNR/Division of Environmental Management
P.O. Box 29535
Raleigh, North Carolina 27626-0535

The envelope containing the petition shall clearly bear the notation: RULE-MAKING PETITION FOR ORW CLASSIFICATION.

(e) Listing of Waters Classified ORW with Specific Actions. Waters classified as ORW with specific actions to protect exceptional resource values are listed as follows:

~~(1) Roosevelt Natural Area [White Oak River Basin, Index Nos. 20-36-9.5-(1) and 20-36-9.5-(2)]~~ including all fresh and saline waters within the property boundaries of the natural area shall have only new development which complies with the low density option in the stormwater rules as specified in 15A NCAC 2H .1003(a)(2) within 575 feet of the Roosevelt Natural Area (if the development site naturally drains to the Roosevelt Natural Area).

(2) Chattooga River ORW Area (Little Tennessee River Basin and Savannah River Drainage Area): the following undesignated waterbodies that are tributary to ORW designated segments shall comply with Paragraph (c) of this Rule in order to protect the designated waters as per Rule .0203 of this Section. However, expansions of existing discharges to these segments shall be allowed if there is no increase in pollutant loading:

(A) North and South Fowler Creeks,
(B) Green and Norton Mill Creeks,
(C) Cane Creek,
(D) Ammons Branch,
(E) Glade Creek, and

(F) Associated tributaries.

(3) Henry Fork ORW Area (Catawba River Basin): the following undesignated waterbodies that are tributary to ORW designated segments shall comply with Paragraph (c) of this Rule in order to protect the designated waters as per Rule .0203 of this Section:

(A) Ivy Creek,

(B) Rock Creek, and

(C) Associated tributaries.

(4) South Fork New and New Rivers ORW Area [New River Basin (Index Nos. 10-1-33.5 and 10)]: the following management strategies, in addition to the discharge requirements specified in Subparagraph (c)(1) of this Rule, shall be applied to protect the designated ORW areas:

(A) Stormwater controls described in Subparagraph (c)(1) of this Rule shall apply within one mile and draining to the designated ORW areas;

(B) New or expanded NPDES permitted wastewater discharges located upstream of the designated ORW shall be permitted such that the following water quality standards are maintained in the ORW segment:

(i) the total volume of treated wastewater for all upstream discharges combined shall not exceed 50 percent of the total instream flow in the designated ORW under 7Q10 conditions;

(ii) a safety factor shall be applied to any chemical allocation such that the effluent limitation for a specific chemical constituent shall be the more stringent of either the limitation allocated under design conditions (pursuant to 15A NCAC 2B .0206) for the normal standard at the point of discharge, or the limitation allocated under design conditions for one-half the normal standard at the upstream border of the ORW segment;

(iii) a safety factor shall be applied to any discharge of complex wastewater (those containing or potentially containing toxicants) to protect for chronic toxicity in the ORW segment by setting the whole effluent toxicity limitation at the higher (more stringent) percentage effluent determined under design conditions (pursuant to 15A NCAC 2B .0206) for either the instream effluent concentration at the point of discharge or twice the effluent concentration calculated as if the discharge were at the upstream border of the ORW segment;

(C) New or expanded NPDES permitted wastewater discharges located upstream of the designated ORW shall comply with the following:

(i) Oxygen Consuming Wastes: Effluent limitations shall be as follows: BOD = 5 mg/1, and NH_3-N = 2 mg/1;

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) shall be limited to effluent concentrations of 10 mg/1 for trout waters and to 20 mg/1 for all other waters;

(iii) Emergency Requirements: Failsafe treatment designs shall be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs;

(iv) Nutrients: Where nutrient overenrichment is projected to be a concern, appropriate effluent limitations shall be set for phosphorus or nitrogen, or both.

(5) Old Field Creek (New River Basin): the undesignated portion of Old Field Creek (from its source to Call Creek) shall comply with Paragraph (c) of this Rule in order to protect the designated waters as per Rule .0203 of this Section.

(6) In the following designated waterbodies, no additional restrictions shall be placed on new or expanded marinas. The only new or expanded NPDES permitted discharges that shall be allowed shall be non-domestic. non-process industrial discharges. The Alligator River Area (Pasquotank River Basin) extending from the source of the Alligator River to the U.S. Highway 64 bridge including New Lake Fork, North West Fork Alligator River, Juniper Creek, Southwest Fork Alligator River, Scouts Bay, Gum Neck Creek, Georgia Bay, Winn Bay, Stumpy Creek Bay, Stumpy Creek, Swann Creek (Swann Creek Lake), Whipping Creek (Whipping Creek

Lake), Grapevine Bay, Rattlesnake Bay, The Straits, The Frying Pan, Coopers Creek, Babbitt Bay, Goose Creek, Milltail Creek, Boat Bay, Sandy Ridge Gut (Sawyer Lake) and Second Creek, but excluding the Intracoastal Waterway (Pungo River-Alligator River Canal) and all other tributary streams and canals.

(7) In the following designated waterbodies, the only type of new or expanded marina that shall be allowed shall be those marinas located in upland basin areas, or those with less than 30 slips, having no boats over 21 feet in length and no boats with heads. The only new or expanded NPDES permitted discharges that shall be allowed shall be non-domestic, non-process industrial discharges.

(A) The Northeast Swanquarter Bay Area including all waters northeast of a line from a point at Lat. 35° 23' 51" and Long. 76° 21' 02" thence southeast along the Swanquarter National Wildlife Refuge hunting closure boundary (as defined by the 1935 Presidential Proclamation) to Drum Point.

(B) The Neuse-Southeast Pamlico Sound Area (Southeast Pamlico Sound Section of the Southeast Pamlico, Core and Back Sound Area); (Neuse River Basin) including all waters within an area defined by a line extending from the southern shore of Ocracoke Inlet northwest to the Tar-Pamlico River and Neuse River basin boundary, then southwest to Ship Point.

(C) The Core Sound Section of the Southeast Pamlico, Core and Back Sound Area (White Oak River Basin), including all waters of Core Sound and its tributaries, but excluding Nelson Bay, Little Port Branch and Atlantic Harbor at its mouth, and those tributaries of Jarrett Bay that are closed to shellfishing.

(D) The Western Bogue Sound Section of the Western Bogue Sound and Bear Island Area (White Oak River Basin) including all waters within an area defined by a line from Bogue Inlet to the mainland at SR 1117 to a line across Bogue Sound from the southwest side of Gales Creek to Rock Point, including Taylor Bay and the Intracoastal Waterway.

(E) The Stump Sound Area (Cape Fear River Basin) including all waters of Stump Sound and Alligator Bay from marker Number 17 to the western end of Permuda Island, but excluding Rogers Bay, the Kings Creek Restricted Area and Mill Creek.

(F) The Topsail Sound and Middle Sound Area (Cape Fear River Basin) including all estuarine waters from New Topsail Inlet to Mason Inlet, including the Intracoastal Waterway and Howe Creek, but excluding Pages Creek and Futch Creek.

(8) In the following designated waterbodies, no new or expanded NPDES permitted discharges and only new or expanded marinas with less than 30 slips, having no boats over 21 feet in length and no boats with heads shall be allowed.

(A) The Swanquarter Bay and Juniper Bay Area (Tar-Pamlico River Basin) including all waters within a line beginning at Juniper Bay Point and running south and then west below Great Island, then northwest to Shell Point and including Shell Bay, Swanquarter and Juniper Bays and their tributaries, but excluding all waters northeast of a line from a point at Lat. 35° 23' 51" and Long. 76° 21' 02" thence southeast along the Swanquarter National Wildlife Refuge hunting closure boundary (as defined by the 1935 Presidential Proclamation) to Drum Point and also excluding the Blowout Canal, Hydeland Canal, Juniper Canal and Quarter Canal.

(B) The Back Sound Section of the Southeast Pamlico, Core and Back Sound Area (White Oak River Basin) including that area of Back Sound extending from Core Sound west along Shackleford Banks, then north to the western most point of Middle Marshes and along the northwest shore of Middle Marshes (to include all of Middle Marshes), then west to Rush Point on Harker's Island, and along the southern shore of Harker's Island back to Core Sound.

(C) The Bear Island Section of the Western Bogue Sound and Bear Island Area (White Oak River Basin) including all waters within an area defined by a line from the western most point on Bear Island to the northeast mouth of Goose Creek on the mainland, east to the southwest mouth of Queen Creek, then south to green marker No. 49, then northeast to the northern most point on Huggins Island, then southeast along the shoreline of Huggins Island to the southeastern most point of Huggins Island, then south to the northeastern most point on Dudley Island, then southwest along the shoreline of Dudley Island to the eastern tip of Bear Island.

(D) The Masonboro Sound Area (Cape Fear River Basin) including all waters between the Barrier Islands and the mainland from Carolina Beach Inlet to Masonboro Inlet.

(9) Black and South Rivers ORW Area (Cape Fear River Basin) [Index Nos. 18-68-(0.5), 18-68-(3.5), 18-68-(11.5), 18-68-12-(0.5), 18-68-12-(11.5), and 18-68-2]: the following management strategies, in addition to the discharge requirements specified in Subparagraph (c)(1) of this Rule, shall be applied to protect the designated ORW areas:

(A) Stormwater controls described in Subparagraph (c)(1) of this Rule shall apply within one mile and draining to the designated ORW areas;

(B) New or expanded NPDES permitted wastewater discharges located one mile upstream of the stream segments designated ORW (upstream on the designated mainstem and upstream into direct tributaries to the designated mainstem) shall comply with the following discharge restrictions:

(i) Oxygen Consuming Wastes: Effluent limitations shall be as follows: BOD = 5 mg/l and NH3-N = 2 mg/l;

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) shall be limited to effluent concentrations of 20 mg/l;

(iii) Emergency Requirements: Failsafe treatment designs shall be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs;

(iv) Nutrients: Where nutrient overenrichment is projected to be a concern, appropriate effluent limitations shall be set for phosphorus or nitrogen, or both.

(v) Toxic substances: In cases where complex discharges (those containing or potentially containing toxicants) may be currently present in the discharge, a safety factor shall be applied to any chemical or whole effluent toxicity allocation. The limit for a specific chemcial constituent shall be allocated at one-half of the normal standard at design conditions. Whole effluent toxicity shall be allocated to protect for chronic toxicity at an effluent concentration equal to twice that which is acceptable under flow design criteria (pursuant to 15A NCAC 2B .0206).

History Note: ~~*Statutory*~~ *Authority G.S. 143-214.1;*
Eff. October 1, 1995;
Amended Eff. April 1, 1996.

To become effective April 1, 1996.

15A NCAC 2B.0224 has been amended with changes as published in 10:16B NCR 1841-1842 as follows:

.0224 HIGH QUALITY WATERS

High Quality Waters (HQW) are a subset of waters with quality higher than the standards and are as described by 15A NCAC 2B .0101(e)(5). The following procedures shall be implemented in order to implement the requirements of Rule .0201(d) of this Section.

(1) New or expanded wastewater discharges in High Quality Waters shall comply with the following:

(a) Discharges from new single family residences shall be prohibited. Those existing subsurface systems for single family residences which fail and must discharge shall install a septic tank, dual or recirculating sand filters, disinfection and step aeration.

(b) All new NPDES wastewater discharges (except single family residences) shall be required to provide the treatment described below:

(i) Oxygen Consuming Wastes: Effluent limitations shall be as follows: BOD_5= 5 mg/l, NH_3-N = 2 mg/l and DO = 6 mg/l. More stringent limitations shall be set, if necessary, to ensure that the cumulative pollutant discharge of oxygen-consuming wastes shall not cause the DO of the receiving water to drop more than 0.5 mg/l below background levels, and in no case below the standard. Where background information is not readily available, evaluations shall assume a percent saturation determined by staff to be generally applicable to that hydroenvironment.

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) shall be limited to effluent concentrations of 10 mg/l for trout waters and PNA's, and to 20 mg/l for all other High Quality Waters.

(iii) Disinfection: Alternative methods to chlorination shall be required for discharges to trout streams, except that single family residences may use chlorination if other options are not economically feasible. Domestic discharges are prohibited to SA waters.

(iv) Emergency Requirements: Failsafe treatment designs shall be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs.

(v) Volume: The total volume of treated wastewater for all discharges combined shall not exceed 50 percent of the total instream flow under 7Q10 conditions.

(vi) Nutrients: Where nutrient overenrichment is projected to be a concern, appropriate effluent limitations shall be set for phosphorus or nitrogen, or both.

(vii) Toxic substances: In cases where complex wastes (those containing or potentially containing toxicants) may be present in a discharge, a safety factor shall be applied to any chemical or whole effluent toxicity allocation. The limit for a specific chemical constituent shall be allocated at one-half of the normal standard at design conditions. Whole effluent toxicity shall be allocated to protect for chronic toxicity at an effluent concentration equal to twice that which is acceptable under design conditions. In all instances there may be no acute toxicity in an effluent concentration of 90 percent ~~percent~~. Ammonia toxicity shall be evaluated according to EPA guidelines promulgated in "Ambient Water Quality Criteria for Ammonia - 1984"; EPA document number 440/5-85-001; NTIS number PB85-227114; July 29, 1985 (50 FR 30784) or "Ambient Water Quality Criteria for Ammonia (Saltwater) - 1989"; EPA document number 440/5-88-004; NTIS number PB89-169825. This material related to ammonia toxicity is hereby incorporated by reference including any subsequent amendments and editions and is available for inspection at the Department of Environment, Health and Natural Resources Library, 512 North Salisbury Street, Raleigh, North Carolina. Copies may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 at a cost of forty-seven dollars ($47.00).

(c) All expanded NPDES wastewater discharges in High Quality Waters shall be required to provide the treatment described in Sub-Item (1)(b) of this Rule, except for those existing discharges which expand with no increase in permitted pollutant loading.

(2) Development activities which require an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or local erosion and sedimentation control program approved in accordance with 15A NCAC 4B .0218, and which drain to and are within one mile of High Quality Waters (HQW) shall be required to ~~control runoff from the one inch design storm as follows:~~ follow the stormwater management rules as specified in 15A NCAC 2H .1000. Stormwater management requirements specific to HQW are described in 15A NCAC 2H .1006.

~~(a) Low Density Option: Developments which limit single family developments to one acre lots and other type developments to 12 percent built upon area, have no stormwater collection system as defined in 15A NCAC 2H .1002(13), and have built upon areas at least 30 feet from surface waters shall be deemed to comply with this requirement, unless it is determined that additional runoff control measures are required to protect the water quality of High Quality Waters necessary to maintain existing and anticipated uses of those waters, in which case more stringent stormwater runoff control measures may be required on a case by case basis. Activities conforming to the requirements described in 15A NCAC 2H .1003(a) [except for Subparagraphs (2) and (3) which apply only to waters within the 20 coastal counties as defined in 15A NCAC 2H .1002(9)] shall also be deemed to comply with this requirement, except as provided in the preceding sentence.~~

~~(b) High Density Option: Higher density developments shall be allowed if stormwater control systems utilizing wet detention ponds as described in 15A NCAC 2H .1003(i), (k) and (l) are installed, operated and maintained which control the runoff from all built upon areas generated from one inch of rainfall, unless it is determined that additional runoff control measures are required to protect the water quality of High Quality Waters necessary to maintain existing and anticipated uses of those waters, in which case more stringent stormwater runoff control measures may be required on a case by case basis. The size of the control system must take into account the runoff from any pervious surfaces draining to the system.~~

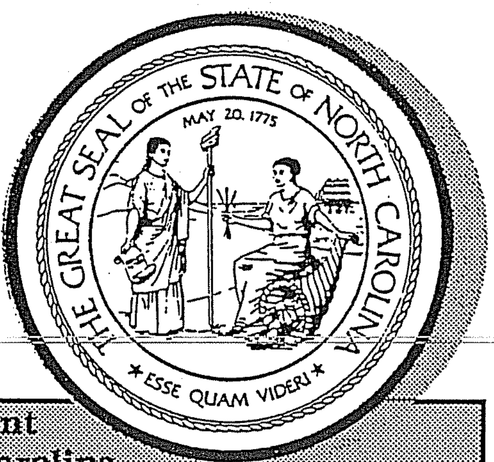
~~(c) All waters classified WS-I or WS-II and all waters located in the 20 coastal counties as defined in Rule 15A NCAC 2H .1002(9) are excluded from this requirement since they already have requirements for nonpoint source controls.~~

If an applicant objects to the requirements to protect high quality waters and believes degradation is necessary to accommodate important social and economic development, the applicant can contest these requirements according to the provisions of G.S. 143-215.1(e) and 150B-23.

History Note: *~~Statutory~~ Authority G.S. 143-214.1; 143-215.1; 143-215.3(a)(1);*
Eff. October 1, 1995;
Amended Eff. April 1, 1996.

STATE OF
NORTH CAROLINA
DEPARTMENT OF
ENVIRONMENT, HEALTH,
AND NATURAL RESOURCES

Classifications and Water Quality Standards Assigned to The Waters of the Roanoke River Basin



Division of Environmental Management
Raleigh, North Carolina

Reprint from North Carolina Administrative Code: 15A NCAC 2B .0313
Current through: February 1, 1993

SECTION .0300 - ASSIGNMENT OF STREAM CLASSIFICATIONS

.0301 CLASSIFICATIONS: GENERAL

(a) Schedule of Classifications. The classifications assigned to the waters of the State of North Carolina are set forth in the schedules of classifications and water quality standards assigned to the waters of the river basins of North Carolina, 15A NCAC 2B .0302 to .0317. These classifications are based upon the existing or contemplated best usage of the various streams and segments of streams in the basin, as determined through studies and evaluations and the holding of public hearings for consideration of the classifications proposed.

(b) Stream Names. The names of the streams listed in the schedules of assigned classifications were taken as far as possible from United States Geological Survey topographic maps. Where topographic maps were unavailable, U.S. Corps of Engineers maps, U.S. Department of Agriculture soil maps, and North Carolina highway maps were used for the selection of stream names.

(c) Classifications. The classifications assigned to the waters of North Carolina are denoted by the letters WS-I, WS-II, WS-III, WS-IV, WS-V, B, C, SA, SB, and SC in the column headed "class." A brief explanation of the "best usage" for which the waters in each class must be protected is given as follows:

Fresh Waters

Class WS-I:	waters protected as water supplies which are in natural and undeveloped watersheds; point source discharges of treated wastewater are permitted pursuant to Rules .0104 and .0211 of this Subchapter; local programs to control nonpoint source and stormwater discharge of pollution are required; suitable for all Class C uses;
Class WS-II:	waters protected as water supplies which are generally in predominantly undeveloped watersheds; point source discharges of treated wastewater are permitted pursuant to Rules .0104 and .0211 of this Subchapter; local programs to control nonpoint source and stormwater discharge of pollution are required; suitable for all Class C uses;
Class WS-III:	waters protected as water supplies which are generally in low to moderately developed watersheds; point source discharges of treated wastewater are permitted pursuant to Rules .0104 and .0211 of this Subchapter; local programs to control nonpoint source and stormwater discharge of pollution are required; suitable for all Class C uses;
Class WS-IV:	waters protected as water supplies which are generally in moderately to highly developed watersheds; point source discharges of treated wastewater are permitted pursuant to Rules .0104 and .0211 of this Subchapter; local programs to control nonpoint source and stormwater discharge of pollution are required; suitable for all Class C uses;
Class WS-V:	waters protected as water supplies which are generally upstream and draining to Class WS-IV waters; no categorical restrictions on watershed development or treated wastewater discharges are required, however, the Commission or its designee may apply appropriate management requirements as deemed necessary for the protection of downstream receiving waters (15A NCAC 2B .0203); suitable for all Class C uses;
Class B:	primary recreation and any other usage specified by the "C" classification;
Class C:	aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture.

Tidal Salt Waters

Class SA:	shellfishing for market purposes and any other usage specified by the "SB" and "SC" classification;
Class SB:	primary recreation and any other usage specified by the "SC" classification;
Class SC:	aquatic life propagation and survival, fishing, wildlife, and secondary recreation.

Supplemental Classifications

Trout Waters:	Suitable for natural trout propagation and maintenance of stocked trout;
Swamp Waters:	Waters which have low velocities and other natural characteristics which are different from adjacent streams;
NSW:	Nutrient Sensitive Waters which require limitations on nutrient inputs;
HQW:	High Quality Waters which are waters that are rated as excellent based on biological and physical/chemical characteristics through division monitoring or special studies, native and special native trout waters (and their tributaries) designated by the Wildlife Resources Commission, primary nursery areas (PNA) designated by the Marine Fisheries Commission and other functional nursery areas designated by the Wildlife Resources Commission, critical habitat areas designated by the Wildlife Resources Commission or the Department of Agriculture, all water supply watersheds which are either classified as WS-I or WS-II or those for which a formal petition for reclassification as WS-I or WS-II has been received from the appropriate local government and accepted by the Division of Environmental Management and all Class SA waters.
ORW:	Outstanding Resource Waters which are unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.

(d) Water Quality Standards. The water quality standards applicable to each classification assigned are those established in 15A NCAC 2B .0200, Classifications and Water Quality Standards Applicable to the Surface Waters of North Carolina, as adopted by the North Carolina Environmental Management Commission.

(e) Index Number.

(1) Reading the Index Number. The index number appearing in the column so designated is an identification number assigned to each stream or segment of a stream, indicating the specific tributary progression between the main stem stream and the tributary stream.

(2) Cross-Referencing the Index Number. The inclusion of the index number in the schedule is to provide an adequate cross reference between the classification schedules and an alphabetic list of streams.

(f) Classification Date. The classification date indicates the date on which enforcement of the provisions of Section 143-215.1 of the General Statutes of North Carolina became effective with reference to the classification assigned to the various streams in North Carolina.

(g) Reference. Copies of the schedules of classifications adopted and assigned to the waters of the various river basins may be obtained at no charge by writing to:

Director
Division of Environmental Management
Department of Environment, Health, and Natural Resources
Post Office Box 29535
Raleigh, North Carolina 27626-0535

(h) Places where the schedules may be inspected:

Division of State Library
Archives -- State Library Building
109 E. Jones Street
Raleigh, North Carolina.

(i) Unnamed Streams.

(1) Any stream which is not named in the schedule of stream classifications carries the same classification as that assigned to the stream segment to which it is tributary except:

(A) unnamed streams specifically described in the schedule of classifications; or

(B) unnamed freshwaters tributary to tidal saltwaters will be classified "C"; or

(C) after November 1, 1986, any newly created areas of tidal saltwater which are connected to Class SA waters by approved dredging projects will be classified "SC" unless case-by-case reclassification proceedings are conducted.

(2) The following river basins have different policies for unnamed streams entering other states or for specific areas of the basin:

Hiwassee River Basin (Rule .0302); Little Tennessee River Basin and Savannah River Drainage Area (Rule .0303); French Broad River Basin (Rule .0304); Watauga River Basin (Rule .0305); Broad River Basin (Rule .0306); New River Basin (Rule .0307); Catawba River Basin (Rule .0308); Yadkin-Pee Dee River Basin (Rule .0309); Lumber River Basin (Rule .0310); Roanoke River Basin (Rule .0313); Tar-Pamlico River Basin (Rule .0316); Pasquotank River Basin (Rule .0317).

History Note: Statutory Authority G.S. 143-214.1; 143-215.1; 143-215.3(a)(1);
Eff. February 1, 1976;
Amended Eff. August 3, 1992; August 1, 1990; October 1, 1989; November 1, 1986.

.0313 ROANOKE RIVER BASIN

(a) Places where the schedules may be inspected:

(1) Clerk of Court:
Bertie County
Caswell County
Forsyth County
Granville County
Guilford County
Halifax County
Martin County
Northampton County
Person County
Rockingham County
Stokes County
Surry County
Vance County
Warren County
Washington County

(2) North Carolina Department of Environment, Health, and Natural Resources:

(A) Raleigh Regional Office
3800 Barrett Drive
Raleigh, North Carolina

(B) Washington Regional Office
1424 Carolina Avenue
Washington, North Carolina

(C) Winston-Salem Regional Office
8025 North Point Boulevard, Suite 100
Winston-Salem, North Carolina

(b) Unnamed Streams. Such streams entering Virginia are classified "C." Except that all backwaters of John H. Kerr Reservoir and the North Carolina portion of streams tributary thereto not otherwise named or described shall carry the classification "B," and all backwaters of Lake Gaston and the North Carolina portion of streams tributary thereto not otherwise named or described shall carry the classification " B".

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
DAN RIVER (North Carolina portion)	From North Carolina-Virginia State Line to Big Creek	C Tr	9/1/57	22-(1)
Archies Creek	North Carolina portion	C Tr	9/1/57	22-2
Silverleaf Creek	From North Carolina-Virginia State Line to Archies Creek	C Tr	9/1/57	22-2-1
Big Dan Lake	Entire Lake and connecting stream to Dan River	C Tr	9/1/57	22-3
Little Dan River	From North Carolina-Virginia State Line to Dan River	C Tr	9/1/57	22-4
Elk Creek	From North Carolina-Virginia State Line to Dan River	C Tr	9/1/57	22-5
Peters Creek	From North Carolina-Virginia State Line to Dan River	C Tr	9/1/57	22-6
Little Peters Creek	From North Carolina-Virginia State Line to Dan River	C Tr	9/1/57	22-6-1
Little Creek	From source to Peters Creek	C Tr	9/1/57	22-6-2
Bonds Branch	From source to Dan River	C Tr	9/1/57	22-7
DAN RIVER	From Big Creek to a point 1.7 miles upstream of Snow Creek	WS-V	8/3/92	22-(8)
Big Creek	From source to Dan River	C Tr	9/1/57	22-9
Pinch Gut Creek	From source to Big Creek	C Tr	9/1/57	22-9-1
Meadow Branch	From source to Pinch Gut Creek	C Tr	9/1/57	22-9-1-1
Beaverdam Creek	From source to Big Creek	C Tr	9/1/57	22-9-2
Marshall Creek	From source to Big Creek	C Tr	9/1/57	22-9-3
Long Branch	From source to Big Creek	C Tr	9/1/57	22-9-4
North Double Creek	From source to Dan River	C	9/1/57	22-10
South Double Creek	From source to Dan River	B	9/1/57	22-11
Vade Mecum Creek	From source to South Double Creek	B	9/1/57	22-11-1
Rocky Branch	From source to Vade Mecum Creek	B	9/1/57	22-11-1-1
Unnamed Tributary at Camp Sertoma	From source to a point 0.6 mile upstream of Stokes County SR 2011	WS-II	8/3/92	22-11-1-2-(1)
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")	WS-II CA	8/3/92	22-11-1-2-(1.5)
Unnamed Tributary at Camp Sertoma	From Camp Sertoma raw water intake to Vade Mecum Creek	B	9/1/57	22-11-1-2-(2)
Cascade Creek (Camp Creek)	From source to Dan River	B	9/1/57	22-12
Indian Creek	From source to Cascade Creek	B	9/1/57	22-12-1
Indian Creek	From source to Dan River	C	8/3/92	22-13
Buck Island Creek (Faggs Creek)	From source to Dan River	C	9/1/74	22-14
Newman Branch	From source to Buck Island Creek	C	9/1/74	22-14-1
Seven Island Creek	From source to Dan River	C	8/3/92	22-15
Sandy Run	From source to Dan River	C	8/3/92	22-16
Scott Creek (Steadmans Creek)	From source to Dan River	C	9/1/74	22-17

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
Mill Creek	From source to Dan River	C	8/3/92	22-18
Flat Shoals Creek	From source to Dan River	C	7/1/73	22-19
DAN RIVER	From a point 1.7 miles upstream of Snow Creek to a point 0.3 mile upstream of Reed Creek	WS-IV	8/3/92	22-(19.5)
Snow Creek	From source to a point 0.4 mile downstream of Mill Creek	C	9/1/57	22-20-(0.5)
Banner Branch	From source to Snow Creek	C	9/1/74	22-20-1
Mountain Branch	From source to Snow Creek	C	9/1/74	22-20-2
Little Snow Creek	From source to Snow Creek	C	9/1/74	22-20-3
Raccoon Creek	From source to Snow Creek	C	9/1/74	22-20-4
Mill Creek (Hawkins Mill Creek)	From source to Snow Creek	C	9/1/74	22-20-5
Snow Creek	From a point 0.4 mile downstream of Mill Creek to Dan River	WS-IV	8/3/92	22-20-(5.5)
Ugly Branch	From source to Snow Creek	WS-IV	8/3/92	22-20-6
Baker Branch	From source to Snow Creek	WS-IV	8/3/92	22-20-7
Redman Creek	From source to a point 0.3 mile downstream of Stokes County SR 1652	C	9/1/57	22-20-8-(1)
Redman Creek	From a point 0.3 mile downstream of Stokes County SR 1652 to Snow Creek	WS-IV	8/3/92	22-20-8-(2)
Lynn Branch (Lynn Creek)	From source to Snow Creek	WS-IV	8/3/92	22-20-9
Wood-Benton Branch	From source to Dan River	WS-IV	8/3/92	22-21
Blackies Branch	From source to Dan River	WS-IV	8/3/92	22-22
Zilphy Creek	From source to Dan River	WS-IV	8/3/92	22-23
Fulk Creek	From source to Dan River	WS-IV	8/3/92	22-24
Town Fork Creek	From source to Mills Creek	C	9/1/57	22-25-(0.5)
Brushy Fork Creek	From source to Town Fork Creek	C	9/1/74	22-25-1
Straight Fork Creek	From source to Brushy Fork Creek	C	9/1/74	22-25-1-1
Timmons Creek	From source to Town Fork Creek	C	9/1/57	22-25-2
Paynes Branch	From source to Town Fork Creek	C	9/1/57	22-25-3
Leak Branch	From source to Town Fork Creek	C	9/1/57	22-25-4
Buffalo Creek	From source to Town Fork Creek	C	9/1/74	22-25-5
Trick-Um Creek	From source to Buffalo Creek	C	9/1/74	22-25-5-1
Rough Fork	From source to Buffalo Creek	C	9/1/74	22-25-5-2
Lucy Branch	From source to Rough Fork	C	9/1/74	22-25-5-2-1
Neatman Creek	From source to Town Fork Creek	C	9/1/57	22-25-6
Little Neatman Creek	From source to Neatman Creek	C	9/1/74	22-25-6-1
Red Bank Creek	From source to Town Fork Creek	C	9/1/57	22-25-7
Martin Creek	From source to Town Fork Creek	C	9/1/74	22-25-8
Watts Creek (Little Sandy Branch)	From source to Town Fork Creek	C	9/1/74	22-25-9
Voss Creek (Sandy Branch)	From source to Town Fork Creek	C	9/1/74	22-25-10
Old Field Creek (Redbank Creek)	From source to Town Fork Creek	B	9/1/57	22-25-11
Mill Creek	From source to Old Field Creek	B	9/1/57	22-25-11-1
Old Mill Branch	From source to Old Field Creek	B	9/1/57	22-25-11-2

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
Kansas Branch (Lake Woussicket)	From source to Old Field Creek	B	9/1/57	22-25-11-3
Walls Lakes	Entire lakes and connecting stream to Old Field Creek	B	9/1/57	22-25-11-4
Coolico Creek (Fulp Creek) (Morgan Pond)	From source to Old Field Creek	C	9/1/74	22-25-11-5
Ash Camp Creek	From source to Town Fork Creek	C	9/1/57	22-25-12
Mills Creek	From source to Town Fork Creek	C	9/1/57	22-25-13
Town Fork Creek	From Mills Creek to Dan River	WS-IV	8/3/92	22-25-(13.5)
Lick Creek	From source to N.C. Hwy. 65	C	9/1/57	22-25-14-(0.5)
Ader Creek	From source to Lick Creek	C	9/1/57	22-25-14-1
Coffer Creek	From source to Lick Creek	C	9/1/57	22-25-14-2
Right Prong Lick Creek	From source to Lick Creek	C	9/1/57	22-25-14-3
Lick Creek	From N.C. Hwy. 65 to Town Fork Creek	WS-IV	8/3/92	22-25-14-(4)
Bull Run	From source to Town Fork Creek	WS-IV	8/3/92	22-25-15
Eurins Creek	From source to Dan River	WS-IV	8/3/92	22-26
Belews Creek	From source to a point 0.5 mile upstream of backwaters of Kernersville Lake	WS-IV	8/3/92	22-27-(1)
Belews Creek (Kernersville Lake)	From a point 0.5 mile upstream of backwaters of Kernersville Lake to Town of Kernersville Water Supply Dam	WS-IV CA	8/3/92	22-27-(1.5)
Belews Creek	From Town of Kernersville Water Supply Dam to Forsyth County SR 1966 Extension	C	9/1/57	22-27-(2)
Right Fork Belews Creek (Dean Creek)	From source to Belews Creek	C	7/1/73	22-27-3
Hartley Creek	From source to Belews Creek	C	7/1/73	22-27-4
Left Fork Belews Creek	From source to Belews Creek	C	7/1/73	22-27-5
Belews Creek (Belews Creek Arm of Belews Lake below elevation 725)	From backwaters of Belews Lake (Forsyth County SR 1966 Extension) to Southern Railroad Bridge	B	7/1/73	22-27-(6)
Belews Creek (including Belews Lake below elevation 725) (1)	From Southern Railroad Bridge to Dan River, excluding the Arms of Belews Lake described below which are classified "B".	WS-IV	8/3/92	22-27-(7)
East Belews Creek	From source to Forsyth County SR 1971	C	9/1/57	22-27-8-(1)
East Belews Creek (East Belews Creek Arm of Belews Lake below elevation 725)	From backwaters of Belews Lake (Forsyth County SR 1971) to Southern Railroad Bridge	B	7/1/73	22-27-8-(2)
Kings Creek	From source to East Belews Creek Arm of Belews Lake	B	7/1/73	22-27-8-3
West Belews Creek (Little Belews Creek)	From source to backwaters of Belews Lake (2000 feet upstream from N.C. Hwy. 65)	C	9/1/57	22-27-9-(1)
West Belews Creek (Little	From backwaters of Belews Lake (2000	B	7/1/73	22-27-9-(2)

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Name of Stream	Description	Class	Classification Date	Index No.
Belews Creek) (West Belews Creek Arm of Belews Lake below elevation 725)	feet upstream from N.C. Hwy. 65) to Southern Railroad Bridge			
Arm of Belews Lake immediately southeast of Belews Lake Dam (Below elevation 725)	Entire Arm	WS-IV&B	8/3/92	22-27-10
DAN RIVER	From a point 0.3 mile upstream of Reed Creek to Rockingham County SE 1138 (Madison water supply intake)	WS-IV CA	8/3/92	22-(27.5)
Reed Creek	From source to a point 0.3 mile upstream of mouth	WS-IV	8/3/92	22-28-(1)
Reed Creek	From a point 0.3 mile upstream of mouth to Dan River	WS-IV CA	8/3/92	22-28-(2)
DAN RIVER	From Rockingham County SR 1138 to a point 0.7 mile upstream of Jacobs Cr.	WS-V	8/3/92	22-(28.5)
Big Beaver Island Creek	From source to Dan River	C	9/1/57	22-29
Little Beaver Island Creek (West Prong Beaver Island Creek)	From source to Big Beaver Island Creek	C	9/1/57	22-29-1
Mayo River	From North Carolina-Virginia State Line to a point 0.9 mile downstream from Avalon Dam	WS-IV	8/3/92	22-30-(1)
South Mayo River	From North Carolina-Virginia State Line to Mayo River	WS-IV	8/3/92	22-30-2
Caldwell Creek	From source to North Carolina-Virginia State Line	WS-IV	8/3/92	22-30-2-1-1
Crooked Creek (North Carolina portion)	From source to last crossing of North Carolina-Virginia State Line	WS-IV	8/3/92	22-30-2-2
White Mud Branch (White Mud Creek)	From North Carolina-Virginia State Line to Crooked Creek	WS-IV	8/3/92	22-30-2-2-1
~~Little Crooked Creek~~	~~From source to Crooked Creek~~	~~WS-IV~~	~~8/3/92~~	~~22-30-2-2-2~~
South Crooked Creek	From source to Little Crooked Creek	WS-IV	8/3/92	22-30-2-2-2-1
Fall Creek	From North Carolina-Virginia State Line to Mayo River	WS-IV	8/3/92	22-30-3
Buffalo Creek	From source to Mayo River	WS-IV	8/3/92	22-30-4
Hickory Creek	From source to Mayo River	WS-IV	8/3/92	22-30-5
Pawpaw Creek	From source to Mayo River	WS-IV	8/3/92	22-30-6
Means Creek	From source to Mayo River	WS-IV	8/3/92	22-30-7
Boaz Creek	From source to Mayo River	WS-IV	8/3/92	22-30-8
Unnamed Tributary near Stoneville	From source to Mayo River	WS-IV	8/3/92	22-30-9
Mayo River	From a point 0.9 mile downstream from Avalon Dam to dam at Mayodan Water Supply Intake	WS-IV CA	8/3/92	22-30-(9.5)
Mayo River	From dam at Mayodan Water Supply	C	8/3/92	22-30-(10)

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Name of Stream	Description	Class	Classification Date	Index No.
	Intake to Dan River			
Hogans Creek	From source to Dan River	C	9/1/57	22-31
Little Hogans Creek (West Prong Hogans Creek)	From source to Hogans Creek	C	9/1/57	22-31-1
DAN RIVER	From a point 0.7 mile upstream of Jacobs Creek to a point 0.8 mile downstream of Matrimony Creek	WS-IV	8/3/92	22-(31.5)
Jacobs Creek	From source to N.C. Hwy. 704	C	9/1/57	22-32-(0.5)
Brushy Creek (West Prong Jacobs Creek)	From source to Jacobs Creek	C	9/1/57	22-32-1
Little Jacobs Creek (East Prong Jacobs Creek)	From source to Jacobs Creek	C	9/1/57	22-32-2
Huffines Mill Creek	From source to Little Jacobs Creek	C	9/1/74	22-32-2-1
Jacobs Creek	From N.C. Hwy. 704 to Dan River	WS-IV	8/3/92	22-32-(3)
Massy Creek	From source to Dan River	WS-IV	8/3/92	22-33
Rock House Creek	From source to Rockingham County SR 2381	C	9/1/57	22-34-(1)
Rock House Creek	From Rockingham Countly SR 2381 to Dan River	WS-IV	8/3/92	22-34-(2)
Roach Creek	From source to Dan River	WS-IV	8/3/92	22-35
Whetstone Creek	From source to Dan River	WS-IV	8/3/92	22-36
Buffalo Creek	From source to Dan River	WS-IV	8/3/92	22-37
Matrimony Creek (North Carolina portion)	From source to Dan River	WS-IV	8/3/92	22-38
Bear Creek	From source to North Carolina-Virginia State Line	WS-IV	8/3/92	22-38-1
Jones Branch (Jones Creek)	From North Carolina-Virginia State Line to Matrimony Creek	WS-IV	8/3/92	22-38-2
Little Matrimony Creek	From source to Matrimony Creek	WS-IV	8/3/92	22-38-3
Poplar Creek	From North Carolina-Virginia State Line to Matrimony Creek	WS-IV	8/3/92	22-38-4
Boiling Springs Branch	From source to Matrimony Creek	WS-IV	8/3/92	22-38-5
DAN RIVER	From a point 0.8 mile downstream of Matrimony Creek to Mill Branch (Town of Eden water supply intake)	WS-IV CA	8/3/92	22-(38.5)
DAN RIVER (North Carolina portion)	From Mill Branch to last crossing of North Carolina-Virginia State Line	C	9/1/57	22-(39)
Mill Branch	From source to Dan River	WS-IV	8/3/92	22-39.5
Smith River	From North Carolina-Virginia State Line to a point 0.8 mile downstream of Rockingham County SR 1714 (Aiken Road)	WS-IV	8/3/92	22-40-(1)
Martin Creek	From source to North Carolina-Virginia State Line	WS-IV	8/3/92	22-40-2
Smith River	From a point 0.8 mile downstream of Rockingham County SR 1714 (Aiken Road) to Fieldcrest Mills Water	WS-IV CA	8/3/92	22-40-(3)

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
	Supply Intake			
Smith River	From Fieldcrest Mills Water Supply Intake to Dan River	C	9/1/57	22-40-(3)
Tackett Branch	From source to Smith River	C	9/1/57	22-40-4
Fishing Creek	From source to Dan River	C	9/1/57	22-41
Town Creek (Sharps Lake)	From source to Dan River	C	9/1/74	22-42
Machine Creek	From source to Town Creek	C	9/1/74	22-42-1
Rock Creek	From source to Dan River	C	9/1/57	22-43
Covenant Branch	From source to Dan River	C	9/1/57	22-44
Cascade Creek	From North Carolina-Virginia State Line to Dan River	C	8/3/92	22-45
Mountain Run	From North Carolina-Virginia State Line to Cascade Creek	C	8/3/92	22-45-2
Dry Creek	From source to Cascade Creek	C	3/1/77	22-45-4
White Oak Creek	From source to North Carolina-Virginia State Line	C	9/1/74	22-46
Buckhorn Branch	From source to White Oak Creek	C	9/1/74	22-46-1
Williamson Creek	From source to Dan River	C	9/1/74	22-47
Wolf Island Creek	From source to Dan River	C	9/1/57	22-48
Carroll Creek (Lake Hazel)	From source to Wolf Island Creek	C	9/1/57	22-48-1
Lake LeMar	Entire lake and connecting stream to Carroll Creek	C	9/1/57	22-48-1-1
Quaqua Creek	From source to Wolf Island Creek	C	9/1/74	22-48-2
Lovelace Creek	From source to Wolf Island Creek	C	9/1/74	22-48-3
Birch Fork	From source to Wolf Island Creek	C	9/1/74	22-48-4
Little Wolf Island Creek	From source to Wolf Island Creek	C	9/1/57	22-48-5
Tardy Branch	From source to Wolf Island Creek	C	9/1/57	22-48-6
Pumpkin Creek	From source to North Carolina-Virginia State Line	B	3/1/77	22-49
Whalebone Branch	From source to Pumpkin Creek	B	3/1/77	22-49-1
Rutledge Creek	From source to North Carolina-Virginia State Line	B	3/1/77	22-49-2
Hogans Creek	From source to Dan River	C	9/1/57	22-50
Williamsburg Wildlife Lake	Entire lake and connecting stream to Hogans Creek	C	9/1/57	22-50-1
Rockingham Lake	Entire lake and connecting stream to Hogans Creek	C	9/1/57	22-50-2
Jones Creek (Lake Wade)	From source to Hogans Creek	C	9/1/74	22-50-3
Lick Fork Creek	From source to Hogans Creek	C	7/1/73	22-50-4
Little Mill Creek	From source to Hogans Creek	C	9/1/57	22-50-5
Moon Creek (Wildwood Lake)	From source to Dan River	C	7/1/73	22-51
East Prong Moon Creek	From source to Moon Creek	C	9/1/74	22-51-1
West Prong East Prong Moon Creek	From source to East Prong Moon Creek	C	9/1/74	22-51-1-1
Park Spring Lake	Entire lake and connecting stream to Moon Creek	C	7/1/73	22-51-2

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Name of Stream	Description	Class	Classification Date	Index No.
Bear Branch	From source to Moon Creek	C	7/1/73	22-51-3
Rattlesnake Creek	From source to Dan River	C	7/1/73	22-52
North Fork Rattlesnake Creek	From source to Rattlesnake Creek	C	9/1/74	22-52-1
South Fork Rattlesnake Creek	From source to Rattlesnake Creek	C	9/1/74	22-52-2
Coy Creek	From North Carolina-Virginia State Line to Dan River	C	9/1/57	22-53
Cane Creek	From North Carolina-Virginia State Line to Dan River	C	9/1/57	22-54
Glasby Branch	From North Carolina-Virginia State Line to Cane Creek	C	9/1/57	22-54-1
Little Rattlesnake Creek	From source to Dan River	C	9/1/57	22-55
Country Line Creek	From source to a point 1.0 mile downstream of Nats Fork	WS-II	8/3/92	22-56-(1)
Hostler Branch	From source to Country Line Creek	WS-II	8/3/92	22-56-2
Nats Fork	From source to Country Line Creek	WS-II	8/3/92	22-56-3
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)	WS-II CA	8/3/92	22-56-(3.5)
Country Line Creek	From dam at Farmer Lake to Dan River	C	8/3/92	22-56-(3.7)
Fullers Creek	From source to a point 0.8 mile upstream of Yanceyville water supply dam	WS-II	8/3/92	22-56-4-(1)
Fullers Creek	From a point 0.8 mile upstream of Yanceyville water supply dam to Yanceyville water supply dam	WS-II CA	8/3/92	22-56-4-(2)
Fullers Creek	From Yanceyville water supply dam to Country Line Creek	C	8/3/92	22-56-4-(3)
Jail Branch	From source to Country Line Creek	C	3/1/77	22-56-5
South Country Line Creek	From source to Caswell County SR 1759	C	9/1/57	22-56-7-(1)
South Country Line Creek (including proposed Country Line Watershed Project Structure # 4 impoundment below normal pool elevation 490.0 feet MSL)	From Caswell County SR 1759 to proposed dam located 0.1 mile, more or less, downstream from Caswell County SR 1736	B	7/1/73	22-56-7-(2)
Byrds Creek	From source to Caswell County SR 1751	C	9/1/57	22-56-7-3-(1)
Byrds Creek	From Caswell County SR 1751 to South Country Line Creek	B	7/1/73	22-56-7-3-(2)
Penson Creek	From source to N.C. Hwy. 62	C	9/1/57	22-56-7-4-(1)
Penson Creek	From N.C. Hwy. 62 to South Country Line Creek	B	7/1/73	22-56-7-4-(2)
Burkes Creek	From source to N.C. Hwy. 62	C	9/1/57	22-56-7-4-3-(1)

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
Burkes Creek	From N.C. Hwy. 62 to Penson Creek	B	7/1/73	22-56-7-4-3-(2)
South Country Line Creek	From proposed dam located 0.1 mile, more or less, downstream from Caswell County SR 1736 to Country Line Creek	C	9/1/57	22-56-7-(5)
Beneja Creek	From source to South Country Line Creek	C	9/1/57	22-56-7-6
Kilgore Creek	From source to Country Line Creek	C	9/1/57	22-56-8
Winns Creek	From source to North Carolina-Virginia State Line	B	3/1/77	22-57
Brandon Creek	From source to North Carolina-Virginia State Line	B	3/1/77	22-57-1
Hyco River, including Hyco Lake below elevation 410	From source in Hyco Lake to dam of Hyco Lake, including tributary arms below elevation 410	B	7/1/91	22-58-(0.5)
Hyco Creek (North Hyco Creek)	From source to Hyco Lake, Hyco River	C	9/1/57	22-58-1
Negro Creek	From source to Hyco Creek	C	9/1/57	22-58-1-1
Lynch Creek	From source to Hyco Creek	C	9/1/57	22-58-1-2
Panther Branch (Morgans Pond)	From source to Hyco Creek	C	9/1/74	22-58-1-3
Coneys Creek (Cobbs Creek)	From source to Hyco Creek	C	9/1/74	22-58-1-4
Kilgore Creek	From source to Hyco Creek	C	9/1/57	22-58-1-5
Reedy Fork Creek	From source to Hyco Lake, Hyco River	C	9/1/74	22-58-2
Cobbs Creek	From source to Hyco Lake, Hyco River	C	9/1/74	22-58-3
South Hyco Creek	From source to backwaters of Lake Roxboro	WS-II	8/3/92	22-58-4-(0.5)
Sugartree Creek	From source to South Hyco Creek	WS-II	8/3/92	22-58-4-1
South Hyco Creek (Lake Roxboro)	From backwaters of Lake Roxboro to dam at Lake Roxboro	WS-II&B	8/3/92	22-58-4-(1.4)
South Hyco Creek	From dam at Lake Roxboro to a point 0.6 mile downstream of Double Creek	WS-II	8/3/92	22-58-4-(1.7)
Double Creek	From source to South Hyco Creek	WS-II	8/3/92	22-58-4-2
Broachs Mill Creek	From source to Double Creek	WS-II	8/3/92	22-58-4-2-1
Snipe Creek	From source to Broachs Mill Creek	WS-II	8/3/92	22-58-4-2-1-1
South Hyco Creek	From a point 0.6 mile downstream of Double Creek to Hyco Lake, Hyco River (City of Roxboro water supply intake)	WS-II CA	8/3/92	22-58-4-(3)
Cub Creek	From source to Hyco Lake, Hyco River	C	7/18/79	22-58-5
Richland Creek	From source to Hyco Lake, Hyco River	C	9/1/74	22-58-6
Little Duck Creek	From source to Hyco Lake, Hyco River	C	9/1/57	22-58-7
Sargents Creek	From source to Hyco Lake, Hyco River	C	9/1/57	22-58-8
Cane Creek	From source to Hyco Lake, Hyco River	C	9/1/74	22-58-9
Hyco River	From dam of Hyco Lake to North Carolina-Virginia State Line, including all portions in North Carolina	C	7/17/79	22-58-(9.5)
Ghent Creek	From source to Hyco River	C	9/1/74	22-58-10

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Name of Stream	Description	Class	Classification Date	Index No.
Powells Creek	From North Carolina-Virginia State Line to Hyco River	C	9/1/74	22-58-11
Storys Creek	From source to a point 0.9 mile downstream of N.C. Hwy. 57	WS-II	8/3/92	22-58-12-(1)
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	WS-II CA	8/3/92	22-58-12-(1.5)
Satterfield Creek	From source to a point 0.5 mile downstream of N.C. Hwy. 57	WS-II	8/3/92	22-58-12-2-(1)
Satterfield Creek	From a point 0.5 mile downstream of N.C. Hwy. 57 to Roxboro City Lake, Storys Creek	WS-II CA	8/3/92	22-58-12-2-(2)
Lick Branch	From source to a point 0.6 mile upstream of mouth	WS-II	8/3/92	22-58-12-3-(1)
Lick Branch	From a point 0.6 mile upstream of mouth to Roxboro City Lake, Storys Cr.	WS-II CA	8/3/92	22-58-12-3-(2)
Storys Creek (Chub Lake)	From Roxboro City Lake Dam to dam at Chub Lake	B	9/1/57	22-58-12-(4)
Storys Creek	From dam at Chub Lake to Hyco River	C	7/1/73	22-58-12-(5)
Marlowe Creek	From source to Storys Creek	C	8/1/85	22-58-12-6
Tanyard Branch	From source to Marlowe Creek	C	3/1/77	22-58-12-6-2
Mitchell Creek	From source to Marlowe Creek	C	9/1/74	22-58-12-6-3
Fishing Creek	From source to Marlowe Creek	C	9/1/74	22-58-12-6-4
Castle Creek	From source to Hyco River	C	9/1/74	22-58-13
Bamboo Branch	From source to Castle Creek	C	9/1/74	22-58-13-1
Bowes Branch	From source to North Carolina-Virginia State Line	C	9/1/57	22-58-14
Mayo Creek (Maho Creek) (Mayo Reservoir)	From source to North Carolina-Virginia State Line	C	9/1/57	22-58-15
Donaldson Creek	From source to Mayo Reservoir, Mayo Creek	C	9/1/74	22-58-15-1
Mill Creek	From source to Mayo Reservoir, Mayo Creek	C	9/1/57	22-58-15-2
Spoonwater Creek	From source to Mayo Reservoir, Mayo Creek	C	9/1/74	22-58-15-3
Crutchfield Branch	From source to North Carolina-Virginia State Line	B	3/1/77	22-58-15-4
Big Bluewing Creek (Blue Wing Creek)	From source to North Carolina-Virginia State Line	C	9/1/57	22-58-16
Cattail Branch	From source to Big Bluewing Creek	C	9/1/57	22-58-16-1
Bredlov Creek	From source to Big Bluewing Creek	C	9/1/57	22-58-16-2
Aarons Creek	From source to North Carolina-Virginia State Line	C	9/1/57	22-59
Crooked Fork	From source to Aarons Creek	C	9/1/57	22-59-1
Wolfpit Run	From source to North Carolina-Virginia State Line	C	9/1/57	22-59-2
ROANOKE RIVER (For identification only)	From mouth of Dan River in Virginia to North Carolina-Virginia State Line	-		23-(1)

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Name of Stream	Description	Class	Classification Date	Index No.
Grassy Creek (Grass Creek)	From source to John H. Kerr Reservoir at Granville County SR 1431	C	9/1/57	23-2-(1)
Bearskin Creek	From source to Grassy Creek	C	7/1/73	23-2-2
Mountain Creek	From source to Grassy Creek	C	7/1/73	23-2-3
Little Grassy Creek (Little Grass Creek)	From source to Grassy Creek	C	9/1/57	23-2-4
Blue Creek	From source to Little Grassy Creek	C	7/1/73	23-2-4-1
Graham Branch	From source to Little Grassy Creek	C	7/1/73	23-2-4-2
Rattlesnake Creek	From source to Grassy Creek	C	9/1/57	23-2-5
Grassy Creek Arm of John H. Kerr Reservoir (Below normal pool elevation 300 feet MSL or as this elevation may be adjusted by the Corps of Engineers	From Granville County SR 1431 to the North Carolina-Virginia State Line	B	1/1/62	23-2-(6)
Johnson Creek	From source to Little Johnson Creek	C	9/1/57	23-2-7-(1)
Johnson Creek	From Little Johnson Creek to Grassy Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-2-7-(2)
Little Johnson Creek	From source to Johnson Creek	C	9/1/57	23-2-7-3
Beech Creek	From North Carolina-Virginia State Line to Grassy Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-2-8
Spewmarrow Creek	From source to Deer Pond Branch	C	7/1/73	23-2-9-(1)
Spewmarrow Creek	From Deer Pond Branch to Grassy Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-2-9-(2)
Deer Pond Branch	From source to Spewmarrow Creek	C	7/1/73	23-2-9-3
Lick Branch	From source to Grassy Creek Arm of John H. Kerr Reservoir	C	9/1/57	23-2-10
Cedar Branch	From source to Grassy Creek Arm of John H. Kerr Reservoir	C	9/1/57	23-2-11
Beaver Pond Creek (including Beaver Pond Creek Arm of John H. Kerr Reservoir below normal pool elevation)	From source to North Carolina-Virginia State Line	B	7/1/73	23-3
Island Creek (Island Creek Reservoir)	From source to North Carolina-Virginia State Line, including that portion of Island Creek Reservoir in North Carolina below normal operating elevation	C	9/1/57	23-4
Gill Creek (Formerly called Little Island Creek, Granville County)	From source to Island Creek	C	9/1/57	23-4-1
Michael Creek	From source to Island Creek	C	9/1/57	23-4-2
Marion Branch	From source to Island Creek	C	9/1/57	23-4-2.5
Little Island Creek (Vance County)	From source to Island Creek Reservoir, Island Creek	C	9/1/57	23-4-3

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Name of Stream	Description	Class	Classification Date	Index No.
Poplar Spring Branch	From source to Island Creek Reservoir, Island Creek	C	9/1/57	23-4-4
Gilliams Branch (Gilliams Creek)	From source to North Carolina-Virginia State Line	C	9/1/57	23-4-5
Carter Branch	From source to North Carolina-Virginia State Line	C	9/1/57	23-5
Mill Creek (Including Mill Creek Arm of John H. Kerr Reservoir below normal pool elevation)	From source to North Carolina-Virginia State Line	C	9/1/57	23-6
Long Grass Branch (Including Long Grass Branch Arm of John H. Kerr Reservoir below normal pool elevation)	From source to North Carolina-Virginia State Line	C	9/1/57	23-7
Nutbush Creek (Including Nutbush Creek Arm of John H. Kerr Reservoir below normal pool elevation)	From source to Crooked Run	C	9/1/57	23-8-(1)
Nutbush Creek Arm of John H. Kerr Reservoir (below normal pool elevation 300 feet MSL or as this elevation may be adjusted by the Corps of Engineers)	From Crooked Run to North Carolina-Virginia State Line	B	1/1/62	23-8-(2)
Crooked Run	From source to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-3
Indian Creek (Including Indian Creek Arm of John H. Kerr Reservoir below normal pool elevation)	From source to Carolina Power & Light Company Power Line	C	9/1/57	23-8-4-(1)
Indian Creek Arm of John H. Kerr Reservoir (below normal pool elevation 300 feet MSL or as this elevation may be adjusted by the Corps of Engineers)	From Carolina Power & Light Company Power Line to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-4-(2)
Flat Creek	From source to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-5
Anderson Swamp Creek (Including Anderson Swamp Creek Arm of John H. Kerr Reservoir below normal pool elevation)	From source to a point 0.6 mile upstream of Vance County SR 1374	WS-III&B	8/3/92	23-8-6-(1)
Anderson Swamp Creek (Including Anderson Swamp Creek Arm of John H. Kerr	From a point 0.6 mile upstream of Vance County SR 1374 to Mill Creek	WS-III&B CA	8/3/92	23-8-6-(1.5)

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Name of Stream	Description	Class	Classification Date	Index No.
Reservoir below normal pool elevation)				
Anderson Swamp Creek Arm of John H. Kerr Reservoir (below normal pool elevation 300 feet MSL or as this elevation may be adjusted by the Corps of Engineers)	From Mill Creek to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-6-(2)
Mill Creek	From source to Anderson Swamp Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-6-3
Little Nutbush Creek	From source to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-7
Dodson Creek (Dobson Creek)	From source to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-8
Case Quarry Creek	From source to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-9
Dix Branch (Dicks Creek)	From source to Nutbush Creek Arm of John H. Kerr Reservoir	B	1/1/62	23-8-10
Keats Branch (Including Keats Branch Arm of John H. Kerr Reservoir below normal pool elevation)	From source to North Carolina-Virginia State Line	C	9/1/57	23-9
Smith Creek	From source to North Carolina-Virginia State Line	C	7/1/73	23-10
Cabin Branch	From source to Smith Creek	C	7/1/73	23-10-1
Newmans Creek (Little Deep Creek)	From source to Smith Creek	C	9/1/74	23-10-2
Ellington Branch	From source to Newmans Creek	C	9/1/74	23-10-2-1
Blue Mud Creek	From source to Smith Creek	C	7/1/73	23-10-3
Malones Creek	From source to Blue Mud Creek	C	9/1/74	23-10-3-1
West Branch Malones Creek	From source to Malones Creek	C	9/1/74	23-10-3-1-1
Terrapin Creek	From source to Blue Mud Creek	C	3/1/77	23-10-3-2
Reedy Branch	From source to North Carolina-Virginia State Line	C	9/1/74	23-10-4
Hawtree Creek	From source to Warren County SR 1304	C	7/1/73	23-11-(1)
Sawmill Creek (Mill Creek)	From source to Hawtree Creek	C	7/1/73	23-11-2
Rocky Branch (Sauls Creek)	From source to Hawtree Creek	C	7/1/73	23-11-3
Hawtree Creek (Hawtree Creek Arm of Lake Gaston below normal pool elevation)	From Warren County SR 1304 to North Carolina-Virginia State Line	B	8/3/92	23-11-(4)
Coleman Branch	From source to Hawtree Creek Arm of Lake Gaston	C	7/1/73	23-11-5
ROANOKE RIVER (Lake Gaston	From North Carolina-Virginia State	WS-V&B	8/3/92	23-(12)

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
below normal full power pool elevation 200 MSL)	Line to a line across Lake Gaston following the Warren-Northampton County Line			
Sixpound Creek	From source to Lake Gaston, Roanoke River	C	7/1/73	23-13
Jordan Creek	From source to Lake Gaston, Roanoke River	C	7/1/73	23-14
Lyons Creek	From source to Lake Gaston, Roanoke River	C	8/3/92	23-15
Hubquarter Creek	From source to Lake Gaston, Roanoke River	C	7/1/73	23-16
Little Hubquarter Creek	From source to Hubquarter Creek	C	9/1/74	23-16-1
Mill Creek	From North Carolina-Virginia State Line to Lake Gaston, Roanoke River	C	8/3/92	23-17
Big Stonehouse Creek	From source to Lake Gaston, Roanoke River	C	7/1/73	23-18
Little Stonehouse Creek	From source to Lake Gaston, Roanoke River	C	7/1/73	23-19
West Littleton Branch	From source to Little Stonehouse Creek	C	9/1/74	23-19-1
Bagley Academy Branch	From source to Lake Gaston, Roanoke River	C	9/1/74	23-20
ROANOKE RIVER (Lake Gaston below normal full power pool elevation 200 MSL)	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	WS-IV&B	8/3/92	23-(20.2)
Mill Creek	From source to Lake Gaston, Roanoke River	WS-IV	8/3/92	23-20.3
Poe Creek	From source to Lake Gaston, Roanoke River	WS-IV	8/3/92	23-20.6
Dogwood Branch	From North Carolina-Virginia State Line to Lake Gaston, Roanoke River	C	9/1/74	23-21
Jimmies Creek (Jimmies Run)	From North Carolina-Virginia State Line to Lake Gaston, Roanoke River	WS-IV	8/3/92	23-22
ROANOKE RIVER (Lake Gaston below normal full power pool elevation 200 MSL and Roanoke Rapids Lake below normal full power pool elevation 132 feet MSL)	From a line across Lake Gaston 0.5 mile upstream of Lake Gaston Dam to Roanoke Rapids Dam	WS-IV&B CA	8/3/92	23-(22.5)
Black Gut Creek	From source to Devils Branch	WS-IV	8/3/92	23-23-(0.3)
Black Gut Creek	From Devils Branch to Roanoke Rapids Lake, Roanoke River	WS-IV CA	8/3/92	23-23-(0.8)
Devils Branch (Double	From source to Black Gut Creek	WS-IV	8/3/92	23-23-1

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
Branch)				
Deep Creek	From source to a point 0.5 mile upstream of mouth	WS-IV	8/3/92	23-24-(1)
Deep Creek	From a point 0.5 mile upstream of mouth to Roanoke Rapids Lake, Roanoke River	WS-IV CA	8/3/92	23-24-(2)
ROANOKE RIVER	From Roanoke Rapids Dam to a point 0.6 mile upstream of N.C. Hwy. 48 bridge	WS-IV	8/3/92	23-(25)
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)	WS-IV CA	8/3/92	23-(25.5)
ROANOKE RIVER	From a line across the river 50 feet downstream from N.C. Hwy. 48 bridge to 18 mile marker at Jamesville	C	9/1/57	23-(26)
Black Duck Creek (Deep Creek)	From source to Roanoke River	C	9/1/74	23-27
Lees Creek	From source to Black Duck Creek	C	9/1/74	23-27-1
Arthurs Creek	From source to Roanoke River	C	9/1/74	23-28
Chockoytte Creek	From source to Roanoke River	C	9/1/57	23-29
Quankey Creek	From source to Roanoke River	C	7/1/73	23-30
Little Quankey Creek	From source to Quankey Creek	C	9/1/74	23-30-1
Occoneechee Creek	From source to Roanoke River	C	9/1/74	23-31
Wheeler Creek	From source to Roanoke River	C	9/1/74	23-32
Gumberry Swamp (Boones Millpond, Barrows Mill-Pond)	From source to Wheeler Creek	C	7/1/73	23-32-1
Lilly Pond Creek	From source to Wheeler Creek	C	9/1/74	23-32-2
Conconnara Swamp	From source to Roanoke River	C	7/1/73	23-33
Bridgers Creek	From source to Roanoke River	C	7/1/73	23-34
Looking Glass Run	From source to Roanoke River	C	9/1/57	23-35
Cypress Swamp	From source to Roanoke River	C	9/1/57	23-36
Sandy Run	From source to Roanoke River	C	9/1/74	23-37
Dynamite Lake	Entire lake and connecting stream to Sandy Run	C	9/1/74	23-37-1
Bull Neck Swamp	From source to Sandy Run	C	9/1/74	23-37-2
Quinine Swamp	From source to Roanoke River	C	9/1/74	23-38
Brittons Creek	From source to Roanoke River	C	9/1/74	23-39
Flag Run Gut	From source to Roanoke River	C	9/1/74	23-40
Cypress Swamp	From source to Roanoke River	C	9/1/57	23-41
Kehukee Swamp (White Millpond)	From source to Roanoke River	C	7/1/73	23-42
Webbs Mill Branch	From source to Kehukee Swamp	C	9/1/74	23-42-1
Thompson Gut	From source to Roanoke River	C	9/1/74	23-43
Kiahs Gut	From source to Roanoke River	C	9/1/57	23-44

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
Blue Hole Swamp	From source to Roanoke River	C	9/1/57	23-45
Matthew Slough	From source to Blue Hole Swamp	C	9/1/57	23-45-1
Canal Gut	From source to Roanoke River	C	9/1/74	23-46
Indian Creek	From source to Roanoke River	C	9/1/74	23-47
Coniott Creek (Town Swamp)	From source to Roanoke River	C	7/1/73	23-48
Frog Level Swamp	From source to Coniott Creek	C	9/1/74	23-48-1
Conoho Creek	From source to Roanoke River	C	9/1/57	23-49
Etheridge Swamp	From source to Conoho Creek	C	9/1/74	23-49-1
Beaverdam Creek	From source to Conoho Creek	C	9/1/57	23-49-2
Mill Branch	From source to Conoho Creek	C	9/1/74	23-49-3
Sweetwater Creek (Statons Pond)	From source to Roanoke River	C	9/1/57	23-50
Hardison Mill Creek	From source to Statons Pond, Sweetwater Creek	C	9/1/57	23-50-1
Long Creek	From source to Hardison Mill Creek	C	9/1/57	23-50-1-1
Smithwick Creek	From source to Statons Pond, Sweetwater Creek	C	9/1/57	23-50-2
Ready Branch	From source to Statons Pond, Sweetwater Creek	C	9/1/74	23-50-3
Dog Branch	From source to Ready Branch	C	9/1/74	23-50-3-1
Conine Creek	From source to Roanoke River	C	9/1/57	23-51
Devils Gut	From source to Roanoke River	C	9/1/57	23-52
Gardners Creek	From source to Devils Gut	C	9/1/57	23-52-1
Deep Run Swamp	From source to Gardners Creek	C	9/1/74	23-52-1-1
Lanier Swamp	From source to Gardners Creek	C	9/1/74	23-52-1-2
Copper Swamp	From source to Gardners Creek	C	9/1/74	23-52-1-3
ROANOKE RIVER	From 18 mile marker at Jamesville to Albemarle Sound (Batchelor Bay)	C Sw	9/1/57	23-(53)
Broad Creek	From source to Roanoke River	C Sw	9/1/57	23-54
Welch Creek	From source to Roanoke River	C Sw	7/13/80	23-55
Conaby Creek	From source to Roanoke River	C Sw	9/1/57	23-56
ALBEMARLE SOUND (Batchelor Bay)	West of a line extending from a point of land on the southside of the mouth of Black Walnut Swamp in a southerly direction to a point of land on the eastside of the mouth of Roanoke River	B Sw	9/1/74	24
Eastmost River	From Roanoke River to N.C. Hwy. 45	C Sw	9/1/57	24-1-(1)
Eastmost River	From N.C. Hwy. 45, including cutoff between Eastmost River and Middle River to Albemarle Sound	B Sw	9/1/74	24-1-(2)
Cashie River	From source to a point 1.0 mile upstream from Bertie County SR 1500	C Sw	9/1/57	24-2-(1)
Wahtom Swamp	From source to Cashie River	C Sw	9/1/74	24-2-2
Connaritsa Swamp	From source to Cashie River	C Sw	7/1/73	24-2-3
White Oak Swamp	From source to Cashie River	C Sw	7/1/73	24-2-4
Chiska Creek	From source to Cashie River	C Sw	9/1/74	24-2-5

.0313 ROANOKE RIVER BASIN

Name of Stream	Description	Class	Classification Date	Index No.
Hoggard Mill Creek	From source to Cashie River	C Sw	9/1/57	24-2-6
Chucklemaker Swamp	From source to Hoggard Mill Creek	C Sw	9/1/74	24-2-6-1
Flat Swamp Creek	From source to Hoggard Mill Creek	C Sw	9/1/74	24-2-6-2
Roquist Creek	From source to Cashie River	C Sw	9/1/57	24-2-7
Jacks Branch	From source to Roquist Creek	C Sw	9/1/57	24-2-7-1
Choowatic Creek	From source to Roquist Creek	C Sw	9/1/57	24-2-7-2
Mill Swamp	From source to Roquist Creek	C Sw	9/1/74	24-2-7-3
Wading Place Creek	From source to Cashie River	C Sw	9/1/57	24-2-8
Cashie River	From a point 1.0 mile upstream from Bertie County SR 1500 to the Thoroughfare (The Gut between Cashie and Roanoke Rivers)	B Sw	9/1/74	24-2-(9)
Swamp Creek	From source to Cashie River	C Sw	9/1/57	24-2-10
Cashie River	From the Thoroughfare (The Gut between Cashie and Roanoke Rivers) to N.C. Hwy. 45	C Sw	9/1/57	24-2-(11)
Thoroughfare (The Gut)	From Roanoke River to Cashie River	C Sw	9/1/57	24-2-12
Broad Creek	From source to Cashie River	C Sw	9/1/57	24-2-13
Grennell Creek	From source to Cashie River	C Sw	9/1/57	24-2-14
Cashie River	From N.C. Hwy. 45 to Albemarle Sound (Batchelor Bay)	B Sw	9/1/74	24-2-(15)
Middle River	From source to N.C. Hwy. 45	C Sw	9/1/57	24-2-16-(1)
Middle River	From N.C. Hwy. 45 to Cashie River	B Sw	9/1/74	24-2-16-(2)
Cashoke Creek (Cashote Creek)	From source to Cashie River	C Sw	9/1/57	24-2-17
Morgan Swamp	From source to Albemarle Sound (Batchelor Bay)	B Sw	9/1/74	24-3

(1) Editor's Note: On March 27, 1970, a variance from temperature standards was granted by the Board of Water and Air Resources to Duke Power Company for the waters of Belews Lake, including Belews Creek, West Belews Creek and East Belews Creek arms from the Southern Railroad Bridge to Belews Lake Dam. The maximum instantaneous surface temperature (as measured at a depth of one foot) in these waters shall not exceed 35 C (95 F).

APPENDIX II

CONTENTS:

BENTHIC MACROINVERTEBRATES

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 many taxa in a community have life cycles of six months to 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 bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S). Higher taxa richness values are associated with better water quality. Likewise, ratings can be assigned with a Biotic Index. This index summarizes tolerance data for all taxa in each collection. The two rankings are given equal weight in final site classification for qualitative samples. Taxa richness alone is used to assign bioclassifications for EPT samples. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is poorly assessed by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal) within North Carolina.

Classification Criteria by Ecoregion*

A. EPT taxa richness values

	10-sample Qualitative Samples			4-sample EPT Samples		
	Mountains	Piedmont	Coastal	Mountains	Piedmont	Coastal
Excellent	>41	>31	>27	>35	>27	>23
Good	32-41	24-31	21-27	28-35	21-27	18-23
Good-Fair	22-31	16-23	14-20	19-27	14-20	12-17
Fair	12-21	8-15	7-13	11-18	7-13	6-11
Poor	0-11	0-7	0-6	0-10	0-6	0-5

B. Biotic Index Values (Range = 0-10)

	Mountains	Piedmont	Coastal
Excellent	<4.05	<5.19	<5.47
Good	4.06-4.88	5.19-5.78	5.47-6.05
Good-Fair	4.89-5.74	5.79-6.48	6.06-6.72
Fair	5.75-7.00	6.49-7.48	6.73-7.73
Poor	≥7.00	≥7.48	≥7.73

*These criteria apply to flowing water systems only. Biotic index criteria are only used for full-scale (10-sample) qualitative samples.

Benthos data for each subbasin are presented in Chapter 4.

FISHERIES

FISH COMMUNITY STRUCTURE ASSESSMENT

The North Carolina Index of Biotic Integrity (NCIBI) is a modification of the Index of Biotic Integrity (Karr, 1981; Karr et al., 1986). The method was developed for assessing a stream's biological integrity by examining the structure and health of its fish community. The scores derived from this index are a measure of the ecological health of the waterbody and may not necessarily directly correlate to water quality. A stream with excellent water quality, but poor to fair habitat, would not rate asexcellent using this index; however, a stream which rates excellent on the NCIBI would be expected to have excellent water quality. The NCIBI is not applicable to high elevation trout streams, lakes, or estuaries.

The Index incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

The assessment of biological integrity using the 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, 5 scale. A score of 5 represents conditions expected for undisturbed streams in the specific river basin or ecoregion, while a score of 1 indicates that the conditions vary greatly from those expected in undisturbed streams of the region. The scores for each metric are summed to attain the overall IBI score.

Each metric is designed to contribute unique information to the overall assessment. A brief explanation of each of the NCIBI metrics is presented below. Some metrics have been grouped together.

1. Number of Species and Number of Individuals: The total number of species and individuals supported by streams of a given size in a given region decrease with environmental degradation. Both of these metrics are rated according to the river basin in which the sample was taken and the drainage area size at the sampling point. All fish should be keyed to the species level. If a fish can not be keyed below the genus level and it is the only fish of that genus in the collection, it can be counted as a species in the Number of Species metric. Exotics, such as tilapia and grass carp are not included in the index because they are not part of the North Carolina fish fauna.
2. Number of Darter Species: Darters are sensitive to environmental degradation particularly as a result of their specific reproductive and habitat requirements (Page, 1983). Darter habitats are degraded as a result of channelization, siltation, and reduced oxygen levels. Collection of fewer then expected darter species can indicate that some habitat degradation is occurring. This metric includes all species of the tribe Etheostomatini.
3. Number of Sunfish and Salmonid (Trout) Species: Sunfish and trout species are used because they are particularly responsive to degradation of pool habitats and to other aspects of habitat degradation, like quality of instream cover. This metric includes centrarchids of the genera Lepomis, Enneacanthus, Acantharchus, Ambloplites, and Centrarchus as well as all species of salmonids, whether native or stocked.
4. Number of Sucker Species: Sucker species are intolerant of habitat and chemical degradation and, because they are long lived, they provide a multiyear integrated perspective. They also reflect the condition of the benthic community, which may be harmed by sediment contamination. This metric includes all members of the family Catostomidae.
5. Number of Intolerant Species: Intolerant species are those which are most affected by environmental perturbations and therefore should disappear, at least as viable populations, by the time a stream is rated fair. This metric is a list of all intolerant species in the sample as determined from Appendix F-IV.
6. Percent Tolerant Fish: Tolerant species are those which are often present in a stream in moderate numbers, but as the stream degrades they can become dominant. Appendix F-IV is used to determine which species are tolerant. The number of individuals in each of these

species is summed and divided by the total number of fish collected to obtain the percent tolerant fish.

7. Percentages of Omnivores, Insectivores, and Piscivores: The three trophic composition metrics, proportion of omnivores, total insectivores (or specialized insectivores), and piscivores are used to measure the divergence from expected production and consumption patterns in the fish community that can result from environmental degradation. The main cause for a shift in the trophic composition of the fish community, (a greater proportion of omnivores and few insectivores), is nutrient enrichment. In the mountain drainages, the metric Percentage of Piscivores is changed to the Number of Piscivorous Species and the Percent Insectivores metric can be interchanged with Percent Specialized Insectivores. Use whichever metric gives the highest score. These metrics are determined from trophic types given in Appendix F-IV and are determined from the percent of individuals belonging to each trophic class.
8. The Percent of Diseased Fish: The percent of fish with disease, tumors, fin damage, and skeletal anomalies increases as a stream is degraded. This metric is rated by counting the number of fish in the sample which have sores, lesions, skeletal anomalies, or fin damage and determining a percentage. Fin damage caused as a result of spawning, should not be counted. Fish are considered spawning fish when tubercles are present. Diseased or rotten fins should be counted. Diseased fish are noted by circling their length record on the species list data sheet.
9. Length Distribution: Length distribution data is used to determine the presence of different age groups and thus the amount of reproductive success. This metric is rated by first counting the number of species. Secondly, the total lengths of all the fish of each species are examined to determine whether or not all the fish of that species are of one or multiple age groups. Finally, the percentage of species with multiple age groups is determined. Since some fish are rare, and some fish species have fewer age groups, some professional judgement must be used in calculating this metric.

Streams with larger watersheds or drainage areas can be expected to support more fish species and a larger number of fish.

Tolerance rating and adult trophic guild assignments were researched from the literature (Lee et al. 1980, Karr et al. 1986, Plafkin et al. 1989 and Angermeier personal communication). A list of tolerance ratings was derived from the literature (Karr et al. 1986, Saylor and Scott 1987, Menhinick 1979, and Mike Mills, personal communication), and from polling various university, federal and state fisheries management personnel. The Delphi Technique (Zuboy 1981) was used for acquiring this data from the professionals.

The distribution of various fish species in North Carolina was obtained from Menhinick (1991), Lee et al. (1980), and from distributional records at the North Carolina State Museum of Natural Sciences. This information was used in determining metric expectations.

For wadable streams a backpack electrofisher sample was taken from approximately 200 meters of the stream. Swamps (non or slow flowing streams that aren't easily measured) are sampled on a timed basis. Each of two collection teams samples a variety of habitats for a period of approximately one hour.

Several sources of data, in addition to those collected by DWQ, are available for use in determining the ecological health of the streams in North Carolina drainages. These fish collections provided significant information and were thus suitable to have a NCIBI computed for them. The collections and the abbreviations for the collectors which maybe used in the text tables are as follows:

North Carolina Division of Water Quality	DWQ
North Carolina Wildlife Resources Commission	NCWRC
University of North Carolina-Charlotte (Menhinick)	UNCC
Fritz Rohde (Independent Researcher)	ROHDE
EA Engineering, Science & Technology Inc.	EA
Duke University	DUKE
North Carolina State Museum of Natural Sciences	NCSM

FISH TISSUE

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources, including freshwater, estuarine, and marine fish and shellfish species, have been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.
Fish tissue analysis results are used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

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, U. S. Environmental Protection Agency (EPA) recommended screening values, and criteria adopted by the North Carolina Health Department.

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. A list of fish tissue analytes accompanied by their FDA criteria are presented below. At present, the FDA has only developed metals criteria for mercury. Concentrations of other metals detected in fish samples are shown in Appendix FT-1. Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of the Water Quality Section.

Food and Drug Administration (FDA) Action Levels

Metals

Mercury	1.0 ppm

Organics

Aldrin	0.3 ppm	o,p DDD	5.0 ppm
Dieldrin	0.3 ppm	p,p DDD	5.0 ppm
Endrin	0.3 ppm	o,p DDE	5.0 ppm
Methoxychlor	None	p,p DDE	5.0 ppm
Alpha BHC	None	o,p DDT	5.0 ppm
Gamma BHC	None	p,p DDT	5.0 ppm
PCB-1254	2.0 ppm	cis-chlordane	0.3 ppm
Endosulfan I	None	trans-chlordane	0.3 ppm
Endosulfan II	None	Hexachlorobenzene	None

In the guidance document, Fish Sampling and Analysis: Volume 1 (EPA823-R-93-002), the EPA has recommended screening values for target analytes which are formulated from a risk assessment procedure. EPA screening values are the concentrations of analytes in edible fish tissue that are of potential public health concern. The DWQ compares fish tissue results with EPA screening values to evaluate the need for further intensive site specific monitoring. A list of target analytes and EPA recommended screening values for the general adult population is presented below.

The North Carolina Health Department has adopted a selenium limit of 5 ppm for issuing fish consumption advisories. Total DDT includes the sum of all its isomers and metabolites (i.e. p,p DDT, o,p DDT, DDE, and DDD). Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane. Although the EPA has suggested a screening value of 7.0 x 10^{-7} ppm for dioxins, the State of North Carolina currently uses a value of 3.0 ppt in issuing fish consumption advisories.

Environmental Protection Agency (EPA) Screening Values

Metals

Cadmium	10.0	ppm
Mercury	0.6	ppm
Selenium	50.0	ppm

Organics

Chlorpyrifos	30.0	ppm
Total chlordane	0.08	ppm
Total DDT	0.3	ppm
Dieldrin	0.007	ppm
Dioxins	7.0 x 10^{-7}	ppm
Endosulfan (I and II)	20.0	ppm
Endrin	3.0	ppm
Heptachlor epoxide	0.01	ppm
Hexachlorobenzene	0.07	ppm
Lindane	0.08	ppm
Mirex	2.0	ppm
Total PCB's	0.01	ppm
Toxaphene	0.1	ppm

LAKES ASSESSMENT PROGRAM

Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. The North Carolina Lake Assessment Program seeks to protect these waters through monitoring, pollution prevention and control, and restoration activities. Assessments have been made at all publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed. Data are used to determine the trophic state of each lake -a relative measure of nutrient enrichment and productivity, and whether the designated uses of the lake have been threatened or impaired by pollution.

Tables presented in each subbasin summarize data used to determine the trophic state and use support status of each lake. These determinations are based on information from the most recent summertime sampling (date listed). The most recent North Carolina Trophic State Index (NCTSI) value is shown, followed by the descriptive trophic state classification (O=oligotrophic, M=mesotrophic, E=eutrophic, H=hypereutrophic, D=dystrophic).

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 (NCDNRCD 1982). 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 manipulated to produce a NCTSI score for each lake, using the following equations:

$$\text{TON score} = \frac{\text{Log(TON)} + (0.45)}{0.24} \times 0.90$$

$$\text{TP score} = \frac{\text{Log(TP)} + (1.55)}{0.35} \times 0.92$$

$$\text{SD score} = \frac{\text{Log(SD)} - (1.73)}{0.35} \times -0.82$$

$$\text{CHL score} = \frac{\text{Log(CHL)} - (1.00)}{0.43} \times 0.83$$

$$\text{NCTSI} = \text{TON score} + \text{TP score} + \text{SD score} + \text{CHL score}$$

In general, NCTSI scores relate to trophic classifications as follows: less than -2.0 is oligotrophic, -2.0 to 0.0 is mesotrophic, 0.0 to 5.0 is eutrophic, and greater than 5.0 is hypereutrophic. 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.

APPENDIX III

Modeling Information

APPENDIX III

Modeling Information

INTRODUCTION

In order to assess the impact of pollutants on surface water quality, the Division must often develop and apply water quality models. A water quality model is a simplified representation of the physical, chemical, and biological processes which occur in a water body. The type of model used is dependent on the purpose for which it is needed, the amount of information that is available or attainable for its development, and the degree of accuracy or reliability that is warranted. In most cases, the Division develops and applies a given model to predict the response of the system to a given set of inputs that reflect various management strategies. For example, water quality models such as QUAL2E or the Division's Level B model are used to predict what the instream dissolved oxygen concentration will be under various sets of NPDES wasteflows and discharge limits. The following sections briefly summarize the types of models used by the Division.

Oxygen-Consuming Waste Models

Several factors are considered when choosing an oxygen-consuming waste model including: the type of system (stream, lake, or estuary), whether one, two, or three dimensions are needed, the temporal resolution needed, and the type of data available. Many of the factors are related. For example, in streams, flow usually occurs in one direction and one can assume that a steady state model will result in adequate predictions. A steady state model is one in which the model inputs do not change over time. However, in open water estuaries, the tide and wind affect which way water moves, and they must often be represented by 2 or 3 dimensional models. In addition, the wind and tide can affect the model reaction rates, and therefore a dynamic model must be used rather than one which is steady state. The last factor, the amount of data available, dictates whether an empirical or calibrated model will be used. An empirical model is used when little water quality information is available for a given water body, and hydraulics and decay rates are estimated through the use of equations. For example, in North Carolina's empirical stream model (referred to as a Level B analysis) velocity is determined through a regression equation developed from North Carolina stream time-of-travel (TOT) studies which includes stream slope and flow estimates as independent variables. Stream slope can be measured from a topographic map, and flow is estimated at a given site by the U.S. Geological Survey. Therefore, the empirical model can be run without TOT information specific to a given stream since parameters are estimated through the use of information which can easily be obtained in the office environment. More information regarding the empirical dissolved oxygen model used by DEM can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Field calibration of a BOD/DO model requires collection of a considerable amount of data. For example, in order to develop hydraulics equations specific to a given stream, TOT studies using rhodamine dye are recommended under at least two flow scenarios including one summer low flow period. In addition, during one summer low flow study, dissolved oxygen, temperature, long term BOD and nitrogen series data are collected. Sediment oxygen demand (SOD) data may also be collected. These data are then used to calibrate reaction rates specific to the stream. QUAL2E is the most commonly used calibrated DO/BOD model for streams in North Carolina. A copy of the model guidance can be obtained from EPA's Environmental Research Lab in Athens, Georgia, and further information on North Carolina's calibration procedures can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Data collection for an estuary DO model is even more extensive. Since the system is multi-dimensional and not steady-state, many more data are needed. Dye is often injected into a system over a period of time, and the dye cloud is then followed for a period of time which may last for days. In addition, several tide gages may need to be set up. Due to the stratification which occurs in an estuary, depth integrated data must also be collected. Calibrated estuary models which have been used by DEM include WASP and GAEST. WASP is also supported by EPA, and a user manual may be obtained from them. You should note that both GAEST is a one dimensional and is not applicable to many of North Carolina's estuaries.

Lakes are rarely modeled for BOD. Tributary arms of lakes are modeled as slow-moving streams if it is clearly indicated that the flow goes in one direction at all times. Depending on the system, a one, two, or three dimensional model may be used. If a one dimensional model is needed, the modeler may choose the Level B (if little or no data), or QUAL2E. In multidimensional lake systems, WASP will be used.

The calibrated model will be more accurate than the empirical model since it is based on data collected specifically for a given stream in the State. However, it is much more expensive to develop a calibrated model. Not only do a number of staff spend several days to weeks collecting field data (sometimes having to wait months for appropriate conditions), but it also takes the modeling staff several months to develop and document the calibrated model. An empirical model can be developed and applied in a matter of hours. Therefore, due to resource constraints, the majority of the BOD/DO models developed in North Carolina are empirical.

Eutrophication Models

Eutrophication models are used to develop management strategies to control trophic response of a system to nutrient inputs (usually total phosphorus (TP) or total nitrogen (TN)). Nutrient management strategies are typically needed in areas which are sensitive to nutrient inputs due to long residence times, warm temperature, and adequate light penetration. These characteristics are found in deep slow moving streams, ponds, lakes, and estuaries. Modeling and insitu research are used to relate nutrient loading to the trophic response to the system allowing the manager to establish nutrient targets. Models which may be used include the Southeastern Lakes Model (Reckhow, 1987), Walker's Bathtub Model (Walker, 1981), QUAL2E, and WASP.

Once the nutrient targets are known, watershed nutrient budgets are developed to evaluate the relative nutrient loadings from various point and nonpoint sources. Land use data are obtained for the basin, and export coefficients based on literature values are applied to each land use. An export coefficient is an estimate of how may pounds of nutrient will runoff from each acre of land in a given year.

Toxics Modeling

Toxics modeling is done to determine chemical specific limits which will protect to the "no chronic" level in a completely mixed stream. The standards developed for the State of North Carolina are based on chronic criteria. These chemical specific toxics limits are developed through the use of mass balance models:

(Cup)(Qup) + (Cw)(Qw) = (Cd)(Qd) where

Cup = concentration upstream
Qup = flow upstream
Cw = concentration in wastewater (known being solved for in WLA)
Qw = wasteflow

Cd = concentration downstream (set = to standard or criteria)
Qd = flow downstream (= Qup + Qw)

When no data are available concerning the upstream concentration, it is assumed to be equal to zero. The upstream flow is the 7Q10 at the discharge point unless the parameter's standard is based on human health concerns, in which case the average flow is used.

REFERENCES CITED - MODELING APPENDIX

Reckhow, K. H., 1987. "A Cross-Sectional Analysis of Trophic State Relationships in Southeastern Lakes." Duke University School of Forestry and Environmental Studies, Durham, N.C.

Walker, W. W., Jr. 1981. "Empirical Methods for Predicting Eutrophication in Impoundments," Technical Report E-81-9, prepared by William W. Walker, Jr., Environmental Engineer, Concord, Mass., for the U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

APPENDIX IV

SUMMARY OF BASINWIDE PLANNING WORKSHOPS

March 16 and 31, 1995

Halifax and Yanceyville

North Carolina
Cooperative Extension Service
NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES
DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

Albemarle-Pamlico Estuarine Region Program • Vernon G. James Research & Extension Center • Route 2, Box 141 • Plymouth, NC 27962
Tel: (919) 793-4428 (Office) • (919) 793-5142 (Fax)

May 25, 1995

To Participants in the Roanoke River Basinwide Planning Workshops:

Thank you for participating in the March 16 and March 31 Roanoke River Basinwide Planning Workshops. The Roanoke River Basinwide Water Quality Management Plan being developed by the North Carolina Division of Environmental Management will affect all residents of the Roanoke River Basin. Your input is necessary to make this program successful in meeting its water quality protection goals.

Attached is a summary of both Workshops. Many common issues were identified by participants in both workshops as priorities, including nonpoint source pollution, the need for better and more current water quality data, cooperation with Virginia and the importance of educational programs and getting people to work together to address water quality concerns. Some of the recommended actions would require action by state agencies, but many encourage active involvement by local government and citizens in management and protection of water resources.

The next step in the Basinwide Planning process is development of the draft Management Plan. The Division of Environmental Management will send you a copy of the Draft Management Plan's Executive Summary when available for your review. A full draft Management Plan will be sent to you upon request. A series of public meetings will be conducted in the Roanoke River Basin to receive public comment on this Plan early in 1996.

Thank you again for participating in the Workshops. Please contact us if you have any questions.

Yours truly,

Catherine McCracken

Catherine McCracken
Public Policy Education Specialist

Greg Jennings
Extension Water Quality Specialist

cc: Alan Clark, NC Division of Environmental Management
Paula Thomas, NC League of Municipalities

North Carolina
Cooperative Extension Service
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SUMMARY

ROANOKE RIVER BASINWIDE WORKSHOP #1
March 16, 1995 9:00 a.m. - 12:00 noon
Halifax County Agricultural Complex, Halifax, NC
Sponsored by the Halifax County Extension Center

Number of participants who signed in at registration table: 48

Workshop Objectives

1. Describe the components of the Roanoke River Basinwide Water Quality Management Plan.
2. Increase public involvement in developing the Management Plan.

Workshop Agenda

9:00 a.m.	Introduction and basinwide video presentation Greg Jennings, Extension Water Quality Specialist, NCCES
9:30 a.m.	Description of Basinwide Water Quality Management Program and process for developing Roanoke River Management Plan Alan Clark, Basinwide Program Coordinator, NCDEM
10:15 a.m.	Break
10:30 a.m.	Facilitated discussion groups. Participants were divided into four discussion groups and asked to consider the question "Based on your knowledge of water quality in the Roanoke River Basin, what do you see as priority water quality issues and what actions do you recommend to address these issues?"
11:15 a.m.	Reports from discussion groups. (see additional information attached)
11:45 a.m.	Summary of discussion group comments, questions and wrap-up Greg Jennings, Extension Water Quality Specialist, NCCES

ROANOKE RIVER BASINWIDE WORKSHOP #1

Summary of facilitated discussion groups

Group 1 (facilitated by Wanda Sykes)

Priority issues (alphabetical order) and sub-issues

Education
- Educational efforts before regulation
- Educating the public-oil disposal, contamination control
- Cooperation between regulatory agencies and those who will be regulated (agriculture, industries, municipalities)
- Industry input and work with us

Flow of Roanoke River
- Low flow during late summer
- More flow during periods of low flow in the lower basin
- Dealing with the Virginia Beach water pipeline issue
- Virginia's impact on the Roanoke
- Dealing with existing contamination on river bed and lake bottoms

Groundwater
- Wellhead protection - residential and municipal

Quality of Roanoke River
- Over-allocation of the river's assimilative capacity
- Effects of water quality of slow moving receiving bodies of water, i.e. Albemarle Sound
- Flood control from dams
- More accurately identify sources of impairments
- Withdrawal of water from river
- Wastewater treatment and discharge

Recreation
- Ecotourism
- Increased recreational use in shorter periods of time, i.e. fishing seasons limited to Wednesday, Saturday, Sunday

Run-Off (agriculture and urban)
- Sediment from unpaved roads and side ditches
- Swamp run-off and its natural influence on low dissolved oxygen
- Urban run-off management (dumping oil into storm drains, label entry points)
- Nonpoint source dealing with agricultural discharge, lake weed control, stormwater
- Sedimentation run-off from agriculture
- More control of agricultural run-off
- Agricultural sediment

Run-Off (agriculture and urban) (continued)

- Farmstead chemical, fuel storage and management
- A fresh look at animal waste run-off
- Agriculture waste management
- Run-off from construction sites
- Sedimentation-lack of cover cropping

Action Plans

Runoff

- Soil cover
- Provide sediment ponds
- Increase utilization of nutrients
- Lagoon systems
- Applications of environmentally sound chemicals
- Limit soil exposure

Quality of Roanoke River

- Public policy
- Incentive programs
- Virginia issues
- Hydrilla

Flow of Roanoke River

- Virginia issues
- Involvement in decision making
- Community commitment
- Focus group-advisory capacity

Downstream impact

- Where it goes? Effects of?

Education in all issues: personalized, individual commitment
Government Agency cooperation with community stakeholders

ROANOKE RIVER BASINWIDE WORKSHOP #1
Summary of facilitated discussion groups

Group 2 (facilitated by Leon Allen)

Priority issues (alphabetical order) and sub-issues

Agriculture

- Agricultural management of cropland, i.e. pesticides, no-till
- Nutrient management
- Sediments from agriculture
- Agriculture sediment contribution?
- Sediment control from row crop production

Current and complete data

- The data for determining use support evaluations is insufficient
- Sedimentation is stated as a problem. Need field work to measure nature of bottom deposits and S.O.D.
- This study needs to allocate resources where they can do the greatest good-the largest sources if known
- Public education on recent improvements in forestry practices, WTP operations, etc. Things are improving
- Influence of Virginia on the basin

Economic Development

- Recreational use of the Roanoke River
- Weed control (aquatic)
- Sustained economic development
- Quality for tourism use

Non-Point Issues

- Impact of water draining from swampy wetlands. Is NPS beyond man's control?
- Uncontrolled non-point source pollution
- Non point sources
- Wetlands
- Adequate water flow
- Forest land management practices

Urban Point Source

- Municipality pollution control
- Community waste and runoff from industry
- Industrial wastewater
- Sediments from construction
- Homeowner use of pesticides and fertilizers

ROANOKE RIVER BASINWIDE WORKSHOP #1

Summary of facilitated discussion groups

Action Plans

Data

- Legitimate data from the field/Not what we think is happening
- Work cooperatively with Virginia
- Re-survey for updated data
- Data acquisition
- Get data
- Research/field tests
- Analyze NPDES reports from industry
- Mount field studies on water quality, hydraulics, etc. which are required by models
- Collect REAL data, not anecdotes
- Get new up-to-date data so we'll know which areas are priorities

Education

- Extension demonstration projects
- Education and public awareness
- Nonpoint source educational programs/type specific
- Work on BMP for agriculture and forestry
- Public input
- Training in BMPs to reduce nonpoint source pollution
- Prioritize problem areas-educate those involved on correct steps to take

Regulation

- Increase regulation on point sources
- Enforce current environmental regulations to their intended extent

Group 3 (facilitated by Vernon Cox)

Issues (alphabetical order)

Assess incentive for protecting/improving water quality
Assimilative capacity
Better enforcement of NPS pollution control
Community review of draft plan prior to EMC submission
Continued protection of recreational resources and uses
Habitat protection
Interstate coordination
Nonpoint source (NPS) pollution-what's being done, what will/should be done to address
Public education on basin/water quality issues
Virginia Beach pipeline (outcomes' effect on management plan)

ROANOKE RIVER BASINWIDE WORKSHOP #1

Summary of facilitated discussion groups

Priority issues (alphabetical order)

Balance as a concept-point sources/nonpoint sources
Community input
Economic growth
Education and incentives for nonpoint source control
Habitat protection
Interbasin water transfer (Virginia Beach)

Group 4 (facilitated by Catherine McCracken)

Issues (alphabetical order)
Animal waste
Benefit/cost analysis (costs are not only $)
Development
Dioxin
Educational process-awareness/who?/how?/materials not in layman's terms
Enforcement
Flow/dam management
Governance/equity in region
Groundwater contamination
Harvesting-forestry
Hydrilla/blue-green algae in Lake Gaston
Inter-basin precedent
Inter-state cooperation and information
Lack of nutrient-based data
Land conversion (natural forests into pine)
~~Natural selection~~
Property owner rights
Public information v. environmental education
Quantify nonpoint source (NPS) reductions
Quantity of groundwater
Recreational/commercial fishing competition
Sediment
Septic tanks
Stormwater runoff
Striped bass critical habitat
Surface water contamination
Threatened species in basin
Tourism

ROANOKE RIVER BASINWIDE WORKSHOP #1

Summary of facilitated discussion groups

Issues (alphabetical order) (continued)

Turbidity
Updated water quality information
Virginia Beach/Virginia portion of the basin
Water well quality
Wetland mitigation and re-creation (Highway 17 project/spatial differences)
Whole effluent toxicity (WET) compliance

Some priority issues (alphabetical order)

Cooperation with Virginia (what is the process and who is involved)
Economic development and employment
Education
Enforcement of current regulations
Flow rates (impacts on fishing resources, NPDES permits, water supply, critical habitats)
Nonpoint source pollution (agriculture, forestry, construction, stormwater runoff)
Updated water quality information

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SUMMARY

ROANOKE RIVER BASINWIDE WORKSHOP #2
March 31, 1995 9:00 a.m. - 12:00 noon
Caswell County Civic Center, Yanceyville, NC
Sponsored by the Caswell County Extension Center

Number of participants who signed in at registration table: 67
Participants at the second workshop were asked to indicate their affiliation when signing in at the registration table. Some participants indicated no affiliation while some indicated more than one affiliation: Agriculture (14), Citizen interest group (1), County government (9), Education (6), Municipal government (3), State/federal government (23), Other (industry, press, chamber of commerce and other affiliations) (10)

Workshop Objectives
1. Describe the components of the Roanoke River Basinwide Water Quality Management Plan.
2. Increase public involvement in developing the Management Plan.

Workshop Agenda

9:00 a.m.	Introduction and basinwide video presentation Greg Jennings, Extension Water Quality Specialist, NCCES
9:30 a.m.	Description of Basinwide Water Quality Management Program and process for developing Roanoke River Management Plan Alan Clark, Basinwide Program Coordinator, NCDEM
10:15 a.m.	Break
10:30 a.m.	Facilitated discussion groups. Participants were divided into four discussion groups and asked to consider the question "Based on your knowledge of water quality in the Roanoke River Basin, what do you see as priority water quality issues and what actions do you recommend to address these issues?"
11:15 a.m.	Reports from discussion groups. (see additional information attached)
11:45 a.m.	Summary of discussion group comments, questions and wrap-up Greg Jennings, Extension Water Quality Specialist, NCCES

ROANOKE RIVER BASINWIDE WORKSHOP #2

Summary of facilitated discussion groups

Group 1 (facilitated by Greg Jennings)

Priority issues (alphabetical order) and sub-issues

Agency Resources
- Turnover at DEM
- Incentive v. regulatory fixes
- Coordinated resource management and agency coordination

Education and Research
- Public awareness of water quality issues--youth (school system) and adults (extension education
- Education of problems
- More education of general public on personal responsibility for water quality
- Prevent polarization of opinion "we"
- Use students as educators
- Use students as researchers
- Recognize urgency of having clean water
- Better data on what the sources are and where in order to target
- Community monitoring of nonpoint pollution

Low Dissolved Oxygen
- BOD in lower river
- Low pH in lower river
- Eutrophication
- Water flow out of Roanoke Rapids Lake
- Low DO below Kerr Lake dam
- Get downed trees out of streams

Nonpoint Sources
- Livestock waste discharge (fecal coliform)
- Animal waste
- Agriculture/forestry industries
- Pesticide Use regulations

Planning and Development
- Flow regulation (including farm ponds)
- Development, road construction, population growth
- Land planning
- Highway construction
- Urban/suburban stormwater runoff
- Urban stormwater management
- Stormwater runoff/Land-water runoff

ROANOKE RIVER BASINWIDE WORKSHOP #2

Summary of facilitated discussion groups

Priority issues (alphabetical order) and sub-issues (continued)

Point Sources

Waste disposal

Wastewater assimilative capacity exceeded in lower river?

Recommendations (alphabetical order)

$ incentives for water quality improvement
Cooperation and participation between citizen groups and government
Educate on population growth
Give people a stake in water quality
Incentives for local land use planning (technical assistance, $)
Increase education on individual actions and impacts
Increased publicity for violators
Informed policy makers
Interstate cooperation
Long-range studies and planning
Maintain agency resources (trained and experienced)
Present research in easy to understand format
Regional (interstate) planning
Teacher education
Use citizens for monitoring activities and enforcement (students)
Volunteer education

Group 2 (facilitated by Catherine McCracken)

Issues (alphabetical order)

Awareness of cost-share program
~~Basin management across North Carolina-Virginia border~~
Construction and placement of landfills
Education-urban, rural, political, youth, community groups
Enforcement and tradeoff of not enough people to do inspections
Forestry best management practices (BMPs)
Help people comply with current regulations
How will NPDES limits be set? Watershed or basin as a whole? Tie-in to water quantity
How do you control nonpoint source pollution?
Illegal dumping by stream banks
Impacts of growth-what is the acceptable level?
Incentives for "good actors" (tax breaks, recognize those who have put in agricultural BMPs, other recognition programs, recycling aluminum cans)
Indirect impacts of point source dischargers (more treatment)
Involve community colleges (ex. Wake and Rockingham have special env. programs)

ROANOKE RIVER BASINWIDE WORKSHOP #2
Summary of facilitated discussion groups

Issues (alphabetical order) (continued)
Lack of awareness about who is responsible, ex. landowner or logger
Local input important
More research on natural control of pests/diseases
More technical assistance
More cost-share funds ($)
Offer different training opportunities/accessible to many different levels
Outreach effort
Sedimentation control-forestry, agricultural, urban development
Stormwater control
Use the media
Volunteer monitoring/"hands-on" experience for volunteers
We don't need more regulations
We are dependent on technology
When do we reach carrying capacity of planet? Have we reached in some areas?
Where will $ come from? Share costs with Virginia?
Will always be those who violate-"bad actors"

Group 3 (facilitated by Vernon Cox)

Issues (alphabetical order)
Balance economics/environment
Better education
Better identification of nonpoint source polluters
Consistency among and simplification (regulations?)
Cooperation
Cost share
Economically realistic goals and objectives
Fairness
Local ownership/implementation
Local education and awareness
Monitoring and permitting more closely tied
Proactive/local involvement
State management consistency
State to state local cooperation

Priorities (alphabetical order)
Agree on common goals
Economic incentives
Everyone under same level of regulation
Identify achievable goals

ROANOKE RIVER BASINWIDE WORKSHOP #2

Summary of facilitated discussion groups

Group 4 (facilitated by Larry Whitt, notes taken by Farrell Keough/NCDEM)

Issues (alphabetical order) and sub-issues

Discharges

- Industrial pollution-chemical
- Colored effluent
- Toxins-particularly dioxin in lower part of basin
- Illegal waste dumping-especially chemical

Education/Other

- What is Virginia doing?
- Identifying water quality improvement efforts that can be done at the local level
- Updating water quality information

Growth

- Continued population growth-septic disposal
- People cause pollution-control growth
- Effect of any potential planning for the basin on development
- Protecting water quality without putting small farmers out of business
- Pollution-free water which provides good fishing
- Tighter discharge parameters for NPDES permit holders
- Illegal industrial dischargers and dumping
- Small dischargers which could connect together
- Dam release variability

Runoff

- Runoff from construction sites
- Erosion control/runoff from construction sites
- Run off from road construction
- Continued development--accelerated runoff
- Sedimentation pollution
- Land corrosion
- Non point sediment from agricultural sources
- Conservation practices on agricultural land, i.e. waterways, filter strips (grass), crop rotation
- Stream bed erosion due to urban sprawl into agricultural land
- Stream and reservoir buffer strips
- Soil erosion from clear cutting timber
- Pesticides (improper use)
- Economic impact of regulations on agriculture
- Agricultural runoff
- Pollution from runoff from chemical (pesticide) uses

ROANOKE RIVER BASINWIDE WORKSHOP #2

Summary of facilitated discussion groups

Priority issues (alphabetical order) and sub-issues

Agency Resources

- Interagency cooperation
- Interstate cooperation-how will costs be shared between NC and VA?
- Citizen groups

Cost-Benefit Ratio

- Balance and consistency

Education/Other

- Data retrieval needs and abilities
- What is Virginia doing?
- Identify local efforts
- Updating water quality information
- Need variety of approaches

Growth Control - Planning and Development

- Sedimentation: agriculture v. stormwater runoff due to urbanization problems of uncontrolled growth

Incentives for water quality improvements ($)

NPDES Regulation (Discharger)

- Dam release variability
- Sedimentation: agriculture v. stormwater runoff due to urbanization
- Stick or carrot approach (user fee v. credit)

Sedimentation - Runoff

APPENDIX V

LISTS OF BEST MANAGEMENT PRACTICES (BMPS) FOR:

*** Agriculture**
*** Urban Runoff**
***Sedimentation and Erosion Control**
*** Onsite Watewater Disposal**
*** Forestry**
*** Mining**

LIST OF NONPOINT SOURCE CONTACTS IN THE ROANOKE RIVER BASIN

Agricultural Best Management Practices

Table 4. BMPs for Agriculture

I. Crop and Pasture Lands

A. <u>BMPs for sediment control</u>

Conservation Tillage System
Critical Area Planting
Cropland Conversion
Diversion
Field Border
Filter Strip
Grade Stabilization Structure
Grassed Waterway
Rock-lined Waterways or Outlets
Sediment Control Structure
Sod-based Rotation
Stripcropping
Terrace
Water Control Structure
Pastureland Conversion

B. <u>BMPs for nutrient control</u>

Legumes in Rotation
Soil Testing
Liming
Setting Realistic Crop Yield Goals (determines fertilization rates)
Fertilizer Waste Application (method, rate, and timing)
Sediment Control BMP's

C. <u>BMPs for pesticide control</u>

Alternative Pesticides
Optimize Pesticide Formulation, Amount, Placement Timing, Frequency
Crop Rotation
Resistant Crop Varieties
Other Cultural or Biological Controls
Optimize Crop Planting Time
Plant Pest Quarantines
Proper Disposal of Obsolete Pesticides and Containers
Certification of Applicators
Sediment Control BMP's

Table 4 Cont.

II. Animal Production (esp. Confined Animal Operations)

<u>BMPs for bacteria and nutrient control</u>

Grade Stabilization Structures
Heavy Use Area Protection
Livestock Exclusion
Spring Development
Stock Trails and Walkways
Trough or Tank
Waste Management System
Waste Storage Pond
Waste Storage Structure
Waste Treatment Lagoon
Land Application of Waste
Water Control Structure

Table 5
BEST MANAGEMENT PRACTICES ELIGIBLE FOR COST SHARING UNDER THE AGRICULTURE COST SHARE PROGRAM

Practice	Minimum Life Expectancy (years)
Conservation Tillage System	1
Critical Area Planting	10
Cropland Conversion (Trees, Grasses, or Permanent Wildlife Plantings)	10
Diversion	10
Field Border	10
Filter Strip	10
Grassed Waterway	10
Heavy Use Area Protection	10
Livestock Exclusion	10
Pastureland Conversion	10
Rock-lined Waterway or Outlet	10
Sediment Control Structure	10
Sod-based Rotation	4 or 5
Spring Development	10
Stock Trails and Walkways	10
Stripcropping	5
Terrace	10
Trough or Tank	10
Waste Management System	10
Waste Storage Pond	10
Waste Storage Structure	10
Waste Treatment Lagoon	10
Land Application of Waste	1
Grade Stabilization Structure	10
Water Control Structure	10

The minimum life expectancy of the BMPs is also listed in Table 5. Practices designated by a District shall meet the life expectancy requirement established by the Division for that District BMP.

Conservation tillage systems, sod-based rotation, stripcropping, and land application of animal wastes shall be funded under a cost-share incentive payment. Payments for conservation tillage systems and land application of animal wastes are limited to a maximum of three years per farm. Farmers are expected to incorporate BMPs on their own initiative after this time.

The ACSP has a detailed implementation plan that is to be used in conjunction with the rules and regulations for the Program. The following is a list of definition of practices in the plan:

(1) Conservation Tillage System means a form of non-inversion tillage that retains protective amounts of residue mulch on the surface throughout the year. These include no tillage, strip tillage, stubble mulching and other types of non-inversion tillage which maintain a minimum of 50 percent ground cover at planting or a minimum surface residue of 2,000, 1,500, and 1,000 pounds per acre for corn, soybeans, and small grain, respectively.

(2) Critical Area Planting means planting trees, shrubs, grasses, or legumes on critically eroding agricultural areas in order to reduce erosion, sediment delivery and nonpoint source pollution to receiving waters.

(3) Critical Erosion as applied to critical areas means erosion so severe that special agricultural BMPs must be used to stabilize the area of concern.

(4) Cropland Conversion means the establishment of perennial grasses, trees, or permanent wildlife plantings on excessively eroding cropland. Cost share will be based on 75 percent of the average cost of establishing fescue.

(5) Diversion means a channel with a supporting ridge on the lower side constructed across the slope to divert excess water from cropland areas.

(6) Excessive Erosion means sheet, rill and/or concentrated erosion on agricultural lands occurring at an annual rate greater than the soil loss tolerance (T).

(7) Field Border means a strip of perennial vegetation

established at the edge of the field to control erosion.

(8) Filter Strip means a strip or area of perennial vegetation for removing sediment, organic matter, and other pollutants from cropland or as part of waste management systems for treating runoff from concentrated animal areas.

(9) Grade Stabilization Structure means a structure to stabilize the grade of agricultural cropland or pasture land where concentrated and high velocity runoff results in head cutting and gully formation.

(10) Grassed Waterway means a natural waterway or outlet, shaped or graded, established in suitable vegetation and used to route excess water from cropland, reduce gully erosion and reduce nonpoint source pollutant delivery to receiving waters. As a condition for cost sharing, the field or treatment unit draining into the waterway must have installed, or the farmer must agree to install as part of the agreement, erosion control measures necessary to prevent damage from washout or excessive sedimentation in the waterway.

(11) Heavy Use Area Protection means stabilizing high concentration areas for livestock to reduce stream loading of sediment and/or animal waste.

(12) Livestock Exclusion means permanent fencing used to exclude livestock from an area and is to be used in conjunction with livestock waste treatment systems, stream crossings, streambank protection or other areas as needed to protect surface water quality.

(13) Pastureland Conversion means establishing trees or perennial wildlife plantings on excessively eroding pasture that is too steep to mow or maintain with conventional equipment. (Class VII Land)

(14) Rock-lined Waterway or Outlet means a waterway or outlet having an erosion-resistant lining of permanent material which provides safe disposal of runoff where unlined or grassed waterways would be inadequate.

(15) Sediment Control Structure means a temporary or permanent basin constructed to collect and store sediment and other agricultural nonpoint source pollution.

(16) Sod-based Rotation means establishing perennial grasses and/or legumes or a mixture of them on excessively eroding cropland and maintaining at least a four-year rotation. A one-time incentive payment per field will be made for establishment.

(17) Spring Development means improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities. Springs are to be developed as a source for livestock watering in conjunction with livestock exclusion from streams. The SWCD's have been made aware of the potential conflict of spring development with habitat preservation for wetland flora and fauna. Conflicts are reviewed on a case-by-case basis.

(18) Stock Trails and Walkways means a system used to control erosion where livestock cross ditches, streams, or other areas where surface water quality needs to be protected. Trails and walkways must be used in conjunction with livestock exclusion.

(19) Stripcropping means growing crops in a systematic arrangement of strips or bands across the general slope. The crops are arranged so that a strip of grass or close-growing crop is alternated with a clean-tilled crop or a crop under a conservation tillage system. Cost sharing will be based on a one-time payment of 75 percent of the average cost of establishing fescue multiplied by the acres in sod plus an incentive payment for the establishment of the strips.

(20) Terrace means an earth embankment, a channel, or a combination ridge and channel constructed across the slope.

(21) Trough or Tank means constructing a device for livestock watering in conjunction with livestock exclusion from streams.

(22) Waste Management System means a planned system for managing liquid, solid waste, and runoff from concentrated animal areas. System components may include:

(A) Waste Storage Pond means an impoundment made by excavation or earthfill for temporary storage of animal or other agricultural waste.

(B) Waste Storage Structure means a fabricated structure for temporary storage of animal or agricultural waste.

(C) Waste Treatment Lagoon means an impoundment made by excavation or earthfill for biological treatment of animal or other agricultural waste.

(D) Land application of Wastes means the application of agricultural wastes on land in an environmentally acceptable manner.

(23) Water Control Structure means a man-made structure installed in on-farm water management systems to reduce the delivery of nonpoint source pollutants into main water courses.

Best Management Practices

Structural best management practices for urban runoff control typically are designed to reduce sediment, its attached pollutants, and nutrients. In addition, other BMPs provide shade to waterbodies and reduce the likelihood of excessive water temperatures. Nonstructural BMPs, such as a design manual or a public education program, encourage the comprehensive and effective implementation of structural BMPs. Table 6 contains a list of both structural and nonstructural BMPs. This list will become more complete when the design manual for urban BMPs (currently being written by the Water Quality Section of DEM) is available.

Table 6. BMPS for Urban Runoff Control

STRUCTURAL
- Wet Detention Basin
- Infiltration Basin
- Vegetative Practices
    - Filter Strips
    - Swales with Check Dams
- Oil and Grease Separator
- Rollover-Type Curbing

NONSTRUCTURAL
- Design Manual for Urban BMPs
- Public Education
- Identification and Enforcement of Illegal Discharges
- Land-Use Control

Structural BMPs may affect groundwater quality in certain situations. Devices that recharge groundwater pose the risk of passing soluble pollutants, collected from stormwater runoff, into groundwater systems. At present it is not known whether pollutant concentrations in recharged groundwater areas pose a significant environmental or health risk. USGS is presently conducting a study of the groundwater quality effects of urban BMPs. In addition, if funds are made available, DEM could conduct a similar study in North Carolina. It is hoped that monitoring projects, like the USGS project, will clarify the groundwater quality impacts of urban BMPs.

Best Management Practices

The typical or suggested BMPs of the North Carolina Sedimentation Pollution Control Act of 1973 are selected on the basis of performance in providing protection from the maximum peak rate of runoff from a 10-year storm. This allows the developer/designer of the control measures, structures, or devices to determine and submit for approval the most economical and effective means of controlling erosion and preventing sedimentation damage. Practices are therefore reviewed for acceptability based upon the characteristics of each individual site and its erosion potential. Ideally, the erosion control plan will employ both practices and construction management techniques which will provide the most effective and reasonable means of controlling erosion while considering the uniqueness of each site. Table 7 provides a list of practices commonly used in sedimentation and erosion control plans across North Carolina.

Table 7. BMPs for Sedimentation Control

- Land Grading
- Surface Roughening
- Topsoiling
- Tree Preservation & Protection
- Temporary Gravel Construction Entrance/Exit
- Temporary Seeding
- Permanent Seeding
- Sodding
- Trees, Shrubs, Vines & Ground Covers
- Mulching
- Riprap
- Vegetative Dune Stabilization
- Temporary Diversions
- Permanent Diversions
- Perimeter Dike
- Right-Of-Way Diversions
- Grass-lined Channels
- Grass Channels with Liner
- Riprap-lined Channels
- Paved Channels
- Temporary Slope Drains
- Paved Flume (Chutes)
- Level Spreader
- Outlet Stabilization Structure
- Temporary Excavated Drop Inlet Protection
- Fabric Drop Inlet Protection
- Temporary Block & Gravel Inlet Protection
- Sod Drop Inlet Protection
- Temporary Sediment Trap
- Sediment Basin
- Sediment Fence
- Rock Dam
- Temporary Stream Crossing
- Permanent Stream Crossing
- Vegetative Streambank Stabilization
- Structural Streambank Stabilization
- Construction Road Stabilization
- Subsurface Drain
- Grade Stabilization Structure
- Check Dam
- Dust Control
- Sand Fence (Wind Fence)

On-site Wastewater Disposal Best Management Practices

Best Management Practices

In order to protect public health and water quality, best management practices (BMPs) need to be implemented throughout the life cycle of an on-site wastewater disposal system. Life-cycle management problems can be addressed in three phases (Steinbeck, 1984). The first phase includes system siting, design, and installation. The second phase involves the operation of the system and phase three involves maintenance and repair when the system malfunctions or fails. As BMPs are applied in each life-cycle phase, the primary factor influencing the success of the system is the participation of the local health department and the cooperation of the developer, owner, design engineer, system operator, and the state. The following is a summary of the current life-cycle management practices and penalties utilized in North Carolina to implement the on-site sewage systems program (Steinbeck, 1984).

Table 8. BMPs for On-Site Wastewater Disposal

1. Application -- The developer or property owner meets with the staff of the local health department to review the project proposal and submits an application to the local health department that contains information regarding ownership, plat of property, site plan, type of facility, estimated sewage flow, and proposed method of sewage collection, treatment, and disposal.

2. Site Evaluation -- The local health department, with technical assistance from the state, evaluates the proposed sewage effluent disposal site for several factors, including slope, landscape position, soil morphology, soil drainage, soil depth, and space requirements. Next, the local health department will assign a site suitability classification, establish the design sewage flow, and the design loading rate for the soil disposal system.

3. Design Review --The applicant is required to submit plans and specifications for the sewage collection, treatment, and disposal system prepared by a professional engineer, for complex systems, or for systems exceeding 3,000

gal/day. Reviews are made by both state and local health departments. The designer must also include in the plans and specifications, installation procedures, phasing schedules, operation and maintenance procedures, monitoring requirements, and designate the responsible agents for operation and maintenance.

4. Legal Document Review -- For systems with multiple ownership or off-site disposal, the applicant must prepare and submit to state and local health departments for their legal review documents applicable to the project.

5. Improvement Permit -- Issued only after a successful review of the proposed project, including each of the items discussed above and allows construction to begin for the on-site sewage system. The improvement permit must be issued prior to other construction permits and allows only temporary electrical power to the site. This permit contains the necessary conditions for construction of the projects with the plans, specifications, and legal documentation appended to it.

6. Operation Permit -- Issued to the owner of the on-site sewage system by the local health department when it determines that all the requirements in the rules, plans and specifications are met; all conditions on the improvement permit are met; and the design engineer for the sewage collection, treatment, and disposal system certifies in writing to the local health department that the on-site system has been installed in accordance with the approved plans and specifications. The operation permit is also conditioned to establish performance requirements and may be issued for a specific period of time. It allows the on-site sewage system to be placed into use, prevents permanent electrical service to the project and prevents occupancy of the facilities until issued. The operation permit applies to systems larger than 480 gallons per day. A certificate of completion is required for conventional septic tank systems when the design sewage flow is less than 480 gal/day.

7. Surveillance -- Once an on-site sewage system is placed into operation the local health department must make routine inspections at least annually for large systems to determine that the system is performing satisfactorily and not creating a public health nuisance or hazard. Additionally, required monitoring reports are routinely submitted to the local health department as required in the permits. The state provides technical assistance to the local health department and the system operator in assuring adequate performance. While annual inspections are required, frequent performance checks must be made by the local health department.

8. Remedies -- When voluntary compliance with the performance requirements for the on-site system is unsuccessful, the General Statutes (1983) provide for the following remedies:

   a. Right of Entry -- Allows the state or local health department to enter the premises to determine compliance with the laws and rules and provides for an administrative search and inspection warrant when entry is denied.

   b. Injunction -- The state or local health department may institute an action for injunctive relief against the owner to bring the on-site sewage system into compliance.

   c. Order of Abatement -- The state or local health department is empowered to issue an order of abatement directing the owner to take any necessary action to bring the system into compliance. However, if the on-site system is determined to be creating an imminent health hazard, the state or local health department may, after previous unsuccessful attempts at correction, take the necessary action to correct the problem and recover any costs for abatement from the owner. This is the least frequently applied remedy.

   d. Administrative Penalties -- The state may impose administrative penalties up to $300 per day for violation of the laws, rules, or any permit condition for on-site sewage systems serving multi-family residences with a flow greater than 480 gal/day. A penalty of up to $50 per day can be assessed for malfunctioning systems where the flow is less than or equal to 480 gal/day.

   e. Suspension and Revocation of Permits -- The state may suspend or revoke a permit for violations of the laws, rules, or permit conditions upon a finding that a violation has occurred.

   f. Misdemeanor -- The owner who violates the sewage laws or rules shall be guilty of a misdemeanor and punishable by a fine or imprisonment as determined by the courts. This is the most frequently used remedy.

Best Management Practices for Forestry

The North Carolina Forestry Council has prepared a reference document for silvicultural BMPs entitled "Forest Practices Guidelines Related to Water Quality." Table 10 summarizes these BMPs:

Table 10. BMPs for North Carolina Forests

1. Properly design and place access roads, skid trails, and loading areas on forestland.
   a. Avoid streambanks and channels except when crossing streams.
   b. Install water management structures and techniques.
   c. Stabilize bare soil areas.
   d. Prevent steep slopes on roads and trails.
2. Designate streamside management zones (SMZ) which are undisturbed strips of vegetation parallel and adjacent to the stream channels.
3. Avoid placing debris in stream channels (Stream Obstruction Law).
4. Use practices which minimize soil exposure when reforesting.
5. Use environmentally safe procedures when applying chemicals in forested areas.
6. Train forestry related personnel in nonpoint source pollution control methods.

Best Management Practices

Significant environmental damage can and often times does occur during land-disturbing activities of mining operations, especially during the initial stages. The potential for such damage can be substantially reduced with the installation of BMPs. Once the mining has terminated, BMPs are used to reclaim or reasonably rehabilitate the site (for mined lands after June 11, 1971). The basic objective of the reclamation is to establish on a continuing basis the vegetative covers, soil stability, and water and safety conditions appropriate to the area. The BMPs are basically performance oriented allowing the applicant for a mining permit to design and submit for approval the most economical and effective means of a) controlling erosion and preventing off-site sedimentation damage; b) preventing contamination of surface waters and groundwater; and, c) preventing any condition that will have unduly adverse effects on wildlife or freshwater, estuarine, or marine fisheries. BMP selection is site specific and controlled in part by the pre- and post-mining land use(s). The acceptability, therefore, of a BMP is based upon the characteristics of the individual site and its potential for off-site damage.

Table 12 provides a list of BMPs which is virtually the same as apply in the Sedimentation and Erosion Control Program since the problems are similar.

Table 12. BMPs for Mining

Land Grading
Surface Roughening
Topsoiling
Tree Preservation and Protection
Temporary Gravel Construction Entrance/Exit
~~Temporary Seeding~~
Permanent Seeding
Sodding
Trees, Shrubs, Vines & Ground Covers
Mulching
Riprap
Vegetative Dune Stabilization
Temporary Diversions
Permanent Diversions
Perimeter Dike
Right-of-Way Diversions
Grass-lined Channel
Grass Channels with Liner

Table 12 (Cont.)

Riprap-lined Channels
Temporary Slope Drains
Paved Flume (Chutes)
Level Spreader
Outlet Stabilization Structure
Temporary Excavated Drop Inlet Protection
Temporary Fabric Drop Inlet Protection
Temporary Block and Gravel Inlet Protection
Sod Drop Inlet Protection
Temporary Sediment Trap
Sediment Basin
Sediment Fence
Rock Dam
Temporary Stream Crossing
Permanent Stream Crossing
Vegetative Streambank Stabilization
Structural Streambank Stabilization
Construction Road Stabilization
Subsurface Drain
Grade Stabilization Structure
Check Dam
Dust Control
Sand Fence (Wind Fence)
Groundwater Monitoring Wells
Mining Newsletter

Roanoke River Basin Nonpoint Source Contacts

Agency	Area of Responsibilities	Contacts	Phone	Address
USDA Natural Resources Conservation Service -- Soil & Water Conservation Districts	Formerly the Soil Conservation Service; provides technical specialist for certifying waste management plans; certified trainers for swine applicators training sessions works with landowners on private lands to conserve natural resources helping farmers and ranchers develop conservation systems uniquely suited to their land and individual ways of doing business; provides assistance to rural and urban communities to reduce erosion, conserve and protect water, and solve other resource problems; conducts site evaluations and soil surveys; administers the Wetlands Reserve Program and the Agriculture Cost-Share Program; offers planning assistance for local landowners for installing best management practices; offers technical assistance for the determination of wetlands on agricultural lands.			
	Bertie County	Junius B. Russell, Jr.	919-794-5305	County Ofc. Bldg. Rm 211 Windsor NC 27983
	Caswell County	Warren H. Mincey, Jr	910-694-4581	Ag Bldg. P.O. Box 96 Yanceyville NC 27379
	Granville County	Stephen C. Woodruff	919-693-4603	P.O. Box 10 Oxford NC 27565
	Halifax County	J. Wayne Short	919-583-3481	P. O. Box 8 Halifax NC 27839
	Northampton County	Tony R. Short	919-534-2591	P.O. Box 218 Jackson NC 27845
	Martin County	Rupert W. Hasty, Jr.	919-792-4350	P.O. Box 483 Williamston NC 27892
	Person County	James E. Huey	910-597-2973	County Ofc Bldg. Rm 126 Roxboro NC 27573
	Rockingham County	John I. Timmons	910-342-8225	Gov. Center, Ste 201 Wentworth NC 27375
	Stokes County	Charles F. Anderson	910-593-2846	P.O. Box 98 Danbury NC 27016
	Vance County	E. Brent Bogue	919-438-5727	County Ofc Bldg. 305 Youth St. Henderson NC 27536
	Warren County	John Parrish	919-257-3836	133 1/2 S. Main St. Warrenton NC 27589
NCDA Regional Agronomists	Technical specialist for certifying waste management plans; certified trainers for swine applicators training sessions			
		Robin J. Watson	910-570-6850	1709 Fairview St. Burlington NC 27215
		Charlie Tyson	919-443-4404	5091 South NC 58 Nashville NC 27856
		Roger Sugg	919-793-4118	Tidewater Research Stn Plymouth NC 27962
		Dr. Don Eaddy	919-733-2655	Director of NCDA Agronomic Division 4300 Reedy Creek Rd Raleigh NC 26707-6465
DEM Water Quality Section	Control of water pollution from point sources such as municipal and industrial wastewater discharges, and from nonpoint sources that originate from agricultural drainage, urban runoff, land clearing, construction, mining, forestry, septic tanks and land application of waste; issues permits for both discharging and on-site wastewater treatment systems, conducts compliance inspections, operates an ambient water quality monitoring program, and performs a wide variety of special studies on activities affecting water quality; administers the 319 projects statewide.			
	Central Region	Linda Hargrove (319 Projects)	919-733-5083	DEM Water Quality Section Raleigh NC 27626
	Washington Region	Bill Moore	919-946-6481	1424 Carolina Ave. Washington NC 27889-3314
	Winston-Salem Region	Beth Morton	910-771-4600	585 Waughtown St Winston-Salem NC 27107
	Raleigh Region	Steve Mitchell	919-571-4700	3800 Barrett Dr. Suite 101 Raleigh NC 27609
DEM Groundwater Section	Groundwater classifications and standards, enforcement of groundwater quality protection standards and cleanup requirements, review of permits for wastes discharged to groundwaters, 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.			
	Washington Region	Roger Thorpe	919-946-6481	1424 Carolina Ave. Washington NC 27889-3314
	Winston-Salem Region	Linda Estkowski	910-771-4600	585 Waughtown St Winston-Salem NC 27107
	Raleigh Region	Jay Zimmerman	919-571-4700	3800 Barrett Dr. Suite 101 Raleigh NC 27609
DEHNR Land Resources	Conducts land surveys and studies, produces maps, and protects the state's land and mineral resources			
	Central Office	William (Toby) Vinson	919-733-4574	DLR 512 N. Salisbury St. Raleigh NC 27626
	Washington Region	Floyd Williams	919-946-6481	1424 Carolina Ave. Washington NC 27889-3314

	Winston-Salem Region	Doug Miller	910-771-4600	585 Waughtown St Winston-Salem NC 27107
	Raleigh Region	John Holley	919-571-4700	3800 Barrett Dr. Suite 101 Raleigh NC 27609
DEH Land Application of Wastewater **	Trains and delegates 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.			
	Washington Region	Roger Thorpe	919-946-6481	1424 Carolina Ave. Washington NC 27889-3314
	Raleigh Region	Randy Jones	919-571-4700	3800 Barrett Dr. Suite 101 Raleigh NC 27609
	Central Office	Steve Steinbeck	919-715-3273	DEH 512 N. Salisbury St. Raleigh NC 27626
Div Forest Resources	Forest management; forest pest and disease management; prevention, detection and suppression of forest and wildland fires; produce and sell seedlings and trees; implements Forest Stewardship Program.			
	District 5		919-442-1626	249 Airport Rd Rocky Mount NC 27804
	District 7		919-331-4781	861 Berea Church Rd Elizabeth City NC 27909
	District 10		704-956-2111	P.O Box 272 Lexington NC 27292
	District 11		919-732-8105	P.O. Box 907 Hillsborough NC 27278
	Central Office	Mickey Henson	919-733-2162	P.O. Box 27687 Raleigh NC 27611
DEH Solid Waste Management	Management of solid waste in a way that protects public health and the environment. The District includes three sections and one program -- Hazardous Waste, Solid Waste, Superfund, and the Resident Inspectors program.			
	Washington Region	Chuck Boyette	919-946-6481	1424 Carolina Ave. Washington NC 27889-3314
	Winston-Salem Region	Hugh Jernigan	910-771-4600	585 Waughtown St Winston-Salem NC 27107
	Raleigh Region	Ben Barnes	919-571-4700	3800 Barrett Dr. Suite 101 Raleigh NC 27609
NC Cooperative Extension Service	Provides practical, research-based information and programs to help individuals, families, farms, businesses and communities.			
	Bertie County	Williams J. Griffin, Jr.	919-794-5317	P. O. Box 280 Windsor NC 27983
	Caswell County	Larry Whitt	910-694-4158	P. O. Box 220 Yanceyville NC 27379
	Granville County	Johnsie Cunningham-Redding	919-603-1350	P. O. Box 926 Oxford NC 27565
	Halifax County	Wanda Sykes	919-583-5161	P. O. Box 37 Halifax NC 27839
	Martin County	Leon Allen	919-792-1521	P. O. Box 609 1148 Williamston NC 27892
	Northampton County	William E. Rogister	910-534-2831	P. O. Box 636 Jackson NC 27845
	Person County	Derek Day	910-599-1195	304 S. Morgan St Roxboro NC 27573
	Rockingham County	Scott Shoulars	910-342-8230	P. O. Box 200 Wentworth NC 27375
	Stokes County	John Brasfield	910-593-8179	P. O. Box 460 Danbury NC 27016
	Vance County	Donald Cobb	919-438-8188	P. O. Box 1028 Henderson NC 27536
	Warren County	Philip McMillan	919-257-3640	P. O. Box 708 Warrenton NC 27589
Div of Soil & Water Conservation	Provides administrative and technical assistance to the Soil & Water Conservation Districts in areas pertaining to soil acience and engineering; distribures Wetlands Inventory maps for a small fee.			
	Central Office	David Harrison (National Wetlands Inventory maps only)	919-715-6108	DSWC 512 N. Salisbury St. Raleigh NC 27626
	Washington Region	Pat Hooper	919-946-6481	1424 Carolina Ave. Washington NC 27889-3314
	Raleigh Region	Steve Bennett	919-571-4700	3800 Barrett Dr. Suite 101 Raleigh NC 27609

* Refers to the geographic area within which the agency has responsibility. This can include counties, regional offices, or districts (see maps).

** For questions and concerns pertaining to subsurface applications of wastewater as in septic systems contact the local health department.

APPENDIX VI

List of 303(d) Waters in the Roanoke River Basin

APPENDIX VI

List of 303(d) Waters in the Roanoke River Basin

What is the 303(d) list?

Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or which have impaired uses. Waters may be excluded from the list if existing control strategies for point and nonpoint source pollution will achieve the standards or uses. Waterbodies which are listed must be prioritized, and a management strategy or total maximum daily load (TMDL) must subsequently be developed for all listed waters.

303(d) List Development

The 305(b) report was used as a basis for developing the 303(d) list. Section 305(b) of the CWA requires states to report biennially to the U.S. Environmental Protection Agency (EPA) on the quality of waters in their state. In general, the report describes the quality of the state's surface waters, groundwaters, and wetlands, and existing programs to protect water quality. Information on use support, likely causes (e.g., sediment, nutrients, etc.) and sources (point sources, agriculture, etc.) of impairment are also presented in the report.

Many types of information were used to make use support assessments and to determine causes and sources of use support impairment. Chemical, physical, and biological data were the primary sources of information used to make use support assessments. North Carolina has an extensive ambient and biological monitoring network throughout the state. Benthic macroinvertebrate data which indicate taxa richness of pollution intolerant groups are an important data source. North Carolina also collects fish tissue and fish community structure data and phytoplankton bloom data that are used in the assessments. In addition, fish consumption advisories, information from other agencies, workshops, and reports, predictive modeling results, toxicity data, and self monitoring data is considered when making final use support determinations. Where the list has no problem parameter listed, the use support rating was based on biological data, and available chemical data showed no impairment. It should be noted that where a problem parameter has been identified, the water quality standard for that parameter was exceeded. This parameter is a potential cause of the impairment, but there may be other unidentified causes contributing to the impairment as well.

Only those waterbodies whose use support rating were not supporting (NS) or partially supporting (PS) in the 305(b) report were considered as candidates for the 303(d) list. Of those waterbodies that showed impairment (PS or NS rating) only those waterbodies that had a use support rating based on monitoring data collected in the last five years were included on the 303(d) list. Since many changes can occur within a watershed in a five year period, conclusive information about a waterbody's use support cannot be made with older data. However, North Carolina will be collecting information on as many of these evaluated waterbodies as staffing and time permit for subsequent updates of the basin plans and 303(d) list. As more conclusive information on streams rated using older data or best professional judgment is obtained, evaluated waterbodies will be added to the list if the data indicate impairment. Finally, those waterbodies which were rated as NS or PS were then examined to determine if there were management strategies in place. If so, the streams were eliminated from the list. Management strategies that were considered included the following:

1. Miscellaneous nonpoint programs - Any waterbodies where DEM was aware of nonpoint management studies (e.g. 319 or similar program) were eliminated if nonpoint sources were the only problem.

2. Point sources - All waters where point sources were the only problem were eliminated if the facility was under SOC, under schedule for removal, recently upgraded, or some other strategy was in place. In the Roanoke River Basin, several streams were removed from the list that had fish consumption advisories on them as the point sources that discharged high levels of dioxin or selenium have received NPDES permit limits for these parameters, and improvement in water quality has been noted.

Changes in the Roanoke River Basin's 303(d) list from earlier lists are based on updated chemical and biological monitoring results. If updated information indicated no impairment, a previously listed waterbody was removed. If previously supporting waterbodies had new data that indicated impairment, these waterbodies were added to the list. In addition, if no new data were collected on a given waterbody, and all available data were greater than 5 years old, the waterbody was excluded from the list. If future data indicate impairment, the stream will be added to the list.

Finally, the 303(d) list for the Roanoke River Basin has been prioritized. When developing priorities, the Division considers several factors including stream classification, degree of impairment, whether endangered species are present or the stream has a unique habitat, the degree of public interest, work completed to date, and the level of resources needed to address the problem. Three waterbodies were assigned a medium priority as they are in watersupplies and are classified to support primary recreation. These waterbodies are: Lake Gaston, Roanoke Rapids Lake, and Anderson Swamp Creek. Of these three waters, Lake Gaston will be given highest priority as much work has been done to address the aquatic weed problem by the Division of Water Resources, and further work is planned for 1996. It should be noted that highest priority for TMDL development in the basin is for a non-impaired stream, the lower Roanoke River. A fish kill occurred there in the summer of 1995 in response to sudden changes to the release out of Roanoke Rapids Dam, and the public has had much interest in preventing a future occurrence. Chapter 7 of the Basin Plan outlines the proposed work on the Roanoke mainstem, and lists the Division's priorities for other future work in the Basin. The amount of work that will be completed in time for the 2002 Roanoke Basin Plan will depend on available resources.

Additional Guidance on Using the 303(d) List

The column headings in the 303(d) list refer to the following:

Class - The information in this column indicates the classification assigned to the particular waterbody. Stream classifications are based on the existing and anticipated best usage of the stream as determined through studies and information obtained at public hearings. The stream classifications are described in 15A NCAC 2B .0300, and a summary of the rules is included in Appendix I.

Wtrbdy - The number in this column refers to the DEM subbasin in which the waterbody is located. The NRCS 14 digit hydrologic units nest within the DEM subbasins.

Problem Parameter - These are the causes of impairment as identified in the 305(b) report. Where no cause is listed, the rating was based on biological data, and available chemical data showed no impairment. These biological data may include benthic, fish habitat, and fish tissue information. It should also be noted that where a problem parameter is identified, the parameter listed exceeded the state's water quality standards for that substance. This parameter is a potential cause of the impaired stream, but there may be other, unidentified causes contributing to the impairment as well. Problem parameters included in the Roanoke 303(d) list are outlined below:

Cu - copper
DO - dissolved oxygen
Sed - sediment

Rating - This column lists the overall use support rating. These values may be NS (not supporting) and PS (partially supporting). The 305(b) report describes these use support ratings further.

Major Sources (P,NP) - This column indicates whether point (P) or nonpoint (NP) sources are the major sources of impairment.

Subcategory - This column breaks the point and nonpoint sources down further. A list describing what each number means is provided at the end of this Appendix.

Table A-VI.1: 303(d) LIST FOR THE ROANOKE RIVER BASIN

Name of Stream	Description	Class	Wtrbdy	Problem Parameters	Overall Rating	Major Source P,NP	Subcategory	Priority
Marlowe Creek	From source to Storys Creek/Woodsdale	C	30205	Cu, Sed	FS	P,NP	03,08	Low
Nutbush Ck	From source to Crooked Cr	C	30206		FS	NP,P	40, 03	Low
Anderson Swp Ck	Source to .6 mile up of Vance Co SR 1374	WS-III&B	30206		FS	NP	55,61,63	Medium
Smith Creek	From source to NC/VA Line	C	30207	Sed	FS	NP	10	Low
Quankey Creek	From source to Roanoke River	C	30208		FS	NP,P	21,73,86,02,08	Low
Conconnara Swp	Source to Roanoke River	C	30208		FS	NP		Low
Cashie River	From source to SR 1257, Berti	C Sw	30210	DO	FS	NP		Low

TABLE A-VI.2: LAKES IN ROANOKE RIVER BASIN ON THE 303(D) LIST

LAKE NAME	COUNTY NAME	SUBBASIN	SIZE (acres)	CLASS	OVERALL USE	FISH CONSUMP	AQ. LIFE & SECONDARY CONTACT	SWIMMING	DRINKING WATER	TROPHIC STATUS	PROBLEM PARAMETERS	PRIORITY
LAKE GASTON	HALIFAX/WARRE	30207	13300	WSIV,B	FS	S	FS	S	S	OLIGOTROPHIC	AQUATIC WEEDS	Medium
ROANOKE RAPIDS LK	NORTHAMPTON	30208	4893	WSIV, B	FS	S	FS	S	S	OLIGOTROPHIC	AQUATIC WEEDS	Medium

Subcategory Codes

0 Point Sources
- 01: Industrial
- 02: Municipal
- 03: Municipal Pretreatment (indirect dischargers)
- 04: Combined sewer overflows (end-of-pipe control)
- 05: Storm sewers (end-of-pipe control)
- 06: Schools
- 07: Other non-municipal

1 Nonpoint Sources

10 Agriculture
- 11: Non-irrigated crop production
- 12: Irrigated crop production
- 13: Specialty crop production (e.g., truck farming and orchards)
- 14: Pasture land
- 15: Range Lots
- 16: Feedlots - all types
- 17: Aquaculture
- 18: Animal holding/management areas

20 Silviculture
- 21: Harvesting, reforestation, residue management
- 22: Forest Management
- 23: Road Construction/maintenance

30 Construction
- 31: Highway road/bridge
- 32: Land Development

40 Urban Runoff
- 41: Storm Sewers (source control)
- 42: Combined sewers (source control)
- 43: Surface runoff
- 44: Finger Canals
- 45: Industrial

50 Resource Extraction/Exploration/Development
- 51: Surface mining
- 52: Subsurface mining
- ~~53: Placer mining~~
- 54: Dredge mining
- 55: Petroleum activities
- 56: Mill tailings
- 57: Mine tailings
- 58: Abandoned mines

60 Land Disposal / Runoff / Leachate From Permitted Areas)
- 61: Sludge
- 62: Wastewater
- 63: Landfills
- 64: Industrial land treatment
- 65: On-site wastewater systems (septic tanks, etc.)
- 66: Hazardous Waste

70 Hydrologic/Habitat Modification
- 71: Channelization
- 72: Dredging, sand dipping
- 73: Dam construction
- 74: Flow regulation
- 75: Bridge construction
- 76: Removal of riparian vegetation
- 77: Streambank modification/destabilization
- 78: Collapsed dam

80 Other
- 81: Atmospheric deposition
- 82: Waste storage/storage tank leaks
- 83: Highway maintenance and runoff
- 84: Spills
- 85: In-place contaminants
- 86: Natural
- 87: Marinas, harbors
- 88: Airport
- 89: Military activities (off road)

90 Source Unknown
- 91: General Erosion (road erosion)

References for Abbreviations

AQTox	Aquatic Toxicology Group (DWQ)
ARO	Asheville Regional Office (DWQ)
BMAN	Benthic Macroinvertebrate Survey (DWQ)
Comp	Compliance Group (DWQ)
DEM	Division of Environmental Management
DFR	Division of Forest Resources
DWQ	Division of Water Quality (formerly DEM)
DWR	Division of Water Resources
FAC	Food and Agriculture Committee
FRO	Fayetteville Regional Office (DWQ)
LQ	Division of Land Quality
Meck Co	Mecklenburg County
MRO	Mooresville Regional Office (DWQ)
NCFS	North Carolina Forest Services
RRO	Raleigh Regional Office (DWQ)
SCS	USDA Soil Conservation Service
SWCD	Soil and Water Conservation District
Topo	Topographic Map
WaRo	Washington Regional Office (DWQ)
WiRo	Wilmington Regional Office (DWQ)
WRC	Wildlife Resource Commission
WRRI	Water Resources Research Institute
WSR	Winston-Salem Regional Office (DWQ)
USGS	United States Geological Survey

APPENDIX VII

LIST OF NPDES DISCHARGES IN THE BASIN

Permit Type	Permit Number	Facility Name	Design Flow	Issued Date	Expiration Date	Basin	Pipe #	Stream Description	Permited Flow (MGD)
MAJOR	NC0025071	EDEN-MEBANE BRIDGE WWTP	13.5	4/16/93	2/28/97	30203	1	DAN RIVER/ROANOKE RIVER BASIN	13.5
MUNICIPAL	NC0020559	HENDERSON NUTBUSH CREEK WWTP	4.14	10/5/94	4/30/97	30206	1	NUTBUSH CREEK/ROANOKE RIVER BASIN	4.14
	NC0021873	MAYODAN WWTP, TOWN OF	1.25	5/19/92	1/31/97	30202	1	MAYO RIVER/ ROANOKE RIVER BASIN	1.25
	NC0024201	ROANOKE RAPIDS SANITARY DIST.	8.34	1/29/93	5/31/97	30208	1	ROANOKE RIVER/ROANOKE RIVER BASIN	8.34
	NC0021024	ROXBORO WWTP, CITY OF	5	3/31/93	4/30/97	30205	1	MARLOWE CREEK/ROANOKE RIVER BASIN	5
	NC0025721	WELDON WWTP, TOWN OF	0.6	12/11/92	5/31/97	30208	1	ROANOKE RIVER/ROANOKE RIVER BASIN	1.2
	NC0020044	WILLIAMSTON WWTP, TOWN OF	2	8/21/92	5/31/97	30209	1	ROANOKE RIVER/ROANOKE RIVER BASIN	2
	NC0026751	WINDSOR WWTP, TOWN OF	1.15	7/6/93	5/31/97	30210	1	U T CASHIE RIVER/ROANOKE RIVER BASIN	0.75
MAJOR	NC0001961	ALAMAC KNIT FABRICS, HAMILTON	1.5	5/3/94	5/31/97	30209	1	ROANOKE RIVER/ROANOKE RIVER BASIN	1.5
NONMUNICIPAL	NC0000752	CHAMPION INTERNATIONAL-WWTP	28	1/7/94	5/31/97	30208	1	ROANOKE RIVER/ROANOKE RIVER BASIN	28
	NC0000752	CHAMPION INTERNATIONAL-WWTP	28	1/7/94	5/31/97	30208	4	ROANOKE RIVER/ROANOKE RIVER BASIN	
	NC0038377	CP&L MAYO S.E. (PWR PLT)	21	12/29/95	4/30/97	30205			
	NC0003425	CP&L ROXBORO S.E. (PWR PLT)	0.015	12/27/95	4/30/97	30205	2	HYCO LAKE/ROANOKE RIVER BASIN	
	NC0003425	CP&L ROXBORO S.E. (PWR PLT)	0.015	12/27/95	4/30/97	30205	3	HYCO LAKE/ ROANOKE RIVER BASIN	
	NC0003425	CP&L ROXBORO S.E. (PWR PLT)	0.015	12/27/95	4/30/97	30205	5	HYCO LAKE/ ROANOKE RIVER BASIN	
	NC0003425	CP&L ROXBORO S.E. (PWR PLT)	0.015	12/27/95	4/30/97	30205	6	HYCO LAKE/ ROANOKE RIVER BASIN	
	NC0003425	CP&L ROXBORO S.E. (PWR PLT)	0.015	12/27/95	4/30/97	30205	9	HYCO LAKE/ROANOKE RIVER BASIN	
	NC0024406	DUKE POWER CO., BELEWS CREEK	5	4/16/93	1/31/97	30201	1	WEST BELEWS CREEK/ROANOKE RIVER BASN	
	NC0024406	DUKE POWER CO., BELEWS CREEK	5	4/16/93	1/31/97	30201	3	DAN RIVER/ROANOKE RIVER BASIN	
	NC0024406	DUKE POWER CO., BELEWS CREEK	5	4/16/93	1/31/97	30201	5	BELEWS LAKE/ROANOKE RIVER BASIN	
	NC0003468	DUKE POWER CO., DAN RIVER	0	8/31/94	2/28/97	30203	1	DAN RIVER/ROANOKE RIVER BASIN	
	NC0003468	DUKE POWER CO., DAN RIVER	0	8/31/94	2/28/97	30203	2	DAN RIVER/ROANOKE RIVER BASIN	
	NC0003468	DUKE POWER CO., DAN RIVER	0	8/31/94	2/28/97	30203	3	DAN RIVER/ROANOKE RIVER BASIN	
	NC0003468	DUKE POWER CO., DAN RIVER	0	8/31/94	2/28/97	30203	6	DAN RIVER/ROANOKE RIVER BASIN	
	NC0003468	DUKE POWER CO., DAN RIVER	0	8/31/94	2/28/97	30203	7	DAN RIVER/ROANOKE RIVER BASIN	
	NC0003468	DUKE POWER CO., DAN RIVER	0	8/31/94	2/28/97	30203	8	DAN RIVER/ROANOKE RIVER BASIN	
	NC0003468	DUKE POWER CO., DAN RIVER	0	8/31/94	2/28/97	30203	9	DAN RIVER/ROANOKE RIVER BASIN	
	NC0001643	FIELDCREST CANNON, INC.	0.5	2/3/94	2/28/97	30203	1	DAN RIVER/ROANOKE RIVER BASIN	0.5
	NC0029980	MILLER BREWING	5.2	4/29/93	2/28/97	30203	1	DAN RIVER/ROANOKE RIVER BASIN	5.2
	NC0029980	MILLER BREWING	5.2	4/29/93	2/28/97	30203	2	UT DRY CREEK/ROANOKE RIVER BASIN	
	NC0000680	WEYERHAEUSER, PLYMOUTH	82.5	7/26/93	5/31/97	30209	1	ROANOKE RIVER/ROANOKE RIVER BASIN	55
	NC0000680	WEYERHAEUSER, PLYMOUTH	82.5	7/26/93	5/31/97	30209	2	ROANOKE RIVER/ROANOKE RIVER BASIN	
	NC0000680	WEYERHAEUSER, PLYMOUTH	82.5	7/26/93	5/31/97	30209	5	ROANOKE RIVER/ROANOKE RIVER BASIN	

MINOR	NC0025151	EDEN (DRY CREEK WWTP),CITY OF	0.5	9/25/92	2/28/97	30203	1	DAN RIVER/ ROANOKE RIVER BASIN	0.5
MUNICIPAL	NC0066192	HALIFAX NEW WWTP	0.075	1/12/93	5/31/97	30208	1	QUANKEY CREEK/ ROANOKE RIVER BASIN	0.075
	NC0044776	HAMILTON WWTP, TOWN OF	0.08	7/26/93	5/31/97	30209	1	ROANOKE RIVER/ROANOKE RIVER BASIN	0.08
	NC0035858	JAMESVILLE WWTP, TOWN OF	0.15	6/15/92	5/31/97	30209	1	ROANOKE RIVER/ ROANOKE RIVER BASIN	0.15
	NC0023116	LEWISTON-WOODVILLE UTILITIES	0.15	12/11/93	5/31/97	30210	1	CASHIE RIVER/ ROANOKE RIVER BASIN	0.15
	NC0021075	MADISON WWTP, TOWN OF	0.775	12/4/92	1/31/97	30202	1	DAN RIVER/ROANOKE RIVER BASIN	0.775
	NC0020028	PLYMOUTH WWTP, TOWN OF	0.8	6/15/92	5/31/97	30209	1	ROANOKE RIVER/ROANOKE RIVER BASIN	0.8
	NC0025437	RICH SQUARE WWTP, TOWN OF	0.15	2/5/93	5/31/97	30208	1	BRIDGERS CREEK/ROANOKE RIVER BASIN	0.15
	NC0028011	STONEVILLE WWTP, TOWN OF	0.25	2/26/93	1/31/97	30202	1	MAYO RIVER/ROANOKE RIVER BASIN	0.25
	NC0025526	WALNUT COVE WWTP, TOWN OF	0.192	4/23/93	1/31/97	30201	1	TOWN FORK CREEK/ROANOKE RIVER BASIN	0.192
	NC0040011	YANCEYVILLE WWTP, TOWN OF	0.25	8/28/95	4/30/97	30204	1	COUNTRY LINE CREEK/ROANOKE RVR BASIN	0.25
MINOR	NC0032409	BERTIE CO SCH-ASKEWVILLE ELEM	0.0025	5/20/92	5/31/97	30210	1	UT WHITE OAK SWAMP/ROANOKE RIVER BSN	0.0025
NONMUNICIPAL	NC0078271	BETSY JEFF PENN 4-H EDUCATION	0.0084	7/24/95	2/28/97	30203	1	CARROLL CREEK/ROANOKE RIVER BASIN	0.0084
	NC0061484	BILL W. WATTS/GERMANTOWNE A***	0.09	11/1/91	1/31/97	30201	1	TOWN FORK CREEK/ROANOKE RIVER BASIN	0.09
	NC0044750	BRITTHAVEN OF MADISON	0.025	7/22/94	1/31/97	30202			
	NC0075027	CAINS WAY HOMEOWNERS ASSOC.	0.0432	2/18/94	1/31/97	30201	1	ADER CREEK/ROANOKE RIVER BASIN	0.0432
	NC0060461	CAROLINA WTR SERV.-ABINGTON	0.1	5/31/94	1/31/97	30201	1	BELEWS CREEK/ROANOKE RIVER BASIN	0.1
	NC0064971	CAROLINA WTR SERV.-CARTER RES.	0	1/6/86	12/31/90	30203			
	NC0046752	CAROLINA WTR SERV.-KYNWOOD	0.072	10/18/91	1/31/97	30201	1	BELEWS CREEK/ROANOKE RIVER BASIN	0.072
	NC0065081	COGENTRIX OF N.C.INC.(ROXBORO)	0	4/14/92	4/30/97	30205	1	UT MITCHELL CRK/ROANOKE RIVER BASIN	
	NC0065081	COGENTRIX OF N.C.INC.(ROXBORO)	0	4/14/92	4/30/97	30205	2	UT MARLOWE'S CRK/ROANOKE RIVER BASIN	
	NC0065081	COGENTRIX OF N.C.INC.(ROXBORO)	0	4/14/92	4/30/97	30205	3	UT MITCHELL CRK/ROANOKE RIVER BASIN	
	NC0077135	CURL MODULAR HOME SUBDIVISON	0.022	7/22/94	1/28/97	30203			
	NC0043290	DANBURY, TOWN OF	0	5/31/94	1/31/97	30201	1	UT SCOTT BRANCH/ROANOKE RIVER BASIN	
	NC0030180	DOC - BLANCH CORRECTIONAL INS.	0.018	8/17/92	4/30/97	30204	1	UT COUNTRY LINE CRK/ROANOKE RVR BASN	0.018
	NC0027626	DOC - CALEDONIA CORRECTIONAL	0.8	8/28/92	5/31/97	30208	1	ROANOKE RIVER/ROANOKE RIVER BASIN	0.8
	NC0029734	DOC - HALIFAX SUBSIDIARY	0.018	7/10/92	5/31/97	30208	1	LITTLE QUANKEY CREEK/ROANOKE RVR BSN	0.018
	NC0027642	DOC - ODOM CORRECTIONAL INST.3	0.07	2/23/94	5/31/97	30208	1	ROANOKE RIVER/ROANOKE RIVER BASIN	0.07
	NC0029777	DOC - STOKES CO. SUBSIDIARY	0.0132	11/25/92	1/31/97	30201	1	FLAT SHOALS CREEK/ROANOKE RIVER BASN	0.0132
	NC0050954	DOLLY MADISON MOTEL & REST.	0.012	5/19/92	1/31/97	30202	1	HOGANS CREEK/ROANOKE RIVER BASIN	0.012
	NC0045951	EDMUNDS PROPERTIES	0.0072	11/16/92	2/28/97	30203	1	UT LICK FORK CRK/ROANOKE RIVER BASIN	0.0072
	NC0047007	EVANS LUMBER COMPANY, INC.	0	10/7/92	5/31/97	30210	1	UT CASHIE RIVER/ROANOKE RIVER BASIN	
	NC0035602	FORSYTH CO. SCH-WALKERTOWN E.	0.0102	1/2/92	1/31/97	30201	1	UT WEST BELEWS CRK/ROANOKE RIVER BSN	0.0102
	NC0035599	FORSYTH CO. SCH-WALKERTOWN MS	0.009	1/2/92	1/31/97	30201	1	UT WEST BELEWS CRK/ROANOKE RIVER BAS	0.009
	NC0060542	GOLD HILL MOBILE HOME PARK	0.0176	4/8/93	1/31/97	30202	1	UT HOGANS CREEK/ROANOKE RIVER BASIN	0.0176

	NC0038636	HALIFAX CO SCH-BAKERS ELEM.	0.0073	4/28/95	5/31/97	30208	1	UT KEHUKEE SWAMP/ROANOKE RIVER BASIN	0.0073
	NC0056791	HORIZONS RESIDENTIAL CARE CTR	0.0094	10/16/95	1/31/97	30201	1	UT BUFFALO CREEK/ROANOKE RIVER BASIN	0.0094
	NC0085189	JOSE'S RESTAURANT-SAND FILTER	0.005	11/13/95	2/28/97	30203	1	UT BUFFALO CREEK/ROANOKE RIVER BASIN	0.005
	NC0003441	JPS ELASTOMERICS CORP-CARO.PLT	0.015	2/17/92	1/31/97	30201	2	LITTLE DAN RIVER/ROANOKE RIVER BASIN	0.015
	NC0083101	KERR LAKE REGIONAL WATER SYS	0	6/18/93	4/30/97	30206	1	UT ANDERSON SWAMP CRK/ROANOKE RVR BS	
	NC0035173	KOBE COPPER PRODUCTS, INC.	0.025	6/30/94	1/31/97	30201	1	UT DAN RIVER/ ROANOKE RIVER BASIN	0.025
	NC0035173	KOBE COPPER PRODUCTS, INC.	0.025	6/30/94	1/31/97	30201	3	UT DAN RIVER/ROANOKE RIVER BASIN	
	NC0023710	LIBERTY FABRICS,INC	0.45	7/10/92	5/31/97	30209	1	ROANOKE RIVER/ROANOKE RIVER BASIN	0.45
	NC0070491	LOVE OIL COMPANY	0.0173	4/16/93	2/28/97	30203	1	CARROLL CREEK/ROANOKE RIVER BASIN	0.0173
	NC0046302	MAYODAN WTP-MAYODAN PLT	0	1/2/92	1/31/97	30202	1	UT MAYO RIVER/ROANOKE RIVER BASIN	
	NC0067091	MIKKOLA DOWNS SUBDIVISION	0.072	7/15/92	1/31/97	30201	1	EAST BELEWS CREEK/ROANOKE RIVER BASN	0.072
	NC0027855	NC DOC-ROCKINGHAM CORRECT CTR	0.0195	4/29/94	2/28/97	30203	1	UT ROCK HOUSE CREEK/ROANOKE RVR BASN	0.0195
	NC0024775	NCDOT-REST AREA/WELCOME CENTER	0.01	10/29/93	4/30/97	30207	1	BLUE MUD CREEK/ROANOKE RIVER BASIN	0.01
	NC0044962	NORTH STOKES H. S.	0.0115	5/31/94	1/31/97	30201	1	UT DAN RIVER/ROANOKE RIVER BASIN	0.0115
	NC0079014	PANDA-ROSEMARY, L.P.	0	2/7/92	5/31/97	30208	1	UT CHOCKOYOTTE CREEK/ROANOKE RVR BSN	
	NC0028835	PERDUE INC.-LEWISTON PLT	3	9/25/92	5/31/97	30208	1	ROANOKE RIVER/ROANOKE RIVER BASIN	3
	NC0036544	PERSON CO SCH - BETHEL HILL	0.006	8/27/93	4/30/97	30205	1	UT BAMBOO CREEK/ROANOKE RIVER BASIN	0.006
	NC0036536	PERSON CO SCH - WOODLAND ELEM.	0.006	12/31/93	4/30/97	30205	1	UT SOUTH HYCO CRK/ROANOKE RIVER BASN	0.006
	NC0002313	PLYMOUTH WTP	0	2/26/93	5/31/97	30209	1	UT CONABY CREEK/ROANOKE RIVER BASIN	
	NC0059251	QUAIL ACRES MHP	0.05	7/29/94	10/30/97	30203	1	UT HOGANS CREEK/ROANOKE RIVER BASIN	0.018
	NC0079049	R. H. JOHNSON CONSTRUCTION CO.	0.06		8/31/96	30201	1	ROUGH FORK/ROANOKE RIVER BASIN	0.06
	NC0028754	RAYCO UTIL-WALNUT TREE/STOKES	0.05	3/1/93	1/31/97	30201	1	LICK CREEK/ROANOKE RIVER BASIN	0.05
	NC0078115	RAYCO UTILITIES (GRAYSTONE)	0.04	12/16/91	1/31/97	30201	1	UT BELEWS CREEK/ROANOKE RIVER BASIN	0.04
	NC0028746	RAYCO UTILITIES-BRIARWOOD	0.05	1/17/95	1/31/97	30201	1	UT BRUSHY FORK CRK/ROANOKE RIVER R B	0.05
	NC0003492	RJ REYNOLDS-WALNUT COVE	0.02	1/2/92	1/31/97	30201	1	VOSS CREEK/ ROANOKE RIVER BASIN	0.02
	NC0003492	RJ REYNOLDS-WALNUT COVE	0.02	1/2/92	1/31/97	30201	2	VOSS CREEK/ROANOKE RIVER BASIN	
	NC0055018	ROBERTS MOBILE HOME PARK	0.0025	1/13/93	2/28/97	30203	1	BUFFALO CREEK/ROANOKE RIVER BASIN	0.0025
	NC0073164	ROCKINGHAM CO SCH-ADMINISTRATI	0.0013	12/23/92	2/28/97	30203	1	UT ROCK HOUSE CREEK/ROANOKE RVR BASN	0.0013
	NC0037001	ROCKINGHAM CO SCH-BETHANY ELEM	0.0037	11/15/91	2/28/97	30203	1	UT HUFFINES MILL CRK/ROANOKE RVR BSN	0.0037
	NC0036951	ROCKINGHAM CO SCH-HAPPY HOME	0.0035	11/15/91	2/28/97	30203	1	UT DAN RIVER/ROANOKE RIVER BASIN	0.0035
	NC0036960	ROCKINGHAM CO SCH-LINCOLN	0.005	11/15/91	2/28/97	30203	1	UT ROCK CREEK/ROANOKE RIVER BASIN	0.005
	NC0034410	ROCKINGHAM CO SCH-ROCK. CO HS	0.018	2/7/92	2/28/97	30203	1	UT CARROLL CREEK/ROANOKE RIVER BASIN	0.018
	NC0036986	ROCKINGHAM CO SCH-SADLER ELEM	0.0027	11/15/91	2/28/97	30203	1	UT WOLF ISLAND CRK/ROANOKE RVR BASIN	0.0027
	NC0037010	ROCKINGHAM CO SCH-WENTWORTH EL	0.0095	11/15/91	2/28/97	30203			
	NC0046337	ROCKINGHAM COMM COLLEGE	0.03	1/15/93	2/28/97	30203	1	UT ROCK HOUSE CRK/ROANOKE RIVER BASN	0.03
	NC0082881	ROCKINGHAM COUNTY	0.2	5/25/93	2/28/97	30203	1	ROCK HOUSE CREEK/ROANOKE RIVER BASIN	0.2
	NC0003042	ROXBORO WTP, CITY OF	0	11/12/93	4/30/97	30205	1	UT MARLOWE CREEK/ROANOKE RIVER BASIN	

	NC0083933	SHUGART ENTERPRISES	0.06	12/9/94	1/31/97	30201	1	UT BELEWS CREEK/ROANOKE RIVER BASIN	0.06
	NC0044954	SOUTH STOKES H. S.	0.0173	2/19/92	1/31/97	30201	1	LITTLE NEATMAN CRK/ROANOKE RIVER BSN	0.0173
	NC0074659	STOKES CO. BOE	0.0025	12/16/93	1/31/97	30201	1	SCOTT BRANCH/ROANOKE RIVER BASIN	0.0025
	NC0044181	STOKES CO. COMM. CENTER	0.0036	4/27/94	1/31/97	30201	1	SCOTT BRANCH/ROANOKE RIVER BASIN	0.0036
	NC0071978	STOKES CO. GOVERNMENT CENTER	0.0125	6/30/93	1/31/97	30201	1	SCOTT BRANCH/ROANOKE RIVER BASIN	0.0125
	NC0030171	STOKES, COUNTY OF	0.0225	11/25/92	3/31/97	30201	1	UT DAN RIVER/ROANOKE RIVER BASIN	0.0225
	NC0082384	STOKES, COUNTY OF	0.1	2/26/93	1/31/97	30201	1	DAN RIVER/ROANOKE RIVER BASIN	0.1
	NC0060623	STONE HIGHWAY MHP	0.015	7/22/94	2/28/97	30203	1	UT BUFFALO CREEK/ROANOKE RIVER BASIN	0.015
	NC0037311	TRI-CITY HAVEN REST HOME	0.01	1/13/93	1/31/97	30201	1	UT BELEWS CREEK/ROANOKE RIVER BASIN	0.01
	NC0057720	TWIN LAKES MHP;S.S.B.,INC.	0.04	3/29/94	1/31/97	30201	1	UT TIMMONS CREEK/ROANOKE RIVER BASIN	0.04
	NC0068187	UNITED ORGANICS CORPORATION	0	2/26/93	5/30/97	30209	1	UT ROANOKE RIVER/ROANOKE RIVER BASIN	
	NC0068187	UNITED ORGANICS CORPORATION	0	2/26/93	5/30/97	30209	2	UT ROANOKE RIVER/ROANOKE RIVER BASIN	
	NC0085022	US 220 TRAILER PARK	0	10/30/95	1/31/97	30202	1	UT HOGANS CREEK/ROANOKE RIVER BASIN	
	NC0035491	VANCE CO SCH-E O YOUNG JR ELEM	0.0036	10/30/95	4/30/97	30206	1	UT MILL CREEK/ROANOKE RIVER BASIN	0.0036
	NC0035505	VANCE CO SCH-NORTHERN VANCE HI	0.0144	1/13/93	4/30/97	30206	1	ANDERSON SWAMP CRK/ROANOKE RVR BASIN	0.0144
	NC0027987	VULCAN MATERIALS-STONEVILLE	0	10/29/93	2/28/97	30203	1	UT BUFFALO CREEK/ROANOKE RIVER BASIN	
	NC0007323	YANCEYVILLE WTP, TOWN OF	0	5/12/93	4/30/97	30204	1	FULLERS CREEK/ROANOKE RIVER BASIN	
	NC0002828	ZARN INC-REIDSVILLE	0.005	2/7/92	2/28/97	30203	1	UT LICK FORK CRK/ROANOKE RIVER BASIN	0.005
	NC0002828	ZARN INC-REIDSVILLE	0.005	2/7/92	2/28/97	30203	2	UT LICK FORK CRK/ROANOKE RIVER BASIN	

Table A-VII.2. Facilities Required to Monitor Effluent Toxicity in the Roanoke River Basin.

Subbasin	Facility	NPDES#	Receiving Stream	County	Flow(MGD)	IWC(%)
ROA01	Duke Power-Belews Cr./003	NC0024406/003	Dan River	Stokes	7.7000	33.00
ROA01	Duke Power-Belews Cr./005	NC0024406/005	Belews Lake	Stokes	NA	NA
ROA01	Kobe Copper Products, Inc.	NC0035173/001	UT To Dan River	Stokes	0.0250	34.05
ROA01	Stokes Co. Board Of Education	NC0044954/001	Little Neatman Cr.	Stokes	0.0173	9.00
ROA02	Mayodan WWTP	NC0021873/001	Mayo River	Rockingham	1.250	6.00
ROA02	Stoneville WWTP	NC0028011/001	Mayo River	Rockingham	0.250	0.39
ROA03	Duke Power-Dan River	NC0003468/002	Dan River	Rockingham	1.8000	0.879
ROA03	Eden WWTP/Mebane Bridge	NC0025071/001	Dan River	Rockingham	13.5000	6.000
ROA03	Eden-Dry Cr. WWTP	NC0025151/001	Dan River	Rockingham	0.5000	0.240
ROA03	Fieldcrest Mills-Eden(New St.)	NC0001643/001	Dan River	Rockingham	0.5000	0.246
ROA03	Love Oil Co.	NC0070491/001	Carroll Cr.	Rockingham	0.0173	100.000
ROA03	Miller Brewing Co.	NC0029980/001	Dan River	Rockingham	5.2000	2.510
ROA03	Rockingham Community College	NC0046337/001	UT Rock House Cr.	Rockingham	0.0300	100.000
ROA03	Transportation, NC Dept. of	NC0029190/001	Naked Run	Surry	0.0300	13.000
ROA04	Yanceyville WWTP	NC0040011/001	Country Line Cr.	Caswell	0.2500	24.40
ROA05	Cogentrix-Roxboro/003	NC0065081/003	UT Mitchell Cr.	Person	NA	100.00
ROA05	CP&L-Roxboro/003	NC0003425/003	Hyco Reservoir	Person	NA	NA
ROA05	CP&L-Roxboro/006	NC0003425/006	Hyco Reservoir	Person	NA	NA
ROA05	Roxboro WWTP	NC0021024/001	Marlowe Cr.	Person	5.0000	99.87
ROA06	Henderson Nutbush Cr. WWTP	NC0020559/001	Nutbush Cr.	Vance	4.14	96.97
ROA08	Champion Intrnatl Roanoke 001	NC0000752/001	Roanoke River	Halifax	28.0000	4.20
ROA08	Correc., Dept. Of (Caledonia)	NC0027626/001	Roanoke River	Halifax	0.8000	94.30
ROA08	Halifax WWTP	NC0066192/001	Quankey Cr	Halifax	0.0750	14.00
ROA08	Panda-Rosemary Corp.	NC0079014/001	UT Chockoyotte Cr	Halifax	0.0538	100.00
ROA08	Perdue Inc. Lewiston	NC0028835/001	UT Roanoke River	Bertie	3.0000	100.00
ROA08	Rich Square WWTP	NC0025437/001	Bridgers Cr	Northhampton	0.1500	100.00
ROA08	Roanoke Rapids WWTP	NC0024201/001	Roanoke River	Halifax	8.3400	1.30
ROA08	Weldon WWTP	NC0025721/001	Roanoke River	Halifax	0.6000	0.19
ROA09	Liberty Fabrics, Inc.	NC0023710/001	Roanoke River	Martin	0.4500	0.06
ROA09	West Point Pepperell-Hamilton	NC0001961/001	Roanoke River	Martin	1.5000	0.21
ROA09	Weyerhaeuser-Plymouth(Roanoke)	NC0000680/001	Roanoke River	Martin	55.0000	10.57
ROA09	Williamston WWTP	NC0020044/001	Roanoke River	Martin	2.0000	0.16
ROA10	Windsor WWTP	NC0026751/001	UT Cashie River	Bertie	1.1500	100.0

NPDES# = facility's discharge permit number   MGD = million gallons per day   IWC = instream waste concentration

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