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

4.1 Overview

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

4.2 Habitat Degradation

Instream habitat degradation is identified in the use support summary (Appendix III) where there is a notable reduction in habitat diversity or a negative change in aquatic habitat. This term includes sedimentation, bank erosion, channelization, lack of riparian vegetation, loss of pools or riffles, lack of woody material, and streambed scour. Good instream habitat is necessary for aquatic life to survive and reproduce. Streams that typically show signs of habitat degradation are in watersheds that have a large amount of land-disturbing activities (construction, mining, timber harvest and agricultural activities) or a large percentage of impervious surfaces. A watershed in which most of the riparian vegetation has been removed from streams or channelization has occurred also exhibits instream habitat degradation. Streams that receive a discharge quantity that is much greater than the natural flow in the stream often have degraded habitat as well.

Determining the cause and quantifying amounts of habitat degradation is very difficult in most cases. To assess instream habitat degradation in most streams would require extensive technical and monetary resources and perhaps even more resources to restore the stream. DWQ is working to develop a reliable habitat assessment methodology.

Although DWQ and other agencies are starting to address this issue, local efforts are needed to prevent further instream habitat degradation and to restore streams that have been impaired by activities that cause habitat degradation. As point sources become less of a source of water quality impairment, nonpoint sources that pollute water and cause habitat degradation will need to be addressed to further improve water quality in North Carolina's streams and rivers.

4.2.1 Sedimentation

Introduction

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

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

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

Major Causes of Sedimentation in the Roanoke River Basin

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

Suspended sediment can decrease primary productivity (photosynthesis) by shading sunlight from aquatic plants, affecting the overall productivity of a stream system. Suspended sediment also has several effects on various fish species including avoidance and redistribution, reduced feeding efficiency, and therefore, reduced growth by some species, respiratory impairment, reduced tolerance to diseases and toxicants, and increased physiological stress (Roell, June 1999). Suspended sediment also increases the cost of treating municipal drinking water.

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

Land Clearing Activities

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

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

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

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

Some Best Management Practices

Agriculture

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

Construction

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

Forestry

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

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

New Rules Regarding Sediment Control

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

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

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

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

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

4.2.2 Loss of Riparian Vegetation

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

Removing trees, shrubs and other vegetation to plant grass or place rock (also known as rip-rap) along the bank of a river or stream degrades water quality. Removing riparian vegetation eliminates habitat for aquatic macroinvertebrates that are food for a variety of fish. Rocks lining a bank absorb the sun's heat and warm the water. Some fish require cooler water temperatures as well as the higher levels of dissolved oxygen cooler water provides. Trees, shrubs and other native vegetation cool the water by shading it. Straightening a stream, clearing streambank vegetation, and lining the banks with grass or rock severely impact the habitat that aquatic insects and fish need to survive (WNCT, 1999).

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

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

4.2.3 Channelization

Channelization refers to the physical alteration of naturally occurring stream and riverbeds. Typical modifications are described in the text box. Although increased flooding, bank erosion and channel instability often occur in downstream areas after channelization has occurred; flood control, reduce erosion, increase usable land area, increase navigability and more efficient drainage are frequently cited as the objectives of channelization projects (McGarvey, 1996).

Typical Channel Modifications

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

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

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

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

4.2.4 Recommendations for Reducing Habitat Degradation

DWQ will continue to work cooperatively with DLR and other agencies that administer sediment control and instream mining programs in order to maximize the effectiveness of the programs and to take appropriate enforcement action when necessary to protect or restore water quality.

However, more voluntary implementation of BMPs is needed for activities that are not subject to these rules in order to substantially reduce the amount of widespread sedimentation present in the Roanoke River basin. Public education is needed basinwide to educate landowners about the value of riparian vegetation along small tributaries and the impacts of sedimentation to aquatic life.

Funding is available for cost sharing with local governments that set up new erosion and sedimentation control programs or conduct their own training workshops. The Sediment Control Commission will provide 40% of the cost of starting a new local erosion and sedimentation control program for up to 18 months. Two municipalities or a municipality and county can develop a program together and split the match. It is recommended that local governments draft and implement local erosion and sedimentation control programs.

Funding is also available through numerous federal and state programs for farmers to restore and/or protect riparian buffer zones along fields or pastures, develop alternative watering sources for livestock, and fence animals out of streams (refer to Section C, Part 1.4.3). EPA's *Catalog of Federal Funding Sources for Watershed Protection* (Document 841-B-99-003) outlines some of these and other programs aimed at protecting water quality. A copy may be obtained by calling the National Center for Environmental Publications and Information at (800) 490-9198 or visit the website at http://www.epa.gov/OWOW/watershed/wacademy/fund.html. Local contacts for various state and local agencies are listed in Appendix VI.

4.3 Urban Runoff

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

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

4.3.1 Urbanization

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

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

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

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

4.3.2 Stormwater Regulations

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

4.3.3 Recommendations for Reducing Urban Runoff

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

Planning Recommendations for New Development

- Minimize number and width of residential streets.
- Minimize size of parking areas (angled parking and narrower slots).
- Place sidewalks on only one side of residential streets.
- Vegetate road right-of-ways, parking lot islands and highway dividers to increase infiltration.
- Plant and protect natural buffer zones along streams and tributaries.
- Minimize floodplain development.
- Protect and restore wetland / bog areas.

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

recommendations for new development found in the text box, refer to EPA's website at www.epa.gov/owow/watershed/wacademy/acad2000/protection.

4.4 Turbidity in the Dan River Watershed

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

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

4.4.1 Instream Mining Operations

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

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

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

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

Two Types of Instream Mining Permits

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

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

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

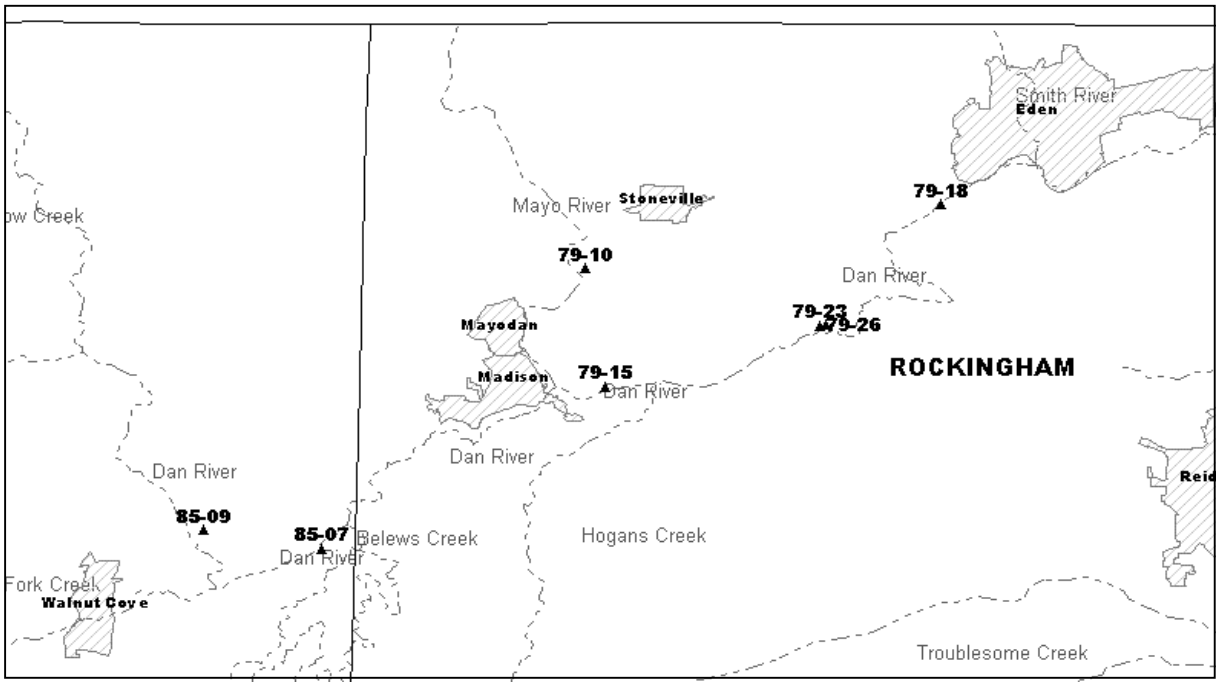

Figure A-23 Permitted Instream Mine Sites in the Dan River Watershed (DLR, June 2001)

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

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

4.4.2 Recommendations

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

4.5 Dissolved Oxygen in the Lower Roanoke River Basin

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

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

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

4.5.1 Discharges to Zero Flow Streams

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

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

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

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

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

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

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

4.5.2 Modeling Dissolved Oxygen in the Roanoke River

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

4.5.3 Other Dissolved Oxygen Studies

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

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

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

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

4.5.4 Recommendations

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

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

4.6 Major Studies Related to Water Quality

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

4.6.1 EPA/Weyerhaeuser Dioxin Contamination Studies

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

4.6.2 FERC Relicensing of Hydropower Projects

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

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

4.6.3 USCOE Section 216 Study

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

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

4.6.4 Recommendations

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

4.7 Protecting Headwaters

Many streams in a given river basin are only small trickles of water that emerge from the ground. A larger stream is formed at the confluence of these trickles. This constant merging eventually forms a large stream or river. Most monitoring of fresh surface waters evaluates these larger streams. The many miles of small trickles, collectively known as headwaters, are not directly monitored and in many instances are not even indicated on maps. However, impairment of headwater streams can (and does) impact the larger stream or river.

Headwater areas are found from the mountains to the coast along all river systems and drain all of the land in a river basin. Because of the small size of headwater streams, they are often overlooked during land use activities that impact water quality. All landowners can participate in the protection of headwaters by keeping small tributaries in mind when making land use management decisions on the areas they control. This includes activities such as retaining vegetated stream buffers and excluding cattle from streams. Local rural and urban planning initiatives should also consider impacts to headwater streams when land is being developed.

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

4.8 Biological Community Assessment Issues

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

4.8.1 Draft Criteria for Assessing Benthic Macroinvertebrates in Swamp Streams

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

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

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

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

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

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

4.8.3 Fish Consumption Advisories

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

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

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

The presence and accumulation of mercury in North Carolina's aquatic environment is similar to contamination observed throughout the country. Mercury has a complex life in the environment, moving from the atmosphere to soil, to surface water and into biological organisms. Mercury circulates in the environment as a result of natural and human (anthropogenic) activities. A dominant pathway of mercury in the environment is through the atmosphere. Mercury that has been emitted from industrial and municipal stacks into the ambient air can circulate across the globe. At any point, mercury may then be deposited onto land and water. Once in the water, mercury can accumulate in fish tissue and humans. Mercury is also commonly found in wastewater. However, mercury in wastewater is typically not at levels that could be solely responsible for elevated levels in fish.

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

4.8.4 Recommendations for Biological Community Assessment

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

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

4.9 Effects of Hurricanes on Water Quality

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

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

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

4.9.1 Contaminants

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

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

4.9.2 De-snagging

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

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

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

4.9.3 Bank Failure

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

4.9.4 Recommendations

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

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

4.10 Priority Issues for the Next Five Years

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

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

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

4.10.1 Strategies for Restoring and Protecting Impaired Waters

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

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

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

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

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

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

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