NEUSE RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN

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This document was approved and endorsed by the NC Environmental Management Commission on February 11, 1993 to be used as a guide by the NC Division of Environmental Management in carrying out its Water Quality Program duties and responsibilities in the Neuse River Basin.

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"One of the basic underlying messages of this exercise, and of the Plan created here, is to create a broader recognition of the way in which actions in one area influence the actions in another area. And in particular to recognize that there are various ...environmental standards that we are creating so that the ecosystems provide the services that we require as a human society from them, and that we will not in the long run deviate and let the systems fall below those standards. What that means, in a context of growing population and growing demands placed upon those systems, is escalating costs, and probably escalating costs per capita, for getting rid of the wastes that we create as a human society and as a people.

...this particular document provides a vision into the future of what the sorts of costs of cleanup are going to be as a consequence of growing population and growing use of resources. In my judgment, these sorts of costs aren't often enough contemplated in the planning that local communities do for their future. And it strikes me that that is one of the major roles in a broader philosophical sense that this exercise plays as it puts a local community in the context of the broader system in which it exists. So that local government leaders can look to the kinds of issues that are going to lie ahead in the sense of costs of activities that they may undertake. And that planning, I think, is part of an important process."

Dr. Charles Peterson, Member
Environmental Management Commission
February 11, 1993

EXECUTIVE SUMMARY

NORTH CAROLINA'S BASINWIDE APPROACH TO WATER QUALITY MANAGEMENT - PURPOSE OF NEUSE BASINWIDE PLAN

Basinwide water quality management is a new watershed-based management approach being implemented by the North Carolina Division of Environmental Management (NCDEM) to improve the efficiency, effectiveness and consistency of its Water Quality Protection Program. Two key features include *basinwide discharge permitting* and preparation of a *basinwide management plan* for each of the seventeen major river basins in the state. The *Neuse Basinwide Water Quality Management Plan* is the first of a series of basinwide plans that will be prepared by NCDEM for all of the state's major river basins over the next five years. The full schedule is presented in Chapter 1.

The purpose of the *Neuse Basinwide 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;
- long-range water quality goals for the basin;
- point and nonpoint source pollution control programs and regulations;
- recommended waste limit strategies for discharges of nutrients, oxygen-demanding wastes and toxic substances; and
- followup monitoring to gauge the Division's performance in implementing the plan to meet established goals.

Basinwide plans will be updated at five-year intervals. The Neuse Basinwide Plan is due for completion in April of 1993 and will be updated in 1998.

BASINWIDE GOALS AND OBJECTIVES

The primary goals of NCDEM'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 so as to protect water quality standards while accommodating population increases and economic growth. Near-term objectives, or those achievable at least in part during the next five years, include implementing management strategies to significantly reduce point and nonpoint source pollution and making measurable improvements towards addressing the major issues presented below. Longer-term objectives will include refining the recommended basinwide management strategies during the next round of water quality monitoring after obtaining feedback on current management efforts.

Near-term *point source* management efforts will include establishing more restrictive waste limits for oxygen-consuming wastes at new and expanding wastewater treatment plants and on a case-by-case basis at some existing plants in areas where documented water quality problems exist; continuing efforts to improve compliance with permitted limits; improving pretreatment of industrial wastes to municipal wastewater treatment plants so as to reduce the toxicity in effluent wastes; increasing compliance surveillance of designated concentrated-animal feeding operations; and requiring multiple treatment trains at wastewater facilities as designated by rules adopted by the Environmental Management Commission.

Near-term *nonpoint source* management efforts will include working with the appropriate nonpoint source agencies to target the implementation of best management practices (BMPs) to reduce sediment and nutrient runoff to the most sensitive surface water areas in the basin, as well as implementing NCDEM's water supply watershed protection, federal urban stormwater and state animal waste control rules. Particular emphasis will be placed on evaluating nonpoint source nutrient loading with a goal of developing nonpoint source nutrient reduction goals in the next five years.

For point sources, long-term 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 recycling wastewater), and keeping abreast of and recommending the most advanced and cost-effective wastewater treatment technologies.

For nonpoint sources, long-term efforts will include more effective controls of urban runoff and continuing efforts to work with the agricultural, forestry and development communities to reduce nutrient, sediment and chemical runoff through expanded and improved best management practices (BMP). Innovative management strategies will be sought to optimize distribution of assimilative capacity and may include tradeoffs between point and nonpoint source controls such as the nutrient trading program that is being developed in the Tar-Pamlico River basin. If proven successful in that basin, similar programs may be developed in other basins including the Neuse. Public review and involvement in the long-range planning process will also be emphasized.

BASINWIDE WATER QUALITY PROTECTION PROGRAMS

Integrating Point and Nonpoint Source Pollution Control Strategies

Basinwide management will facilitate the integration of point and nonpoint source pollution assessment and control, relying in part on a concept called *total maximum daily loads* (TMDLs). This concept, 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 process 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. In this document, it is applied primarily to the control of nutrients and biochemical oxygen-demanding wastes (BOD). Chapter 5 describes North Carolina's approach to the TMDL concept. Recommended strategies for specific water bodies are presented in Chapter 6.

As NCDEM's abilities to quantify and predict the impacts of point and nonpoint source pollution become more sophisticated, the basinwide approach will allow more innovative management strategies to be implemented. Possible strategies that might be considered in future Neuse Basinwide Plans or in the plans for later basins in this first five-year basinwide planning cycle include agency banking, pollution trading among permitted dischargers (or point and nonpoint sources), industrial recruitment mapping and consolidation of wastewater discharges (defined in Chapter 5). Improvements in understanding the relative contributions and effects of point and nonpoint source pollution on water quality will also help in developing a more equitable approach in managing and regulating these sources.

NCDEM's Point Source Control Program

Point source discharges, which are defined and described more fully in Chapter 3, are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the National Pollution Discharge Elimination System (NPDES) program which was delegated to North Carolina from the USEPA. 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, described in Chapter 5, which includes permitting, compliance and enforcement, wasteload allocation modeling, pretreatment, aquatic toxicity testing, water quality monitoring, operator training and consideration of nondischarge alternatives.

NCDEM's Nonpoint Source Control Program
There are a wide array of programs designed to address nonpoint source pollution that are introduced in Chapter 5 and discussed more fully in Appendix IV. The major categories include agriculture, urban stormwater, forestry, onsite wastewater treatment, construction, and mining. NCDEM administers several regulatory programs that address nonpoint sources including coastal and urban stormwater rules, water supply watershed regulations and nonpoint source requirements associated with high quality and outstanding resource waters. However, many programs are administered by other agencies including the Departments of Transportation and Agriculture as well as the Divisions of Land Resources, Soil and Water and Coastal Management. NCDEM coordinates with these agencies to target and implement appropriate nonpoint source controls which generally involve land use controls or best management practices.

NEUSE BASIN OVERVIEW

The Neuse River basin encompasses 6192 square miles in 19 counties and contains roughly one sixth of the state's population. It is the third largest river basin in North Carolina and is one of only three major river basins whose boundaries are located entirely within the state. The Neuse River originates northwest of Durham in the northern Piedmont region of North Carolina and then flows southeasterly for over 200 miles past the cities of Raleigh, Smithfield, Goldsboro, Kinston and New Bern to the tidal waters of Pamlico Sound. There are 3,293 miles of freshwater streams in the basin, 328,700 acres classified as *salt* waters and thousands of acres of freshwater impoundments.

Analysis of land cover data based on 1987 satellite imagery provided by the North Carolina Center for Geographic Information and Analysis (CGIA) reveals that agriculture and forestry comprise nearly two thirds of the basin's total surface area (34.7% and 33.9% of land area, respectively). Wetlands and open water (including the Neuse estuary and large impoundments) comprise over 20% of the surface area, and urban development, concentrated mostly in the upper basin around Raleigh, Durham, Cary and Garner, comprises 5.1%. Comparison of 1970 to 1990 census data indicates that the two most rapidly growing regions in the basin are the greater Raleigh area and the lower Neuse in the vicinity of New Bern and Havelock. Population growth in both areas exceeded 70% over the 20-year period. Total population in the Neuse basin, based on 1990 census data, is estimated at 1,015,511. There are a total of 350 discharge permits issued for the basin, 187 of which are active. Of these, there are 20 major municipal facilities, 10 major nonmunicipals, 20 minor municipals and 137 minor nonmunicipals. Municipals are publicly-owned treatment facilities for towns, cities and counties. Nonmunicipals are privately-owned facilities such as industrial plants and private package plant facilities.

NEUSE BASIN WATER QUALITY STATUS: USE SUPPORT RATINGS

An important method for assessing water quality in a stream, lake or estuary, is to determine whether its quality is sufficient to support the *uses* for which the waterbody has been classified by the state. Uses, depending on the classification of the waters, refers to activities such as swimming, fishing, aquatic life support, water supply and shellfishing. NCDEM has collected extensive chemical and biological water quality monitoring data throughout the Neuse basin. 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 that water quality conditions are marginal. Use support ratings in the Neuse basin, described more fully in Chapter 4, are summarized below for *freshwater streams, saltwaters* (estuarine areas) and *lakes.*

Freshwater Streams

Of the 3,293 miles of freshwater streams in the Neuse basin, information was available to develop use support ratings for 92% or 3,053 miles. Of the 92% that were evaluated, 22% were rated as *fully supporting* their designated uses, 40% were *support-threatened,* 25% were *partially supporting* and 5% were *not supporting.* Those waters not evaluated are primarily headwater streams and small tributaries. Of the total 990 miles of streams rated as partially or not supporting, the probable causes and sources of impairment were identified for approximately 75%.

Sediment (from nonpoint sources such as construction, agriculture, urban development, mining and forestry) was considered the most widespread cause of use support impairment (30%). This was followed by low dissolved oxygen (mostly from point sources), bacteria, metals/toxicants, and solids/turbidity. Metal violations were usually associated with urban areas or located downstream of dischargers where streamflow was often dominated by effluent.

Nonpoint source pollution was identified as the most widespread source of stream use support impairment in the basin. Thirty-four percent of the impaired streams were estimated to be impaired by agriculture, 14 percent by urban development, and 13 percent by construction activity. Eleven percent of the streams were judged to be impaired by point sources. Other categories of nonpoint pollution included forestry, land disposal, hydrologic modifications and general erosion. The type and significance of sources of impairment varies considerably throughout the basin. While agricultural sources were identified throughout the basin, urban sources were, for the most part, more severe and concentrated in the Piedmont area of the basin. Above Falls Lake, more streams were judged to be impaired by point sources than agriculture. Also, in the Raleigh-Durham area, urban and construction related nonpoint runoff were the main sources of impairment. The Contentnea Creek and Trent River subbasins had the highest number of stream miles thought to be impaired by agriculture.

Saltwaters

Use support determinations were made for all of the 328,700 acres of saltwater in the Neuse Basin. Eighty-six percent of the saltwaters were rated fully supporting, 5% support-threatened, and 9% partially supporting. No waters were rated as not supporting.

Eutrophication, as evidenced by high chlorophyll a levels, was the most widespread cause of impairment followed by fecal coliform bacteria. Both of these causes are indicators of water quality degradation and are discussed further under Priority Water Quality Concerns and Management Strategies. Eutrophication is related to nutrient overenrichment and the excessive growth of algae and other aquatic plants. Elevated levels of fecal coliform bacteria require the closure of commercial shellfishing areas. The majority of partially supporting waters were in the upper part of the Neuse River estuary, from New Bern to Minnesott Beach. These waters were mainly impacted by nutrient over enrichment (chlorophyll a exceedances and algal blooms). Waters rated as partially supporting in the lower part of the estuary were related primarily to closed shellfish waters. A smaller number of saltwater acres were impaired by low dissolved oxygen and metals, mainly in the Neuse River above and near New Bern and Oriental Harbor. Waters were impacted by multiple sources, but the most widespread probable source of impairment was agriculture, followed by point source discharges. Swamp drainage, urban runoff and malfunctioning septic tanks were identified as pollution sources for a smaller set of waters.

Lakes

There are nearly 100 named lakes and ponds in the Neuse basin and an innumerable number of unnamed farm ponds and other impoundments. Most of these are considered eutrophic, meaning that they are enriched with nutrients and may have an overabundance of algae and aquatic plants. Thirty of the named lakes, totaling 20,586 acres, were monitored and assigned use support ratings. Of these 30, eleven fully supported their uses, eleven were support-threatened, five were partially supporting, and three were not supporting. Major causes of impairment included nutrient enrichment, noxious aquatic plants (Hydrilla and algal blooms), and siltation. Major sources of impairment include municipal point sources and runoff from construction, urban and agricultural areas.

PRIORITY WATER QUALITY CONCERNS AND RECOMMENDED MANAGEMENT STRATEGIES

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, the number of users affected or the sensitivity of the resources involved. Those issues considered most significant on a basinwide scale and requiring the most immediate attention by NCDEM are presented below as major issues. Other important issues and control strategies are discussed.

Major Issues:

- Lack of Assimilative Capacity for Oxygen-Consuming Wastes in the Neuse Mainstem and Major Tributaries

  Analysis of 1987 to 1991 water quality data collected at 13 ambient sampling stations on the river from Falls Lake Dam to New Bern has revealed occurrences of dissolved oxygen (DO) concentrations below the standard (5 mg/l) in the lower Neuse below Streets Ferry. Low DO is also a problem in some of the major tributaries. Low DO in these areas, which generally occurs in warm weather under low flow conditions, is attributed in large part to biochemical oxygen demanding wastes (BOD) originating primarily from point source discharges, both on the river's mainstem and along its tributaries. BOD is a term referring to organic substances and chemicals, such as ammonia, that use up dissolved oxygen as they decay or react with other substances in the water. The lower Neuse also experiences low DO due to the relatively large inflow of swamp waters that are naturally low in dissolved oxygen.

  To evaluate BOD waste assimilative capacity in the mainstem and the relative impacts of wastewater discharges, a field calibrated computer model was utilized. The model, which applies to a 185 mile reach of the river from Falls Lake Dam to Streets Ferry, indicated that BOD waste loading had been overallocated to many permitted dischargers in the past. The model predicted if all permitted dischargers were to discharge at their full *permitted loadings* of BOD (BOD5 and ammonia), DO violations would be expected in Johnston County (below the Central Johnston WWTP and Swift Creek) and also downstream Kinston.

  #### Recommended NPDES Control Strategies for BOD

  It is clear from analysis of the instream water quality data and the modeling that additional controls on Neuse River BOD loadings from dischargers are required.

The model also indicates that tributary loading of BOD can significantly affect the water quality of the Neuse mainstem and that tributary control strategies will also be needed. Below are recommended point source TMDL control strategies of BOD that are discussed more fully in Chapter 6.

Neuse Mainstem from Falls Dam to Streets Ferry: Advanced tertiary treatment levels (i.e., generally 5 mg/l BOD and 2 mg/l NH3 in summer and 10 mg/l BOD and 4 mg/l NH3 in winter) for municipalities, and an equivalent level of treatment for existing industries, are recommended for facilities discharging to the Neuse mainstem to protect the instream dissolved oxygen standard of 5 mg/l. This recommendation would apply to new and expanding facilities at permit issuance and would be a long-term goal for most dischargers on the mainstem. Wasteloads for nonexpanding dischargers will be handled on a case-by-case basis.

Neuse Tributaries below Falls Lake (not including those tributaries listed below): NPDES allocations will be recommended so as to minimize BOD loading to the mainstem. Where a discharge is close to the mouth of the tributary, the permittee will not be given limits more stringent than for mainstem dischargers unless required to protect water quality standards in the tributary.

Eno River, Knap of Reeds Creek, Ellerbe Creek, Lick Creek, Crabtree Creek (above Lassiter Mill Pond), Swift Creek (below Lake Benson), Middle Creek, and Slocum Creek: Studies indicate that no [1]new discharges should be permitted. Existing discharges should be removed, where feasible. Advanced tertiary treatment will be phased in for those that cannot be removed (this has already been accomplished for several major dischargers in Durham, Cary and Fuquay-Varina).

Neuse River Estuary below Streets Ferry, Contentnea Creek Subbasin, Flat River and Crabtree Creek below Lassiter Mill: Permit strategies are being developed. Water quality problems have been identified but are not fully understood. Wasteloads will be done on a case-by-case basis. A computer model is being developed for the estuary. Tertiary limits are anticipated to be recommended for new and expanding facilities.

Falls Lake, Lake Michie, Orange Reservoir, Wiggins Mill Reservoir, Buckhorn Reservoir and Unnamed Tributaries to the above: Studies indicate that no additional discharges should be permitted in order to protect water quality standards.

Most recently-permitted wastewater treatment plants have already received waste limits consistent with the above recommendations. Scheduling for compliance of these limits for existing nonexpanding discharges will be determined on a case-by-case basis taking into account the type and age of the plant, size of its discharge, current treatment levels, cost feasibility, and significance of water quality impacts.

o Lack of Nutrient Assimilative Capacity in the Neuse Estuary and Major Lakes
Algal blooms resulting from excessive nutrient loading (eutrophication) have occurred regularly in the lower Neuse River between New Bern and Minnesott Beach and in the upper reaches of Falls Lake, and have been observed in several other freshwater lakes throughout the basin, six of which are in the Contentnea Creek subbasin. The nutrients phosphorus and nitrogen, in sufficient quantity and under favorable conditions, can stimulate the occurrence of algal blooms in waters

[1] The term "new" can include previously permitted discharge facilities where no "significant construction" has occurred during the "term of the permit" (15A NCAC 2H .0100)

such as ponds, lakes, and estuaries. The algae, through respiration and decay, deplete the water column of dissolved oxygen resulting in serious water quality problems such as fish kills. Undesirable species of algae are also a leading source of taste and odor problems in drinking water supplies. Studies indicate that municipal wastewater treatment plants and agricultural runoff are the two main sources of nutrients.

Point source nutrient loading has been reduced significantly in the Neuse basin since the state classified it as nutrient sensitive waters (NSW) in 1988 (The Falls Lake watershed portion had been previously classified NSW in 1983). The percentage of total phosphorus (TP) loading attributed to point sources is estimated to have been reduced from 57% in 1986 to 21% in 1990. Total nitrogen (TN) point source loadings have been reduced from 25% to 12%. These reductions were accomplished through implementation of a statewide ban on phosphate detergents and by requiring phosphorus discharge limits at NPDES facilities pursuant to the requirements of the NSW reclassification. For discharges above Falls Lake, all discharges greater than 0.05 million gallons per day (MGD) have been required to meet a total phosphorus limit of no greater than 2.0 mg/l. Most major dischargers have actually been given limits of 0.5 mg/l. For discharges located on the Neuse mainstem or on tributaries to the mainstem downstream of Falls Lake, all existing discharges greater than 0.5 MGD have been required to meet a total phosphorus limit of not greater than 2.0 mg/l by May, 1993. All new or expanding discharges greater than 50,000 gallons per day (0.05 MGD) have been required to meet this limit upon discharge initiation or expansion.

As nutrient loadings from point sources has decreased, the relative significance of nutrient loading from nonpoint sources has increased. While the actual amounts of nonpoint source nutrient loading are difficult to quantify, the relative contributions of nonpoint loading from several major sources in the basin have been estimated in a nutrient study conducted under the Albemarle/Pamlico Estuarine Study program.

Land Cover Type	Phosphorus (%)	Nitrogen (%)
Agriculture	65.5	63.9
Forestry	8.4	14.9
Urban Development	10.3	7.2
Wetlands	1.9	3.3
Atmospheric deposition over open water	12.9	8.9
Other	1.0	1.8

Recommended Control Strategies for Nutrients

The relative contributions of point and nonpoint source nutrient loading combined with the fact that much of the feasible point source phosphorus reduction has already been accomplished suggest the need to actively target nonpoint sources of nutrients for implementation of best management practices. The Contentnea Creek basin, which has six impaired reservoirs and is estimated to contribute 20% of the nonpoint source nutrient loading to the lower Neuse estuary, has been given a high priority for action. NCDEM will work with the appropriate agencies to target sources of agricultural nonpoint pollution for BMP implementation. NCDEM will also be reevaluating its nutrient control strategy for the basin as more information is gained on implementation of agricultural best management practices.

Other Important Issues and Pollution Control Strategies

- Urban and Industrial Stormwater Runoff
  The US Environmental Protection Agency (EPA) is requiring states to implement discharge permit programs for stormwater runoff in urban areas and at industrial sites. North Carolina has taken a leadership role among the states in this effort. Under this program most industrial sites will be covered by general permits. In addition, NPDES discharge permits will eventually be required for stormwater systems in Raleigh and Durham. However, present efforts are focusing on monitoring the waste loading from urban runoff, determining its impacts and developing appropriate management strategies. The program is intended to reduce water quality and flow impacts from urban stormwater in both existing and proposed development areas within the extra-territorial jurisdictions of the affected cities.

- Animal Wastes from Intensive Livestock Operations
  On December 10, 1992, the Environmental Management Commission approved a modification to a rule (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 wastes are not discharged to waters of the state. This means that if criteria are met and no wastes are discharged to surface waters, then an individual permit from NCDEM is not required. The rule applies to new, expanded 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 waste management plan certification are submitted to DEM by the appropriate deadlines.

- Shellfish Water Closures
  Commercial shellfish harvesting occurs throughout the lower Neuse estuary and Pamlico Sound in waters classified SA. Fecal coliform bacteria levels in shellfish waters must be maintained at extremely low levels in order for harvesting to be allowed (14 MF/100 ml). By contrast, the fecal coliform standard for outdoor bathing waters (SB) is 200 MF/100 ml. Shellfish waters are closed for commercial harvesting if the fecal coliform limit is exceeded in order to protect consumers from potential health risks. Sources of fecal coliform problems are often difficult to identify and may include leaking septic tanks, urban runoff, improperly treated wastewater, farm animal runoff or congregations of waterfowl in shellfish areas. Discharge permits are not issued where there is a risk of closure to shellfish waters.

- Metals
  In general, there do not appear to be widespread water quality problems with elevated metals concentrations in the Neuse Basin although metals concentrations have been found on occasion to be above "action level" limits. Independent research through the Albemarle Pamlico Estuarine Study program has identified a number of locations in the lower Neuse where bottom sediments have been found to have elevated levels of metals, especially in Slocum Creek near Cherry Point. Fish tissue analyses conducted by NCDEM in Slocum Creek and other areas have not revealed any significant bioaccumulation and water quality violations have not been found. Monitoring in these areas will continue. Also, throughout the basin, metals discharges from wastewater treatment plants will continue to be closely monitored and controlled. Whole effluent toxicity testing of the treated effluent and continued strengthening of pretreatment programs will be important in this effort.

o Reclassification of Waters to Protect Special Uses

- Water Supply Watershed Protection (HB 156) - Water supply watersheds have recently been reclassified by the EMC into one of five "WS" classifications. Each classification is accompanied by water quality standards and protection provisions. Water quality information generated for preparation of the Neuse basinwide plan was used to help determine the most appropriate WS classification for a given watershed, but the WS classification process takes precedence over and guides the management strategies set forth in this document for water supply protection.
- High Quality (HQW) and Outstanding Resource Waters (ORW) - Several stream segments and estuarine areas are identified in the plan as having excellent water quality and are suggested for further consideration for reclassification to ORW or HQW. These include portions of Deep Creek and a portion of the Flat River above Falls Lake (subbasin 01), and West Thorofare Bay (Subbasin 14).
- Critical Habitat for Rare, Threatened and Endangered Species - Areas formally designated by the North Carolina Wildlife Resources Commission as critical habitat will be considered for reclassification to High Quality Waters by the Environmental Management Commission (EMC). Consideration will also be given to protection of federally and state listed rare, threatened and endangered species through NPDES permit reviews.

o Noncompliance, Enforcement and Treatment Plant Operator Training
NCDEM is aggressively improving permit compliance through such methods as better screening of effluent violations, streamlining enforcement actions and imposing automatic penalties. At the same time, NCDEM's training and certification program for wastewater treatment plant operators is being expanded and improved in order to reduce problems associated with operator errors and to improve plant operations and efficiency.

Attainability of the goals and objectives for the Neuse Basin Plan will require determined, widespread public support along with the combined cooperation of state, local and federal agencies, and agriculture, forestry, industry, and development interests. However, with the needed support and cooperation, NCDEM believes that success can be obtained through the basinwide management approach.

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF THE NEUSE BASIN MANAGEMENT PLAN

The Water Quality Section of the North Carolina Division of Environmental Management (NCDEM) has recently initiated a basinwide approach to water quality management. The Neuse River Basinwide Management Plan is the first of a series of basinwide plans that will be prepared by NCDEM for all seventeen of the state's major river basins over the next five years. Table 1.1 denotes when discharge permit issuance commences in each basin. Completion of the final basinwide plans will be targeted for six months prior to these dates. The preparation of basinwide plans is discussed in more detail in Section 1.3

Table 1.1. Basinwide Permitting Schedule for North Carolina's 17 Major River Basins

Month/Year	Basin	Month/Year	Basin
April 1993	Neuse	**January 1997**	Roanoke
		June 1997	White Oak
November 1994	Lumber	**August 1997**	Savannah
		September 1997	Watauga
January 1995	Tar Pamlico	**October 1997**	Little Tennessee
April 1995	Catawba	**December 1997**	Hiwassee
August 1995	French Broad		
November 1995	New	**January 1998**	Chowan
		January 1998	Pasquotank
January 1996	Cape Fear	**April 1998**	Neuse (2nd cycle)
		July 1998	Yadkin
		November 1998	Broad

The purpose of this plan is to report to citizens, policy makers and the regulated community on the current status of surface waters in the basin, identify major water quality concerns and issues, summarize projected trends in development and water quality, identify the long-range water quality goals for the basin, present recommended management options, and discuss implementation plans. The plan will present potential changes in discharger waste limits and will include recommendations for reductions in nonpoint source loadings. Section 1.2 provides an overview of the plan format to assist in use and understanding of the document.

1.2 GUIDE TO USE OF THIS DOCUMENT

The Neuse Basinwide Management Plan condenses and summarizes the status of water quality in the Neuse basin, identifies problem areas and sets forth management strategies for correcting both immediate and potential long-term problems. The Plan is divided into seven chapters, each of which is summarized below.

<u>CHAPTER 1: Introduction</u> - 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 through NCDEM's Water Quality Section. This chapter 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 - Physical features, population concentrations, land cover and water uses in the Neuse River basin are briefly summarized in three sections. Section 2.0 provides an overview of the physical and geographic features of the Neuse basin as they relate to surface water quality and use. It includes such information as the location and boundaries of the Neuse basin and its major subbasins, physiographic information, and general drainage basin statistics (stream miles, acres of lakes, estuaries and wetlands). Section 2.1 offers a summary of land cover patterns and population and development trends within the basin and its 14 subbasins. The information is presented through a series of maps and tables. Section 2.2 discusses major water uses in the basin and introduces NCDEM's program of water quality classifications and standards.

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

CHAPTER 4: Water Quality Status in the Neuse Basin - Data generated by NCDEM on water quality and biological communities are reviewed (section 4.1) and interpreted to assess current conditions and the status of surface waters within the Neuse basin (sections 4.2 and 4.3). This information is then used to generate a summary of use support ratings for those surface waters that have been monitored or evaluated (sections 4.4 and 4.5).

CHAPTER 5: Existing Point and Nonpoint Source Pollution Control Programs - Chapter 5 summarizes the management tools and strategies available for addressing the priority concerns and issues identified in Chapter 6. It also introduces the concept of Total Maximum Daily Loads (TMDLs).

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 factors such as their severity and the sensitivity or importance of affected waters and biological resources. 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 Neuse basin. This includes generalized wasteload allocations for dischargers (for BOD and nutrients) and recommended programs and best management practices for nonpoint sources. This chapter also presents the results of analyzing water quality impacts from point source discharges using predictive computer modeling and assesses, where possible, the availability of waste assimilative capacity of the Neuse mainstem and its major tributaries.

CHAPTER 7: Implementation, Enforcement and Monitoring Plans - This chapter outlines plans for the Neuse basinwide management program implementation and enforcement as well as future ambient and effluent monitoring. Implementation and enforcement activities are described separately for point and nonpoint sources. For point sources, specific procedures, and the associated rationale, will be defined for assessing compliance with and for enforcement of NPDES permit limits.

1.3 INTRODUCTION TO THE BASINWIDE MANAGEMENT APPROACH

Overview - NCDEM began formulating the idea of basinwide management in the late 1980s, started rescheduling its permitting and monitoring activities in 1990 and published a basinwide program description in August 1991. Basinwide management entails coordinating and integrating, by major river basin, NCDEM's multiple 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 and aquatic resources are assessed simultaneously throughout an entire river basin leading to the development of a basinwide water quality management plan.

Benefits - Several benefits of basinwide planning and management include: (1) *improved 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, in turn will promote a *more equitable* distribution of assimilative capacity, explicitly addressing the trade-offs among pollutant sources (point and nonpoint) and allowances for future growth.

Basinwide management will also facilitate the integration of point and nonpoint source pollution assessment and controls Once waste loadings from both point and nonpoint sources are established, management strategies can be developed to prevent overloading of the receiving waters and to allow for a reasonable margin of safety to ensure compliance with the state's water quality standards.

Preparation, Review and Public Involvement - Preparation of a basinwide plan is a five year process. Major steps in the process are outlined and described briefly below:

Year	**Activity**
1 - 3	Water quality data collection: Biomonitoring, fish community and tissue analyses, special studies and other water quality sampling activities are conducted by the Environmental Sciences Branch (ESB) to provide information for assessing water quality status and trends throughout the basin and to provide data for computer modeling. Information is also requested from other agencies.
1 - 4	Data assessment and model preparation: Water quality data are assessed and used by the Technical Support Branch (TSB) to prepare models for estimating potential impacts of waste loading from point and nonpoint sources using the TMDL approach. Problem areas are identified and water quality control strategies are in early stages of development. Coordination begins with local governments, the regulated community and citizens groups toward the end of this period.
4	Preparation of draft basinwide plan: During the course of year four, the draft plan is prepared by the Planning Branch. Portions of the document are prepared by ESB and TSB and edited by the Basinwide Coordinator. Preliminary findings are presented at meetings, and comments are incorporated into the draft document.
5	Public review and approval of plan: The draft plan, with approval of the 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.

This process is discussed in more detail in the basinwide program description document (Creager and Baker, 1991). Public comment is welcome at any time during the process.

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 Pollution Discharge Elimination System (NPDES) permit renewals within a basin will occur within a prescribed time period after completion of the final basin plan, and will be repeated at five year intervals. The NPDES permit renewal schedule drives the schedule for developing and updating the basinwide management plans.

In large basin, permits are to be issued by subbasin. Permitting in the Neuse basin begins in April 1993 and ends in April, 1994 (Table 1.2).

TABLE 1.2. Subbasin NPDES Permit Schedule for Neuse Basin

Subbasin No.	Month/Year	Subbasin No.	Month/Year
03-04-01	April, 1993	**03-04-08**	March, 1994
03-04-02	May, 1993	**03-04-09**	March, 1994
03-04-03	January, 1994	**03-04-10**	March, 1994
03-04-04	January, 1994	**03-04-11**	April, 1994
03-04-05	January, 1994	**03-04-12**	January, 1994
03-04-06	February, 1994	**03-04-13**	April, 1994
03-04-07	February, 1994	**03-04-14**	April, 1994

Plans to be updated every five years - The earliest basin plans particularly the Neuse, may 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.

1.4 BASINWIDE RESPONSIBILITIES WITHIN THE NCDEM 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 five sections located within the Division of Environmental Management. The other sections are Groundwater, Air Quality, Construction 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 1.1). The major areas of responsibility are water quality monitoring, permitting, planning, and modeling (wasteload allocations).

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 *Classifications and Stormwater Unit* handles surface water reclassifications, development of water quality standards, implementation of the water supply watershed program and development of the stormwater runoff program. The *Program Planning Unit* administers the nonpoint source and basinwide management programs, handles the 401 wetlands certification program, and coordinates EPA grants, state environmental policy act responsibilities and development of water quality rules and regulations.

The Operations Branch is responsible for permit processing as well as enforcement and compliance of the permits. The *Permits and Engineering Unit* handles reviews and processing of permit applications for both discharging and nondischarging wastewater treatment systems. The *Facility Assessment Unit* is responsible for permit enforcement, emergency response, operator training and certification, and facility classifications and ratings.

The Technical Support Branch administers the pretreatment program and TMDL/wasteload allocation program. The *Instream Assessment Unit* provides primary computer modeling support and is responsible for coordinating development of TMDLs and individual NPDES wasteload allocations. The *Pretreatment Unit* handles the administration, development, implementation and enforcement of the pretreatment program.

The Environmental Sciences Branch is responsible for water quality monitoring, toxicity testing and biological laboratory certifications. The branch is divided into the Ecosystems Analysis Unit and the Aquatic Toxicology Unit. Some of the major functions of the *Ecosystems Analysis Unit* include biological and chemical water quality monitoring and evaluation; evaluating reclassification requests; algal analyses; lakes assessments; fish tissue and fish communities studies; benthic macroinvertebrate community structure (biomonitoring); and special water quality studies including time of travel and biochemical and sediment oxygen demand. Major functions of the *Aquatic Toxicology Unit* include effluent toxicity testing, chemical toxicity evaluations, toxicity reduction evaluations (TRE), biological lab certification, biocide evaluations and related special studies.

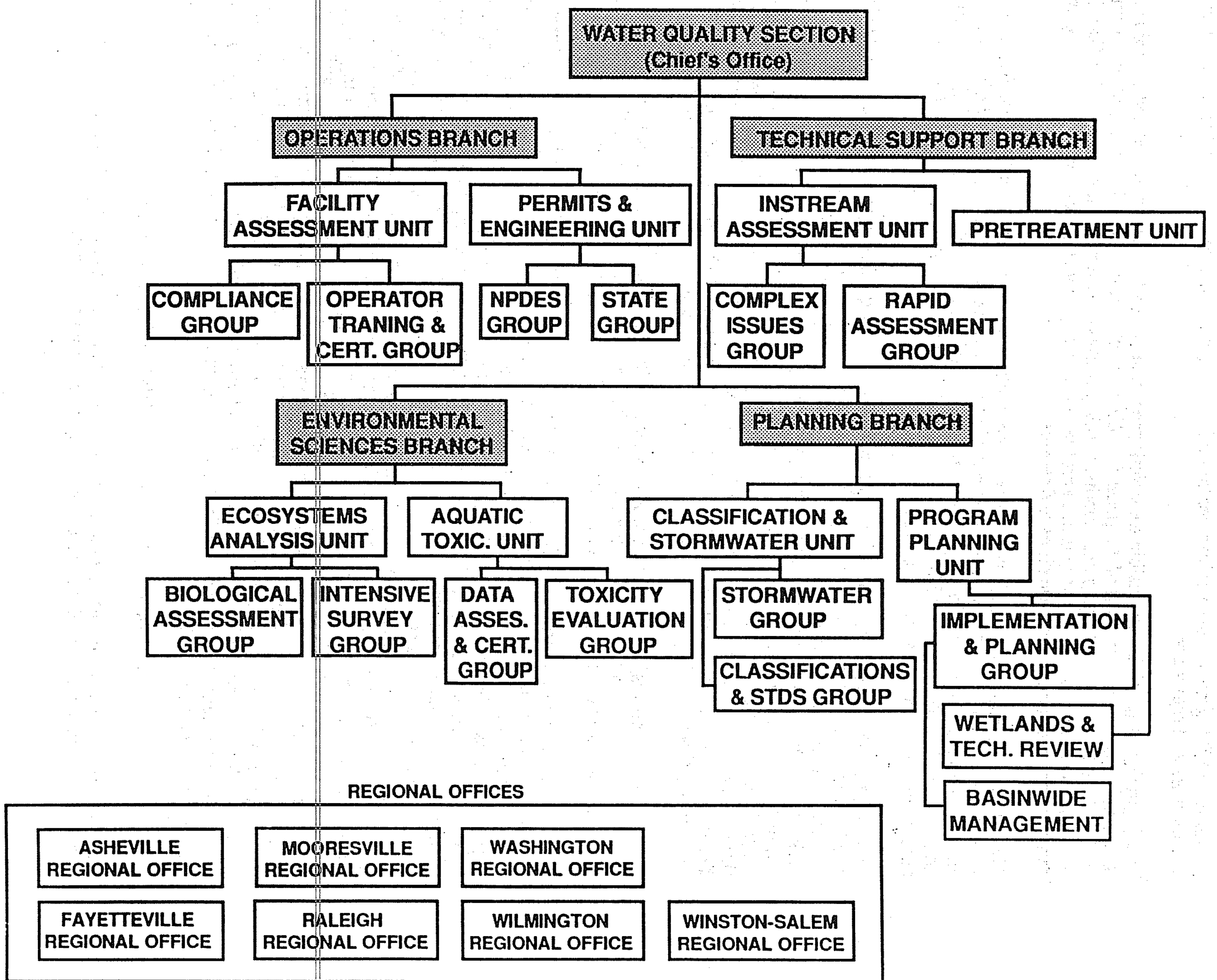
Staff in the seven regional offices conduct waste facility inspections; respond to water quality emergencies such as oil spills and fish kills; assist the Environmental Sciences Branch by collecting water quality data; enforce permits and carry out other field-related responsibilities.

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 increase 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 data base 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 5.2) into the Water Quality Section's management objectives will require model projections of various potential future scenarios to properly 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 Legislative Authorities for the NC'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.

Figure 1.1. Organizational Structure of the NCDEM Water Quality Section



Federal Authorites - The major federal authorities for the state's water quality program are found in various sections of the Clean Water Act (CWA).

- **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 Pollution 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 unless permitted by the US Army Corps of Engineers. Section 401 requires the Corps to receive a state Water Quality Certification prior to issuance of a 404 permit.

State Authorities - The following authorities are derived from North Carolina state statutes.

- **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. 143-215.6** - Outlines 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.
- **G.S. 143-215.75** - Outlines the state's Oil Pollution and Hazardous Substances Control Program.

REFERENCES CITED: CHAPTER 1

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

CHAPTER 2
GENERAL BASIN DESCRIPTION

2.1 PHYSICAL AND GEOGRAPHIC FEATURES

The Neuse River basin, encompassing 6192 square miles in 19 different counties, is the third largest river basin in North Carolina and is one of only three major river basins whose boundaries are located entirely within the state (figure 2.1). There are 3,293 miles of freshwater streams in the basin, 328,700 acres classified as salt waters and thousands of acres of impoundments. It is subdivided into 14 subbasins represented on the map by six digit subbasin codes (03-04-01 through 03-04-14). Throughout the document the individual subbasins will often be referred to by the last two numbers in their respective six digit codes (i.e., 03-04-01 equals subbasin 01).

The Neuse River basin originates in north central North Carolina in Person and Orange Counties. The upper 22 miles of the river's mainstem is impounded behind Falls Lake dam, a large multi-use reservoir constructed by the Corps of Engineers which is located a few miles northeast of Raleigh. The major tributaries to Falls Lake are the Flat and Eno Rivers. Once past the dam, the Neuse flows about 185 miles southeasterly past the cities of Smithfield, Goldsboro, and Kinston until it reaches tidal waters near Streets Ferry upstream of New Bern. Major tributaries of the Neuse include Crabtree Creek, Swift Creek, Little River (Wake/Johnston/Wayne Counties), Contentnea Creek and the Trent River. Below Street's Ferry the river broadens dramatically and changes from a free-flowing river to a tidal estuary that eventually flows into Pamlico Sound.

The upper third of the Neuse basin, or that area generally west of Interstate 95 (I-95) and upstream of Smithfield (subbasins 01, 02 and parts of 03 and 04), is located in the Piedmont physiographic region (Figure 2.2). That portion of the basin to the east of I-95 is located in the Coastal Plain region.

The Piedmont is typified by highly-erodible clay soils; rolling topography with broad ridges and sharply indented stream valleys; and low gradient streams composed of a series of sluggish pools separated by riffles and occasional small rapids. Stream floodplains are relatively narrow and mostly forested. There are no natural lakes in the region. Soils in the region are underlain by a fractured rock formation with limited water storage capacity which offers only a limited supply of groundwater.

The Piedmont portion of the basin, encompassing much of the Raleigh-Durham area, is the most populated and industrialized and has the highest concentration of waste dischargers. Water needs are provided primarily by man-made surface water impoundments owing to the relatively low availability of groundwater associated with the underlying rock formations. In addition to providing a water supply source, many of these impoundments, such as Falls Lake, Lake Wheeler and Lake Crabtree, offer other important uses such as recreation, flood control and fish and wildlife habitat. There are also numerous millponds that were once used as an important energy source for early industrial facilities in this region. Despite the increasingly urban nature of the region, agricultural activity remains widespread, and forests occupy over one third of the land area.

The Coastal Plain, by contrast to the Piedmont, is characterized by flat terrain, "blackwater streams", low-lying swamplands and productive estuarine areas. Streams, including the mainstem of the Neuse, are much more meandering, slower-moving, have lower banks, and are often lined by extensive swamps, bottomland hardwood forests, or marshes. This is particularly true in the lower half of this region sometimes referred to as the outer Coastal Plain. Streams flowing through swampland areas are naturally discolored by tannic acid from decomposing plant material

Figure 2.1 Generalized Map of the Neuse River Basin

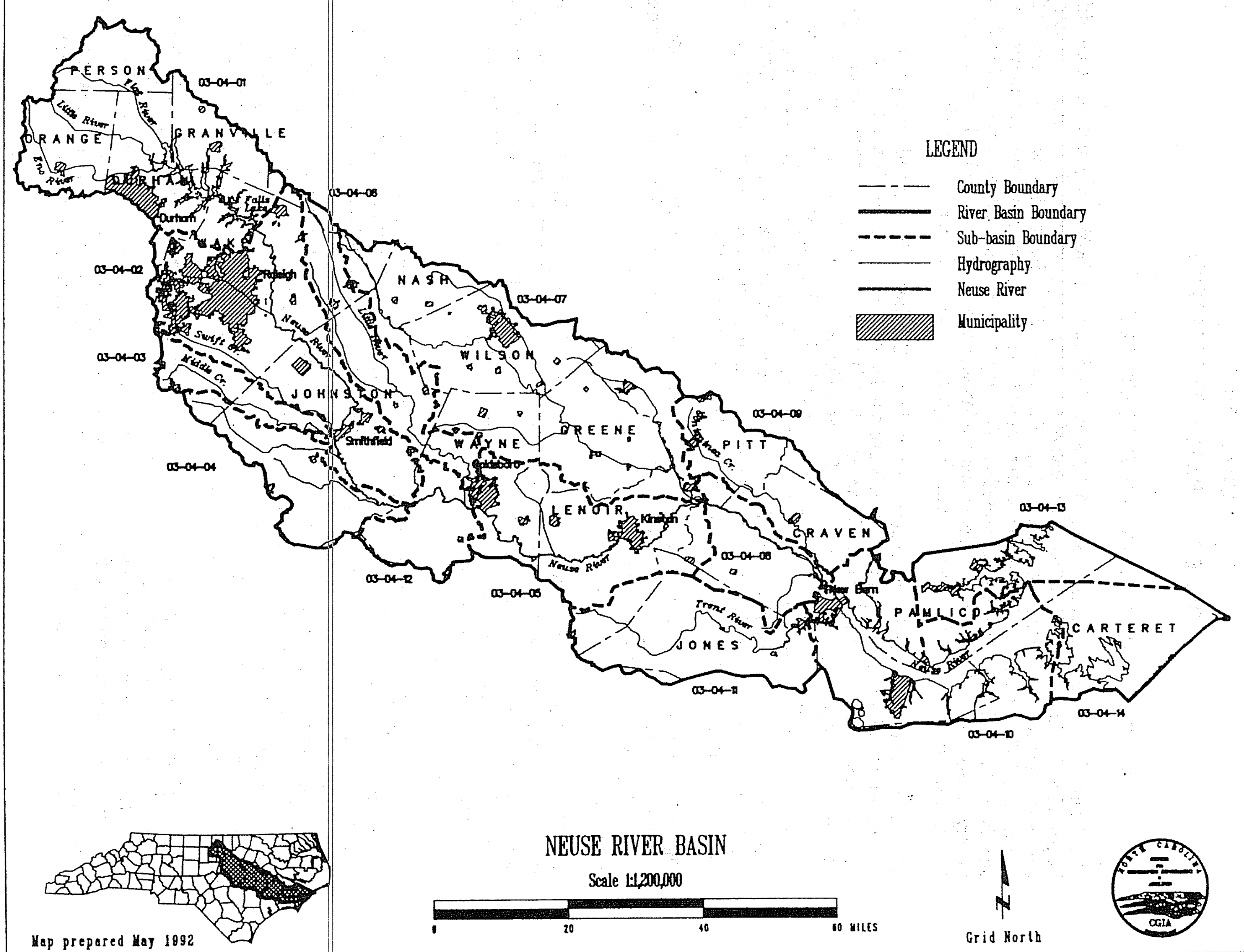
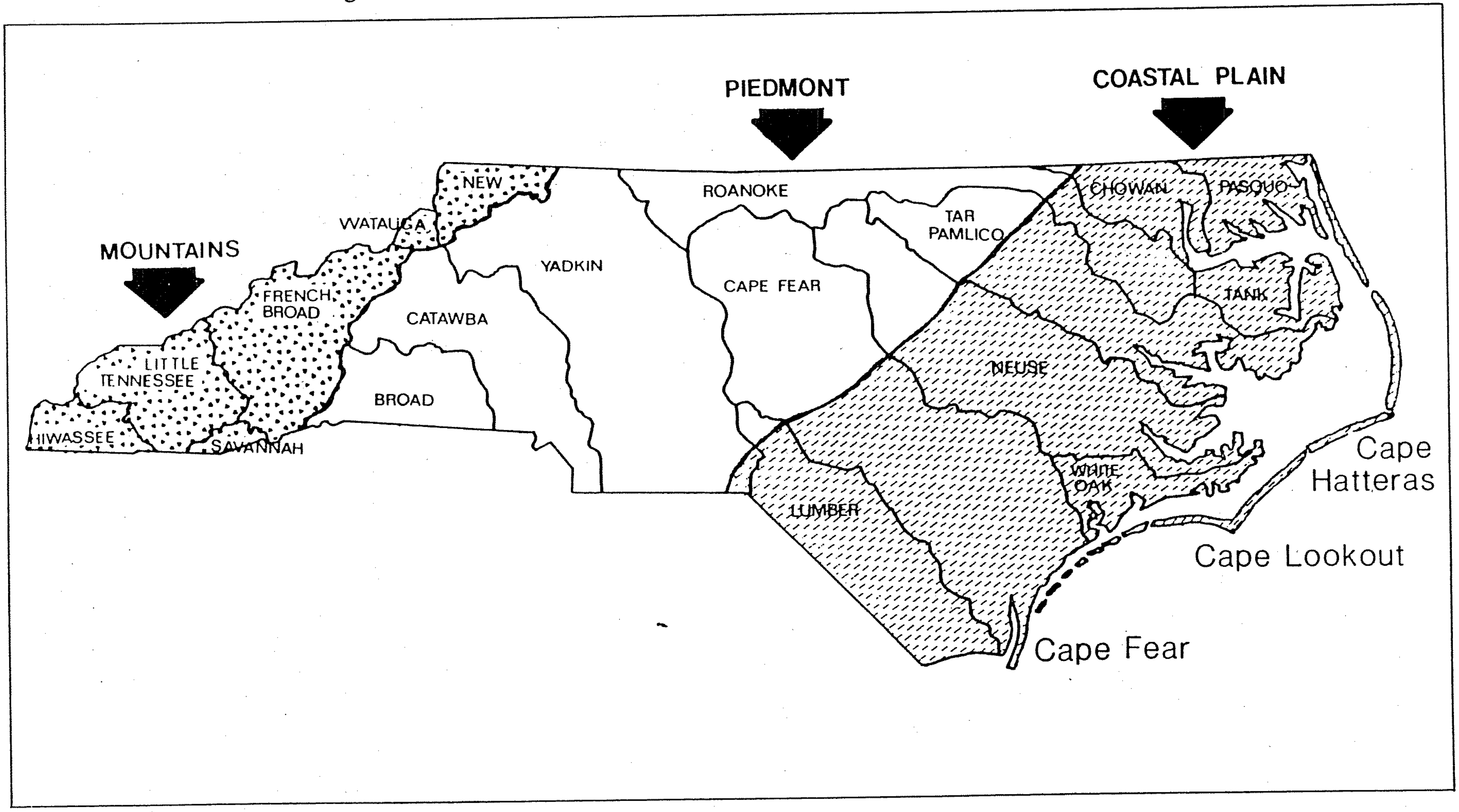


Figure 2.2 River Basins and Physiographic Regions of North Carolina



and become tea-colored, hence the name "blackwater". The Coastal Plain is underlain by deep sands and groundwater is more abundant. In light of the increased abundance of groundwater, permeable soils, and flat terrain, there are few surface water impoundments.

Forestry and agriculture are the primary land use activities in the Coastal Plain. Agriculture tends to be more concentrated in the upper half of this region above New Bern. Urban areas are relatively small and clustered around the cities of Smithfield, Wilson, Goldsboro, Kinston and New Bern. The open waters of the Neuse estuary are used heavily for recreational boating and fishing, as well as commercial fishing and shellfish harvesting. Land and water uses throughout the basin are discussed in more detail in the following section.

2.2 LAND USE, POPULATION AND GROWTH TRENDS

2.2.1 General Land Cover/Land Use Patterns

Figures 2.3 and 2.4 provide an overview of the acreage and percent cover of eight land cover types in the Neuse basin (shown below). This information, derived from Table 2.1, is based on interpretation of 1987 Landsat satellite data that was made available through the North Carolina Center for Geographic Information and Analysis (CGIA) and Research Triangle Institute. The eight land cover types presented in this section are a composite of 20 land cover categories available through CGIA.

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.

Land cover, as shown in Figure 2.3 is dominated by agriculture (34.7%) and forests (33.9%) which jointly comprise roughly two thirds of the land/water surface area in the entire basin. Wetlands (11.8%) and open water (10.4%) comprise about one fifth of the total area. Urban development (5.1%) makes up about one twentieth. The remaining 4% is composed of scrub growth (3.9%), barren land and shadow. It should be noted that the area determined to be urban is most likely very conservative and could be up to 50 percent higher (Holman, pers. comm.) than indicated . This is because residential developments with tree cover were often interpreted as forest from the satellite imagery. Conversely, this would also mean that forested areas might be slightly less than indicated, particularly in subbasin 01 and 02. In addition, the land area attributed to agriculture also includes such open areas as golf courses, beach grasses, wide transportation corridors (e.g. interstate highways), large athletic fields and other grassy features. Land cover distribution for each category is discussed briefly below.

AGRICULTURE - The percent of land cover in agriculture is highest in the central portion of the basin (generally coinciding with the lower Piedmont and upper Coastal Plain regions). Factors limiting the extent of agriculture elsewhere in the basin include competition with urban development and difficult slopes/soils in the upper basin and unsuitable soils (wetlands) in the lower basin. Those subbasins having at least 50% of their area in agriculture include 07 (56% -

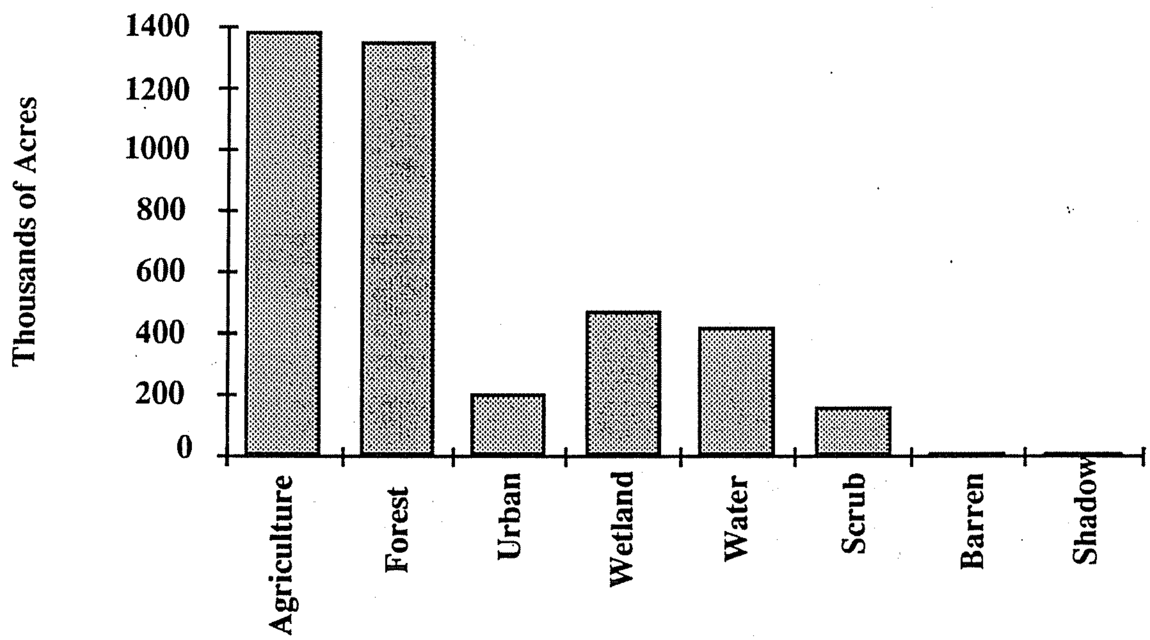


Figure 2.3 Land Cover in the Neuse Basin by Acreage

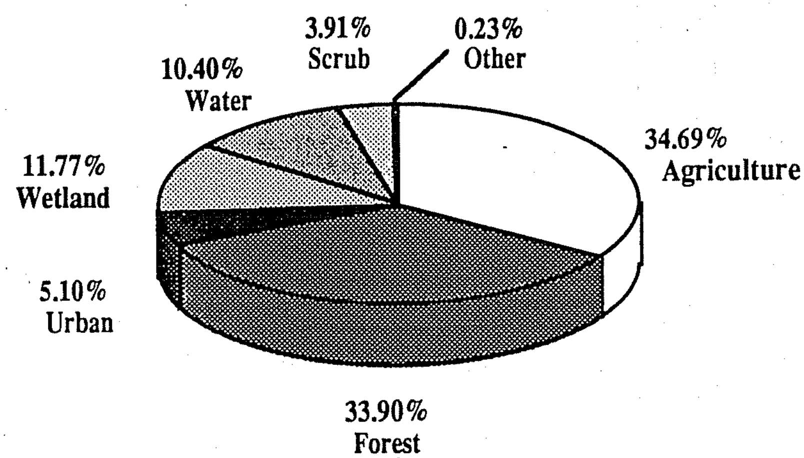


Figure 2.4 Land Cover in the Neuse Basin by Percent Cover

Table 2.1 Land Cover in the Neuse Basin by Acreage and Percent Cover

SUBBASIN	Agriculture (acres)	Forest (acres)	Urban (acres)	Wetland (acres)	Water (acres)	Scrub (acres)	Barren (acres)	Shadow (acres)	TOTAL ACRES	TOTAL PERCENT
03 04 01	127,228	216,936	62,144	50,826	11,243	24,300		1,186	493,864	12.4%
03 04 02	160,450	176,906	80,446	33,038	3,200	9,664		775	464,479	11.7%
03 04 03	40,366	24,694	11,654	5,240	369	1,653		108	84,085	2.1%
03 04 04	99,332	49,377	13,289	11,871	949	2,422		329	177,568	4.5%
03 04 05	171,436	119,724	2,389	12,891	1,849	10,528		261	319,076	8.0%
03 04 06	107,500	75,300	7,854	7,685	660	3,518		246	202,764	5.1%
03 04 07	363,968	241,370	2,958	22,072	2,511	11,420		439	644,738	16.2%
03 04 08	48,583	58,210	2,544	26,125	1,829	10,017	499	264	148,070	3.7%
03 04 09	76,302	100,119	435	26,287	169	9,546		87	212,945	5.4%
03 04 10	45,704	132,495	7,759	113,380	121,173	27,462	433	898	449,303	11.3%
03 04 11	68,812	93,510	5,729	81,645	579	35,059	272	1,549	287,154	7.2%
03 04 12	48,570	38,695	931	3,522	2,038	1,746		316	95,817	2.4%
03 04 13	15,918	13,910	3,646	43,470	93,292	6,413	350	37	177,036	4.5%
03 04 14	3,879	5,084	690	29,418	173,236	1,497	997	328	215,129	5.4%
TOTAL ACRES	1,378,048	1,346,330	202,467	467,469	413,097	155,246	2,550	6,822	3,972,029	
PERCENTAGES	34.7%	33.9%	5.1%	11.8%	10.4%	3.9%	0.1%	0.2%		100.0%

363,968 acres), 04 (56% - 99,332 acres), 05 (53.7% - 171,436 acres), 06 (53% - 107,500 acres) and 12 (50.6% - 48,570 acres). Interestingly, subbasins 02 and 01 which had the highest urban area acreages were in third and fourth respectively in the acreages of agricultural land cover (02 - 160,450 acres; 01 - 127,228 acres, respectively) although the percentage of land in agriculture in these subbasins was less than in the central basin area (02 - 34.5%; 01 - 25.8%).

FOREST - Three subbasins have over 40% of their surface area in forest cover: subbasins 09 (47% - 100,119 acres), 01 (44% - 216,936 acres) and 12 (40.4% - 38,695). As noted earlier, a portion of the land identified as forest, primarily in subbasins 01 and 02, may actually be urban.

URBAN - This category is made of lands that are more than 25% paved. It is composed of developed areas such residential subdivisions, office complexes, shopping centers, industrial parks, college campuses, and commercial development . Subbasin 02, which includes Raleigh, Cary, Clayton and Smithfield-Selma, has the largest acreage (80,446 acres) and largest percentage (17.3%) of area categorized as urban. Subbasin 01, which includes the northeastern half of Durham and Hillsborough, has the second highest acreage of urban (62,144 acres) and the third highest percentage categorized as urban (12.6%). Subbasins 04, 03 and 06 have the third, fourth and fifth highest acreages (04 - 13,289 acres; 03 - 11,654 acres; and 06 - 7,854 acres, respectively) classified as urban. Taken as a group, these five basins which encompass the upper 36% of the basin (roughly coinciding with the Piedmont region discussed in the previous section) contain 86% of the basin's total urban area.

WETLANDS - The largest areas of wetlands are located in the lower reaches of the basin. Subbasin 10, which encompasses both sides of the lower Neuse estuary from Streets Ferry to Pamlico Sound, contains 113,380 acres of wetlands (25.2% of its surface area). Subbasin 11, the Trent River area, contains 81,645 acres of wetlands (or 28% of its surface area). Subbasin 01, which includes Durham and Falls Lake, has the third highest wetlands acreage with 50,826 acres (10.2% of area). Wetlands in the upper basin are primarily bottomland hardwoods concentrated in floodplains around Falls Lake and its major tributaries. Extensive riverine swamp wetlands found along the Neuse mainstem occur between Smithfield and Goldsboro and between Kinston and New Bern.

WATER - The largest expanses of open water are located in the three subbasins encompassing the Neuse estuary and portions of Pamlico Sound (subbasins 10, 13 and 14). 93.8% (387,701 acres) of the total open water area in the Neuse basin is found in these three subbasins. Subbasin 01, which includes Falls Lake, has the fourth largest acreage of open water with 11,243 acres.

SCRUB - These are lands with low density vegetation that do not fall within the forested, wetland or agricultural land cover types. Typically they are disturbed or cleared areas that have been allowed to revegetate to some extent. The largest areas in category are located subbasins 11 (35,359 acres), 10 (27,462 acres) and 01 (24,300). Those scrub areas in 11 and 10 are likely associated with timber harvests or fallow agricultural land.

2.2.2 Population and Growth Trends in the Basin

The Neuse River basin, with an estimated population of 1,016,000, encompasses roughly one sixth of the state's total population. Most of the population is concentrated in the upper basin (Figure 2.5). However, the population *growth rate* of the lower Neuse in the vicinity of New Bern and Havelock, as revealed in Figure 2.6, has rivaled that of the upper basin based on comparison of census data over the 20-year period from 1970 to 1990. Figures 2.5 and 2.6, which are discussed in more detail below, are based on information contained in Table 2.2. This table 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.

Figure 2.5 1990 Population Density by Census Tract

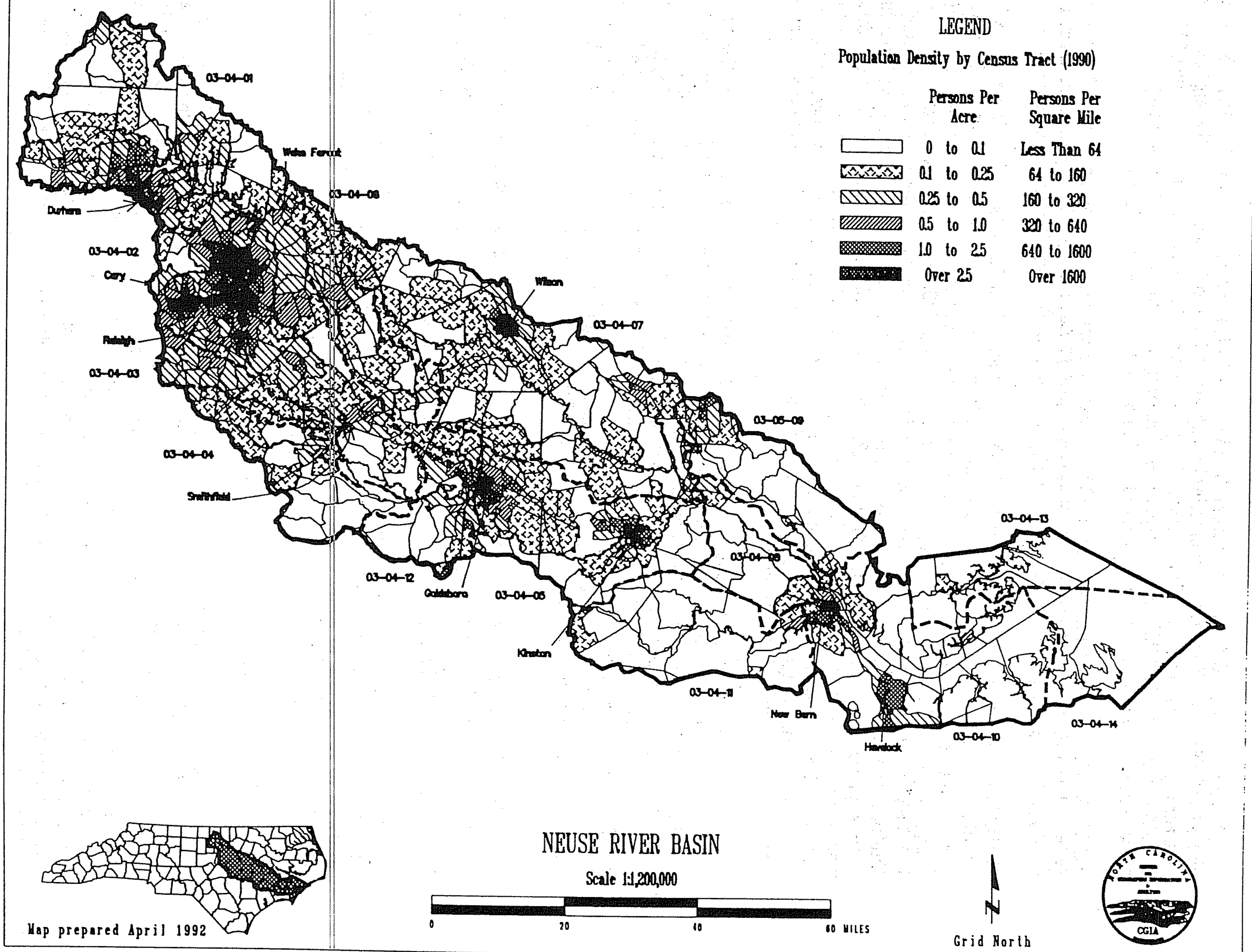


Figure 2.6 Percent Population Growth by Subbasin Between 1970 and 1990

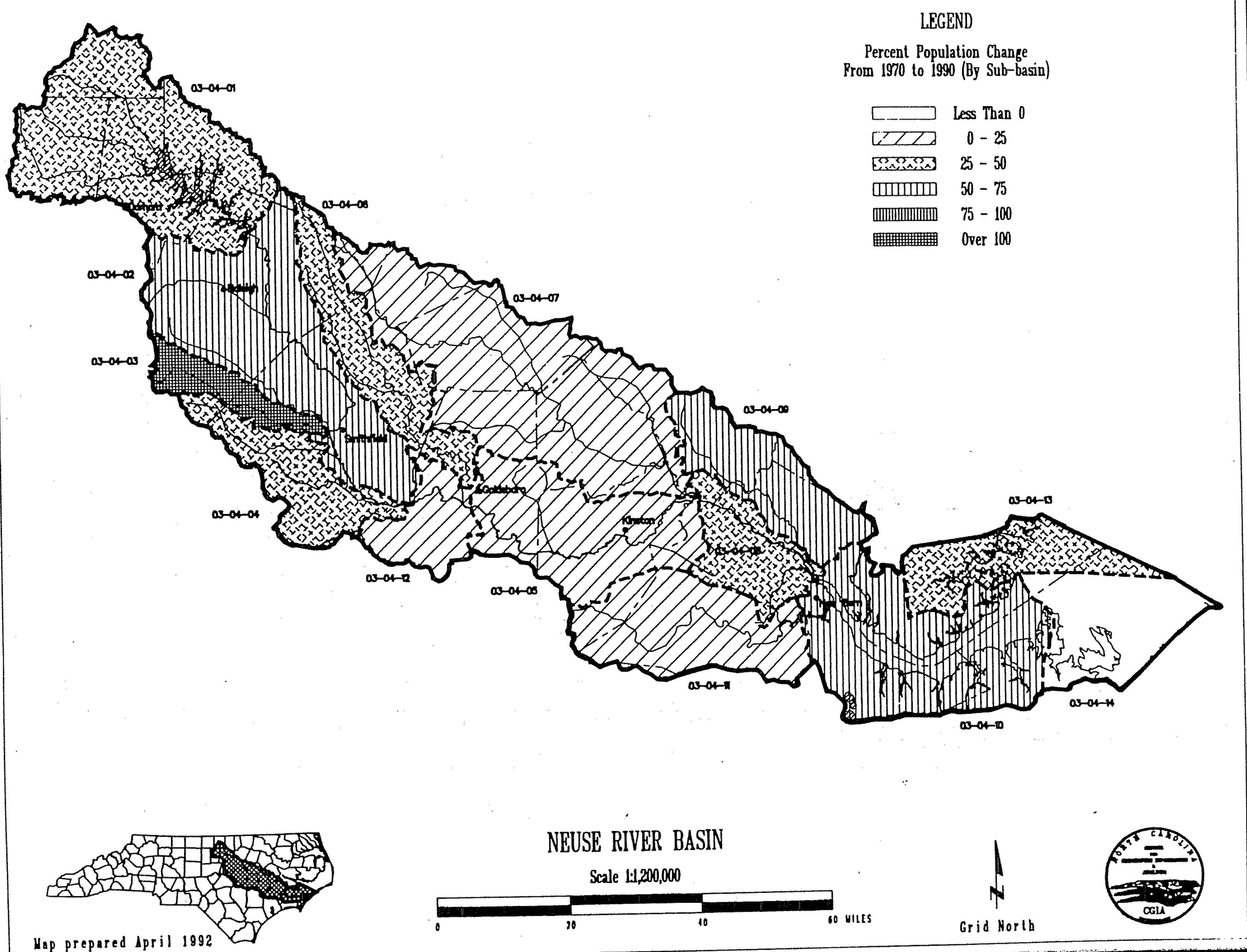


Table 2.2 Neuse Subbasin Population (1970, 1980 and 1990) and Land Area Summaries

SUBBASIN	POPULATION (No. Of Persons)			POPULATION DENSITY (Persons/Sq. Mile)			LAND AND WATER AREAS			
							Total Land and Water Area		Water Area	Land Area
	1970	1980	1990	1970	1980	1990	(Acres)	(Sq. Miles)	(Sq. Miles)	(Sq. Miles)
03-04-01	116,323	134,700	163,228	157	182	221	493,868	772	32	739
03-04-02	226,555	291,284	390,804	313	402	539	464,479	726	1	724
03-04-03	10,017	12,023	23,461	76	92	179	84,085	131	0	131
03-04-04	16,093	17,937	20,974	58	65	76	177,568	278	0	277
03-04-05	85,772	100,279	101,418	173	202	205	319,046	499	3	496
03-04-06	27,337	34,218	40,906	86	108	129	202,767	317	0	317
03-04-07	102,787	110,422	115,397	102	110	115	644,756	1,007	0	1,007
03-04-08	8,793	9,147	11,620	39	40	51	148,071	231	3	229
03-04-09	17,646	21,581	29,073	53	65	87	212,949	333	0	333
03-04-10	38,818	58,596	67,708	75	113	131	449,306	702	183	519
03-04-11	12,357	14,152	14,466	28	32	33	283,763	443	1	443
03-04-12	29,446	25,323	31,126	161	138	170	117,269	183	0	183
03-04-13	3,446	4,647	4,521	24	32	31	177,034	277	132	145
03-04-14	1,128	1,357	809	19	23	14	215,130	336	277	59
TOTALS	696,518	835,666	1,015,511	97	115	141	3,990,091	6,234	633	5,602

In presenting these data, it is important to point out that some of the population figures are estimates because the census tract boundaries do not, specifically, 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 tract 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 census tract area located in the subbasin and then taking that same percentage of the total census tract population and assigning it the subbasin. Use of this method necessitates assuming that population density is evenly distributed throughout a census tract, which is not always the case. The chance of error associated with this method, however, is not expected to be significant for the purposes of this document. It is also important to note that the census tracts change each ten years so comparisons between years must be considered approximate.

Figure 2.5 shows population densities by census tract based on 1990 census data. The population density categories are based on persons/acre. An average family unit size is close to 2.5 persons. Therefore, a density of 2.5 persons/acre (1600 persons/square mile) is very roughly equivalent to one house per acre. The lowest density category of less than 0.1 persons/acre is equivalent to less than 64 persons/square mile. Subbasin 02, encompassing Raleigh, Cary, Clayton and Smithfield is by far the most densely populated with 539.4 persons per square mile. On a per acre basis, this density rate translates into a little less than one person per acre (0.84 person/acre) over the entire subbasin. The next highest basins, having a population density of greater than 200 persons per square mile, are 01 (Durham and Hillsborough - 220.8 persons/square mile) and 05 (Kinston and most of Goldsboro - 204.7 persons/square mile). The lowest population densities are found in subbasins 14, 13 and 11 with respective densities of 13.7, 31.2 and 32.7 persons/square mile.

Figure 2.6, which displays twenty-year growth trends (1970 to 1990) for each subbasin, reveals two major growth areas. Subbasin 03, in the upper Neuse basin, leads all subbasins with a 123% 20-year growth rate. This subbasin encompasses the rapidly developing Middle Creek watershed south of Raleigh, Cary and Garner in south central Wake County and northwest Johnston County. In the upper basin, it is followed by subbasins 02 (72.5% - Crabtree Creek and upper Neuse River in Raleigh, Cary, Garner, Smithfield area), 06 (49.6% - Little River in Zebulon and Wendell area) and 01 (40.3% - Eno, Little and Flat Rivers and Falls Lake in Durham and Hillsborough area).

The other major growth area in the basin is in the lower Neuse in subbasins 10 (74.4% growth rate) and 09 (64.7% growth rate). Subbasin 10 encompasses Neuse River estuary and the municipalities of New Bern, Havelock, Minnesott Beach and Oriental as well as Cherry Point Air Station. Much of the growth in this region is attributable to waterfront development along the Neuse and its tidal tributaries. Subbasin 09 encompasses the Swift Creek watershed in Craven and Pitt Counties. The population increase in this largely rural watershed is attributable to growth around New Bern, at the lower end of Swift Creek, and Greenville, near its headwaters.

2.3 MAJOR SURFACE WATER USES AND CLASSIFICATIONS

Clean water is critical to the health, economic well-being and the quality of life of those residing or working in the Neuse basin. Most water users throughout the basin rely on surface water for basic needs such as water supply and/or wastewater disposal. In addition, many businesses and residents of the Neuse, particularly in the lower end of the basin, rely directly or indirectly on a healthy river and its tributaries for their source of living. Commercial fisherman, water-oriented real estate and building industries, and those businesses that serve the enormous recreational needs of the basin such as fishing, boating and vacationing are just some examples. To these groups and the public they serve, it is important that the waters support viable fisheries and shellfish resources. In addition, full enjoyment of boating, swimming and residing along the water requires the waters to be relatively safe (low risk of contracting water-borne disease) and 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. In order to assure that water quality throughout the basin is maintained at levels that support the various uses presented above, North Carolina has established a water quality *classification and standards program* (15A NCAC 2B .200).

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. Stormwater rules to protect uses and standards of coastal water are an example of North Carolina's water quality authorities.

2.3.1 Classifications and Water Quality Standards

Appendix I summarizes the state's primary and supplemental classifications. Under this system, all surface waters in the state are assigned a *primary* classification that is appropriate to the best uses of that water body (e.g., aquatic life support or swimming). In *freshwaters* these include the following classes: *C*, *B* and *WS* (Water Supply) *I* through *V*. Primary *saltwater* classifications include *SC*, *SB* and *SA*. The WS freshwater classifications may also include a *CA* designation which stands for *critical area*. The critical area is an area in close proximity to a water supply intake and/or the shoreline of the reservoir in which it is located.

The *supplemental classifications* include *HQW* (High Quality Waters), *ORW* (Outstanding Resource Waters), *NSW* (Nutrient Sensitive Waters), *Tr* (Trout Waters) and *Sw* (Swamp Waters). These have been developed in order to afford special protection to sensitive or highly valued resource waters. While all waters, with rare exception, are assigned a single primary classification, they may have one or more supplemental classifications. For example, there are many streams in the lower Neuse basin that are classified C Sw NSW with C as the primary classification followed by Sw and NSW subclassifications.

Each primary and supplemental classification is assigned a set of water quality *standards* that establish the level of water quality that must be maintained in the water body to support the uses associated with each classification. Standards for some of the classifications, particularly the NSW, HQW and ORW classifications, outline protective management strategies aimed at controlling point and nonpoint source pollution. Tables 1 and 2 in Appendix 1 summarize the state's freshwater and saltwater standards. The standards for C and SC waters establish the basic protection level for all state surface waters. With the exception of Sw, all of the other primary and supplemental classifications have more stringent standards and provide for higher levels of protection. The Sw classification allows for a lower dissolved oxygen and pH standard than other waters due to natural conditions in swamp waters.

2.3.2 Water Quality Classifications in the Neuse Basin

The Neuse Basin has examples of all of the classifications and subclassifications presented above except Tr, which is found only in the western half of the state. Since the entire Neuse basin is designated as NSW, all of the surface waters have an NSW supplemental classification. The only area with an ORW classification is located near the mouth of the river in a small area of Core Sound encompassed by the Neuse basin. Swamp waters are located in the lower half, or Coastal Plain portion, of the basin. B and SB waters are uncommon and are scattered throughout the basin. Waters classified as WS are common throughout the Piedmont portion of the basin as depicted on the following map.

CHAPTER 3

SOURCES AND CAUSES OF WATER POLLUTION IN THE NEUSE BASIN

3.1 INTRODUCTION

Water pollution is *caused* by a number of substances including sediment, nutrients, bacteria, oxygen-demanding wastes, metals and organics. *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 Neuse basin. **Sections 3.3 and 3.4** describe point and nonpoint source pollution in the basin.

3.2 DEFINING *CAUSES* OF POLLUTION

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

3.2.1 Oxygen Consuming Wastes

Oxygen consuming wastes are substances which deplete the water of dissolved oxygen. The most significant source of these wastes is point source discharges. Understanding oxygen consuming wastes and their impact on water quality is enhanced by some basic knowledge of dissolved oxygen and the factors which affect its concentrations in the water.

The level of dissolved oxygen (DO) in a water body is one indicator of the general health of an aquatic ecosystem. A lack of sufficient DO in the water will threaten aquatic life. The United States Environmental Protection Agency (USEPA) states that 3 mg/l is the threshold DO concentration needed for many species' survival (USEPA, 1986). Higher concentrations are needed to promote propagation and growth of aquatic life. North Carolina has adopted a water quality standard of 5 mg/l (daily average; minimum instantaneous cannot fall below 4.0 mg/l) to protect the majority of its waters. Exceptions to this standard exist for waters subclassified as *trout waters* and those subclassified as *swamp*. Trout waters have a DO standard of 6.0 mg/l due to the higher sensitivity of trout to low DO levels. Swamp waters that may have naturally low levels of DO can have lower concentrations than those stated above if caused by natural conditions.

DO concentrations are affected by a number of factors. Higher DO is produced by turbulent actions which mix air and water such as waves, rapids and water falls. This process is referred to as reaeration. Aquatic plant life, including algae, can also produce DO, although, as will be discussed below under Nutrients, this affect may be temporary and may only occur near the surface. In addition, lower water temperature generally allows for retention of higher DO concentrations. Cool, rapid mountain streams often have naturally high DO levels of 8.0 mg/l or more.

DO is depleted in large part by bacteria which consume oxygen as they decompose organic matter such as leaves, dead plants and animals, and waste matter that may be washed or discharged into the water. Sewage is naturally high in organic waste matter, and bacterial decomposition can rapidly deplete DO levels unless the sewage is adequately treated at a wastewater treatment plant to remove much of the organic component. DO is also consumed by other aquatic organisms such as fish and insect larvae. In addition, some chemicals may react with and bind up DO, and high water temperatures reduce the ability of water to retain DO. Therefore, in general, lowest DO concentrations usually occur during the warmest summer months and particularly during low flow periods. Low DO levels often occur in warm, slow-moving waters that receive a high input of effluent from wastewater treatment plants or that may have naturally high levels of organic matter (such as swamps). Water depth is also a factor. In deep slow moving waters such as lakes or estuaries, DO concentrations may be very high near the surface due to wind action and algae but may be entirely depleted (anoxic) at the bottom.

Biochemical oxygen demand, or BOD, is a general term that describes the overall demand on DO from the various oxygen-depleting processes presented above. BOD can be further subdivided into *carbonaceous* biochemical oxygen demand (CBOD) and *nitrogenous* biochemical oxygen demand or NBOD (largely comprised of ammonia (NH3)). CBOD accounts for the DO consumed by organic substances breaking down as well as the oxygen used by fish, aquatic insects, and other aquatic organisms for survival. NBOD refers to the bacterial conversion of ammonia to nitrite and nitrate which also uses dissolved oxygen.

The process of decomposition of BOD substances associated with a wastewater treatment plant discharge is not instantaneous but instead occurs over a period of time. A large portion of the organic material discharged from a plant is readily decomposed and 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 actual area of impact may be several miles below the point of discharge. When this happens the area of impact is called the *sag zone*. A commonly used measure of the impact of BOD over time is called BOD5 where the "5" stands for five days. BOD5 is a standard waste limit in most discharge permits. A limit of 30 mg/l of BOD5 is the highest concentration allowed by federal and state regulations for municipal and domestic wastewater treatment plants. However limits less than 30 mg/l and sometimes as low as 5 mg/l are becoming more common in order to maintain the minimum DO standard of 5.0 mg/l in the receiving waters.

Oxygen Consuming Wastes in the Neuse Basin

Carbonaceous biochemical oxygen demand (CBOD) and ammonia (NH3) are the two most important types of oxygen-consuming wastes that are regulated by NCDEM under its permit program. Point source discharges are responsible for the majority of loading of these pollutants under critical low flow conditions. In the Neuse River Basin, 230 facilities have a BOD limit, and 165 facilities have an ammonia limit. These pollutants are modeled through the use of water quality models (see Chapter 6) in which point source loads are input. Since the majority of DO models are run under low flow conditions and nonpoint source impacts occur during storm events, the models only account for residual effects of nonpoint source loads as they impact runoff, background concentrations, and sediment concentrations of oxygen consuming wastes (SOD). Since both BOD and NH3 break down instream, it was not attempted to estimate a total BOD and NH3 load for the basin or a given subbasin. Instead, QUAL2E models of the Neuse River mainstem and major tributaries were calibrated and subbasin empirical models were developed for tributaries to protect the applicable dissolved oxygen (DO) standard. The results of this modeling for the mainstem of the Neuse River are presented in Figure 6.3 in 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. While nutrients, alone, have little impact on water quality, and can be beneficial to aquatic growth in small amounts, in overabundance and under favorable conditions, they 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*. In addition to problems with low DO, the blooms are aesthetically undesirable, impair recreational use and enjoyment of the affected waters, impede commercial fishing and pose difficulties in water treatment at water supply reservoirs. In addition to eutrophication problems, independent researchers have recently found evidence that some fish kills in the lower Neuse and Pamlico Sound may have been caused by toxic dinoflagellates.

Excessive growth of larger plants, or macrophytes, such as milfoil, alligator weed and Hydrilla, is also a problem. These plants, in overabundance, can reduce or eliminate swimming, boating and fishing in infested waters. In addition, the algae and larger plants can form floating layers of organic matter which can cause odor problems.

Agricultural runoff and municipal wastewater treatment plants are the two main sources of nutrients along with urban runoff and forestry. 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.

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.

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), but analysis is underway, and standards or instream criteria may be developed for these parameters in the future. 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 mg/l standard is indicative of excessive algal growth and portends bloom conditions.

Nutrient Loading in the Neuse Basin

DEM typically develops nutrient budgets for watersheds experiencing excessive eutrophication. The budgets identify the amount of nutrient loading from each pollutant source in effected watersheds. This procedure requires an estimate of loads from both point sources and nonpoint sources. Nonpoint source loadings are estimated by land cover type. In 1983, DEM recommended nutrient management in the Falls Lake watershed of the Neuse River Basin. Then later, in 1987, DEM recognized the need for nutrient management in the entire river basin and performed a nutrient budget on the entire basin. As a result of the analysis, the entire Neuse River Basin was declared a nutrient sensitive water (NSW) in January 1988. As part of the Albemarle Pamlico (A/P) Estuarine Study Program, the Research Triangle Institute (RTI) conducted a study that updated the nutrient budget for that part of the Neuse River Basin below Falls Lake in 1991 (Dodd and McMahon, 1992). RTI used actual discharger data from 1989 and 1990 to estimate the point source loading to the basin along with nutrient data collected at the gaging station below Falls Dam to estimate loading from Falls Lake.

Nonpoint source loading was estimated through the use of *export coefficients* for different land cover types. Export coefficients refers 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, therefore, different land uses and cover types have different export coefficients.

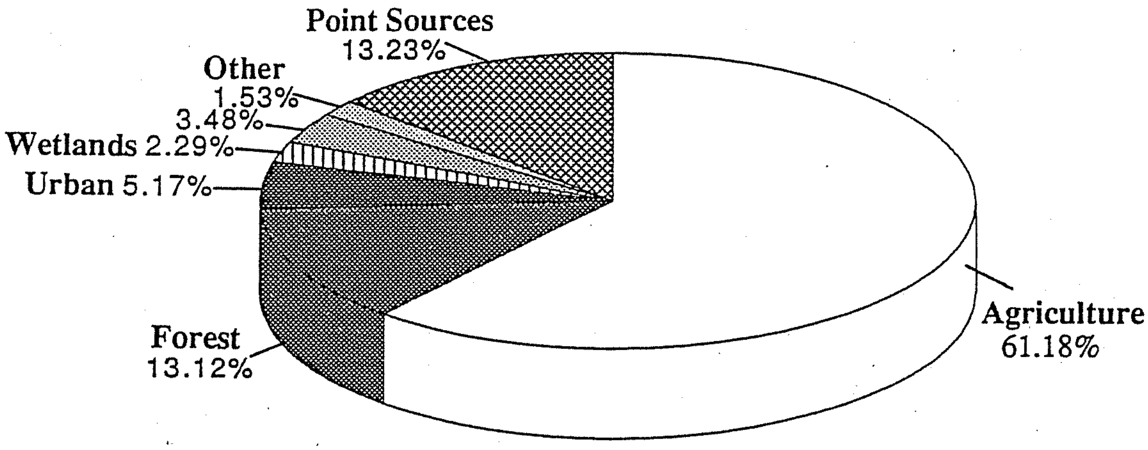
In the RTI study, land use data were obtained from a 1987-1988 LANDSAT land cover classification survey (discussed in Chapter 2), and export coefficients were estimated from a literature search of numerous studies. A range of export coefficients (high, median and low) was identified in the literature 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 3.1, below.

TABLE 3.1. Export Coefficient Literature Review (lbs/acre per year)

	Agriculture	Forest/Wetland	Developed	Atmospheric
Total Phosphorus				
Low (25%)	0.49	0.08	0.40	0.22
Median	**0.88**	**0.16**	**0.95**	**0.58**
High (7%)	1.81	0.19	1.34	0.62
Total Nitrogen				
Low (25%)	4.46	0.62	4.46	7.76
Median	**8.74**	**2.08**	**6.71**	**11.06**
High (7%)	12.75	3.39	8.67	21.41
Number of Studies	**77**	**36**	**78**	**6**

Figure 3.1 summarizes the relative contributions of total phosphorus (TP) and total nitrogen (TN) loadings to the Neuse River between Falls Lake and New Bern from point sources and non-point sources. In other words, it represents the total estimated loadings, by percent, from all of the subbasins except 01, 13 and 14. This figure indicates that point source discharges between Falls Dam and New Bern contribute approximately 23% of the

Total Nitrogen



Total Phosphorus

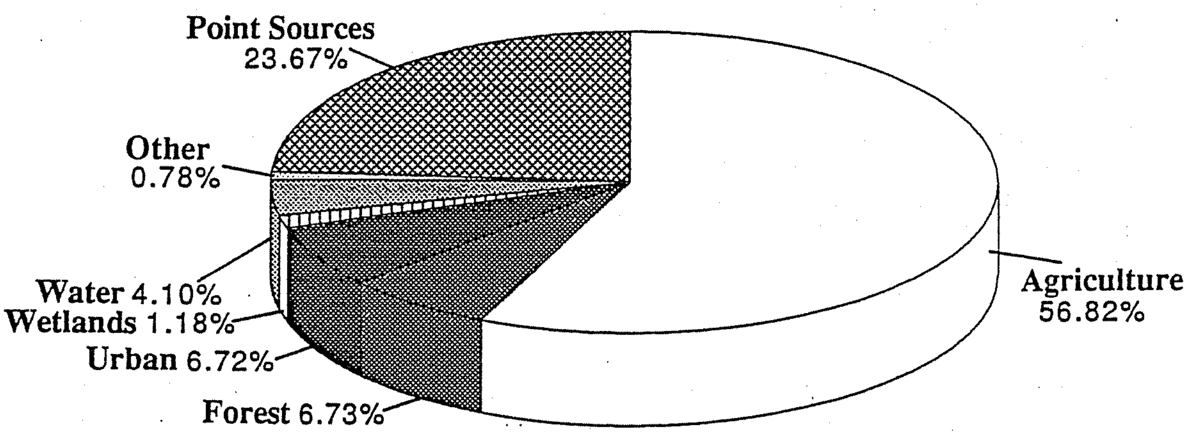


Figure 3.1 Estimated Nutrient Loadings by Source and Percentage to the Neuse Basin from Falls Lake Dam to New Bern

total phosphorus loading and 13% of the total nitrogen loading to the entire basin per year. Agriculture is the main nonpoint source contributor of TP (52.7%) and TN (56.9%) in the basin. Forested land also contributes a significant amount of TN to the basin (13.2%).

Tables 3.2 and 3.3 present RTI's estimated nonpoint source phosphorus and nitrogen loading data by land cover type for each of the Neuse's 14 subbasins. The point source data are based on daily monitoring report data from discharge facilities.

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 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.

Whole effluent toxicity (WET) testing is required on a quarterly basis for major dischargers and any discharger containing complex (industrial) wastewater. This test 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 followup testing is called a *toxicity reduction evaluation* (TRE). Each of the substances below can be toxic in sufficient quantity.

Metals

Municipal and industrial dischargers along with urban runoff are the main sources of metals contamination in surface water. North Carolina has stream standards for many heavy metals, but the most common ones examined for in municipal permits are cadmium, chromium, copper, nickel, lead, mercury, silver, and zinc. Each of these metals (with the exception of silver) is also monitored through the ambient network along with aluminum and arsenic. Point source discharges of metals are controlled through the NPDES permit process. Mass balance models (Appendix II) are employed to determine appropriate limits. Municipalities with significant industrial users discharging wastes the their treatment facilities limit the heavy metals coming to them from their industries through their *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. The new urban stormwater program described in Chapter 5 should help the nonpoint source metals loading instream.

Subbasin	Agriculture (kg/year)	Forest (kg/year)	Urban (kg/year)	Wetland (kg/year)	Water (kg/year)	Other (kg/year)	Point Source (kg/year)	Totals (kg/year)	Totals Percent
03 04 01	504,587	204,558	188,621	47,926	45,298	24,032	266,931	1,281,953	13.0%
03 04 02	636,347	166,812	244,171	30,326	10,530	9,843	503,549	1,601,578	16.2%
03 04 03	160,092	23,285	35,372	4,902	1,219	1,661	112,121	338,651	3.4%
03 04 04	393,950	46,560	40,334	10,443	2,692	2,594	13,383	509,955	5.2%
03 04 05	679,915	112,892	7,250	6,645	4,484	10,173	60,030	881,389	8.9%
03 04 06	426,347	71,003	23,839	6,171	2,033	3,550	6,774	539,717	5.5%
03 04 07	1,443,499	227,597	8,977	12,529	7,182	11,183	189,182	1,900,149	19.2%
03 04 08	192,681	54,888	7,722	15,831	4,184	10,164	235	285,707	2.9%
03 04 09	302,615	94,406	1,319	13,815	400	9,083	3,229	424,868	4.3%
03 04 10	181,262	124,934	23,549	48,455	237,376	27,149	125,311	768,036	7.8%
03 04 11	272,907	88,174	17,388	30,953	1,238	34,775	1,688	447,123	4.5%
03 04 12	192,628	36,487	2,827	2,919	6,327	1,944	40,002	283,135	2.9%
03 04 13	63,129	13,116	11,066	27,186	176,773	6,411	0	297,681	3.0%
03 04 14	15,386	4,794	2,095	21,643	264,659	2,661	0	311,238	3.2%
Totals	5,465,346	1,269,506	614,531	279,743	764,396	155,224	1,322,434	9,871,180	
	55.4%	12.9%	6.2%	2.8%	7.7%	1.6%	13.4%		100.0%

The following subtotals are for the Neuse Basin below Falls Lake Dam to New Bern (all subbasins except 01, 13 and 14)

Total - Kg	4,882,244	1,047,038	412,749	182,989	277,665	122,120	1,055,503	7,980,308
Total - %	61.18%	13.12%	5.17%	2.29%	3.48%	1.53%	13.23%	

Table 3.2 Point and Nonpoint Source Nitrogen Loading to the Neuse River Basin by Land Type and Sub-basin.

Subbasin	Agriculture (kg/year)	Forest (kg/year)	Urban (kg/year)	Wetland (kg/year)	Water (kg/year)	Other (kg/year)	Point Source (kg/year)	Totals (kg/year)	Totals Percent
03 04 01	50,974	11,413	26,658	2,674	2,957	1,341	17,603	113,620	10.7%
03 04 02	64,284	9,307	34,510	1,692	842	549	110,397	221,581	20.8%
03 04 03	16,173	1,299	4,999	273	97	93	8,414	31,348	2.9%
03 04 04	39,797	2,598	5,701	583	250	145	3,436	52,508	4.9%
03 04 05	68,685	6,299	1,025	371	486	568	14,884	92,317	8.7%
03 04 06	43,070	3,962	3,369	344	174	198	1,919	53,036	5.0%
03 04 07	145,823	12,699	1,269	699	661	650	24,614	186,414	17.5%
03 04 08	19,465	3,062	1,091	883	481	541	157	25,680	2.4%
03 04 09	30,570	5,267	186	771	45	530	415	37,784	3.5%
03 04 10	18,311	6,971	3,328	2,703	31,875	1,506	24,772	89,467	8.4%
03 04 11	27,569	4,920	2,457	1,727	152	1,926	405	39,156	3.7%
03 04 12	19,459	2,036	400	163	536	108	16,026	38,728	3.6%
03 04 13	6,377	732	1,564	1,517	24,541	357	0	35,088	3.3%
03 04 14	1,554	268	296	1,207	45,570	148	0	49,043	4.6%
Totals - kg/yr	552,111	70,832	86,854	15,608	108,666	8,659	223,043	1,065,772	
Totals - %	51.8%	6.6%	8.1%	1.5%	10.2%	0.8%	20.9%		100.0%

The following subtotals are for the Neuse Basin below Falls Lake Dam to New Bern (all subbasins except 01, 13 and 14)

Subtotals - kg/yr	493,206	58,418	58,335	10,210	35,598	6,814	205,440	868,021
Subtotals - %	56.82%	6.73%	6.72%	1.18%	4.10%	0.78%	23.67%	100.00%

Table 3.3 Point and Nonpoint Source Phosphorus Loading to the Neuse River Basin by Land Type and Sub-basin.

Chlorine

Chlorine is commonly used as a disinfectant at NPDES discharge facilities which have a domestic (i.e., human) waste component. These discharges are the main source of chlorine in the State's surface waters. Chlorine dissipates fairly rapidly once it enters the water, but its toxic effects can have a significant impact on sensitive aquatic life such as trout and mussels if the amount of wastewater discharged into a stream is high relative to the flow in the stream. At this time, no standard exists for chlorine, but one may be adopted in the near future. In the meantime, all new and expanding dischargers are required to dechlorinate their effluent if chlorine is used for disinfection. If a chlorine standard is developed for North Carolina, chlorine limits may be assigned to all dischargers in the State that use chlorine for disinfection.

Ammonia (NH3)

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 standard for ammonia in North Carolina. However, DEM 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 near future.

Toxics Loading in the Neuse Basin

It is difficult to assess surface water concentrations of toxics on a basinwide scale since they often break down due to physical or chemical reactions, or a significant portion may be lost to the sediments through precipitation and settling. Toxics models which attempt to simulate these reactions are difficult and costly to develop. Due to the difficulty in developing mechanistic toxics models, DEM usually performs mass balance models to determine toxic wasteload allocations. Interaction among dischargers in close proximity is accounted for in the process. Nonpoint sources are accounted for in the background assumptions when stream specific information is available. However, in the majority of the calculations, a background concentration of zero is used, since available data usually are all less than analytical detection levels.

Ambient water column data indicate that there is not excessive loading instream (see Chapter 4 for further information), but certain waterbodies may have elevated concentrations of a given toxic parameter. Sediment data in some locations also show elevated concentrations. These locations are identified in Chapter 4 and management plans are outlined for the areas in Chapter 6. Evidence of toxic accumulation or other biological impacts is limited.

3.2.4 Sediment

Sediment 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. However, aside from a few industrial sources, stream sediment impacts are not usually a problem associated with point sources.

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.

3.2.5 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 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 coliforms include leaking or failing septic systems, leaking sewer lines or pump station overflows, runoff from livestock operations and wildlife.

Fecal coliforms 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 coliforms is 200 MF/100 ml for all waters except SA waters. SA waters, which are suitable for commercial shellfish harvesting, have a standard of 14 MF/100 ml. The majority of domestic waste dischargers receive a limit of 200 MF /100 ml in their NPDES permit (14 /100 ml in SA waters). Fecal coliforms in treatment plant effluent are controlled through disinfection methods including chlorination (sometimes followed by dechlorination), ozonation or ultraviolet light radiation.

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 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. Color monitoring is included in the NPDES permit where it has been perceived to be a problem instream.

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 and in large urban areas (Raleigh and Durham in the Neuse basin) are now considered point source discharges and will be regulated under new urban stormwater runoff regulations being required by U.S. Environmental Protection Agency (EPA). The urban stormwater runoff program is discussed in more detail in Chapter 5.

The primary substances and compounds associated with point source pollution are oxygen-demanding wastes, nutrients, and toxic substances including chlorine, ammonia and metals. Color, pathogens, pH, temperature, oil and grease are several other potential pollutants.

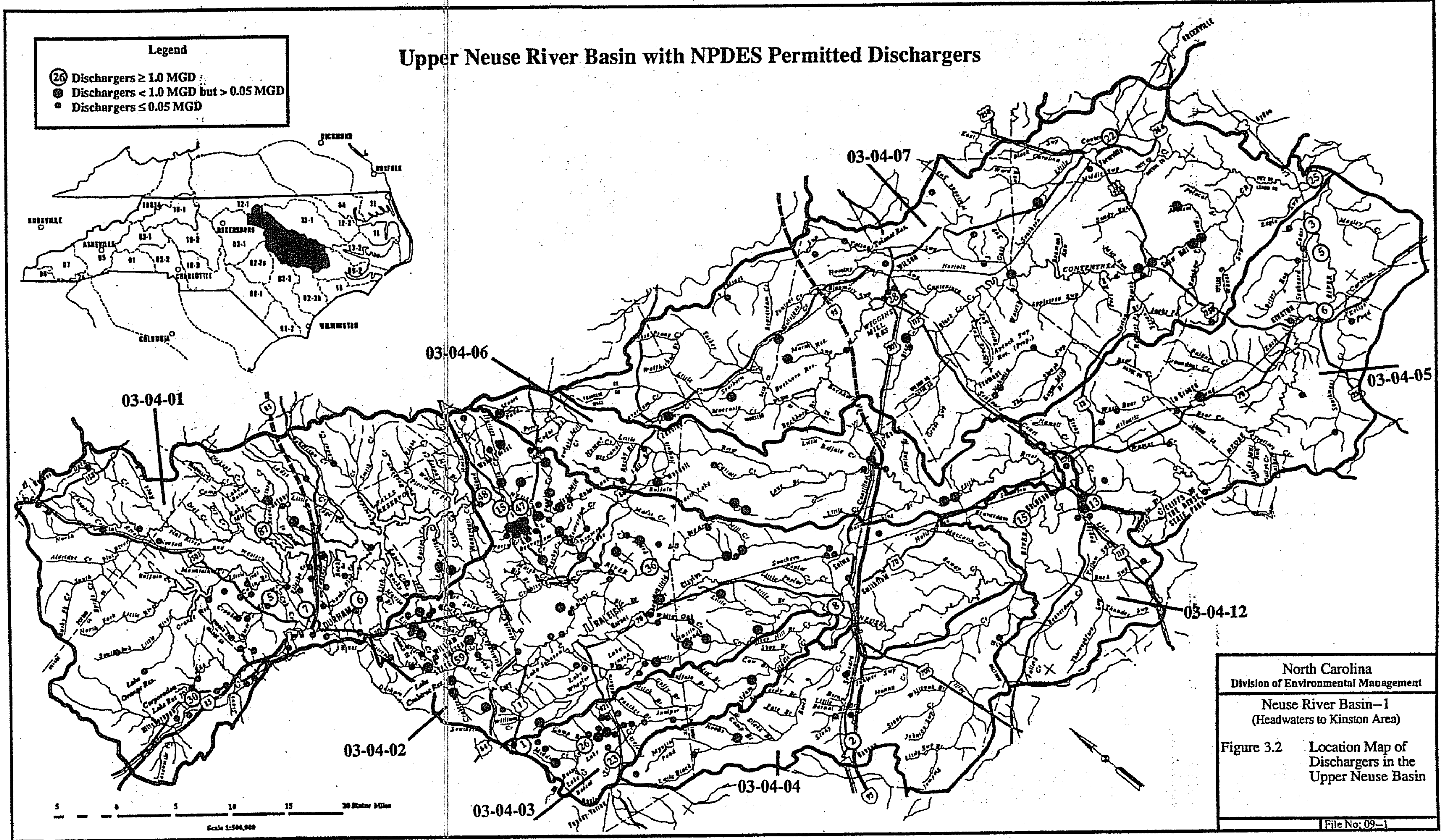
Point source discharges are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the National Pollution Discharge Elimination System (NPDES) program delegated to North Carolina from EPA. The amount or loading of specific pollutants that may be allowed to be discharged into a stream 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 which are 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 NCDEM 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. In addition to the monthly data submitted, all major dischargers are required to perform an annual scan of the priority pollutants. Minimum NPDES monitoring requirements are provided in 15A NCAC 2B .0500.

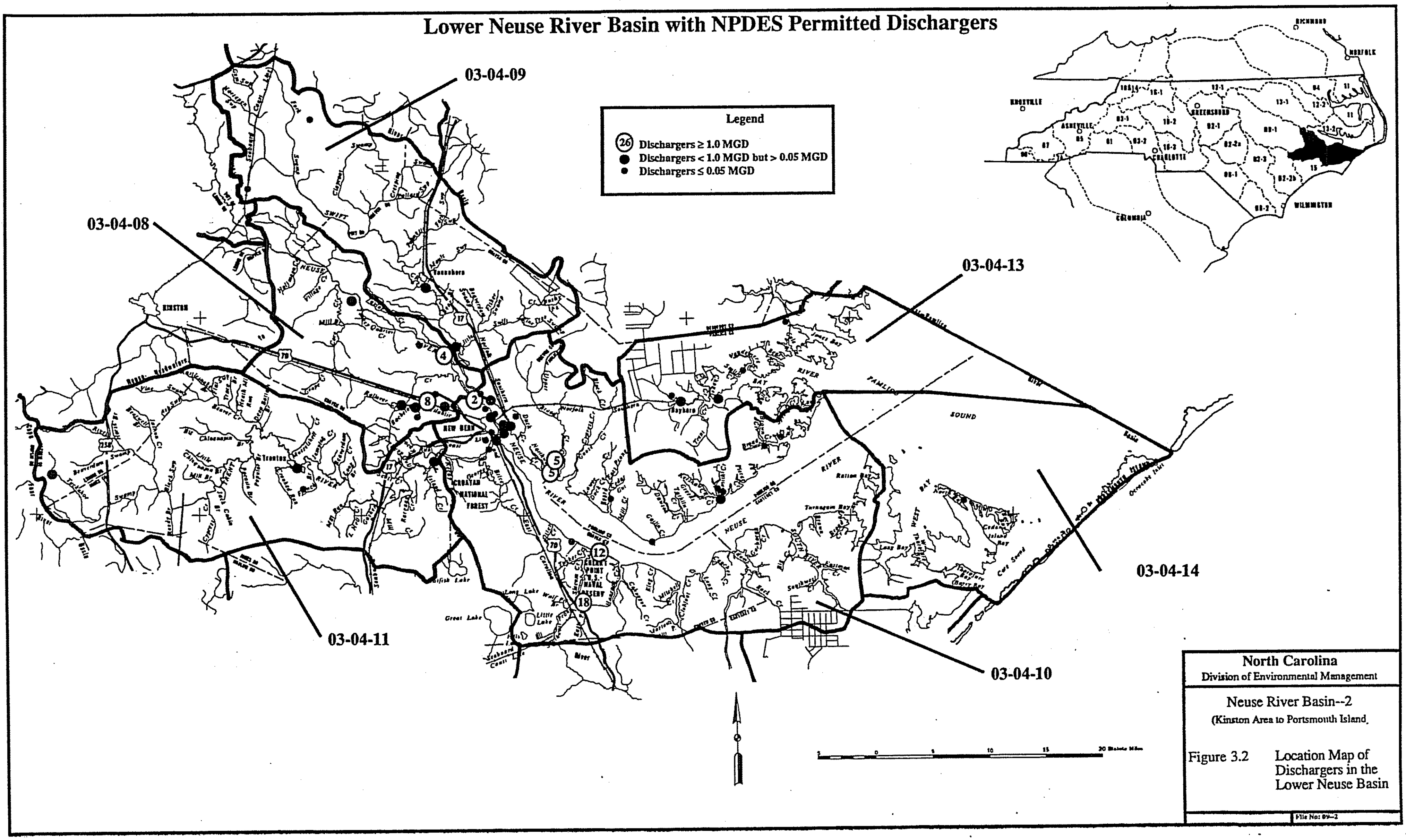
Other methods of collecting point source information include effluent sampling by NCDEM during inspections and special studies. The regional offices may collect data at a given facility if they believe there may be an operational problem or as a routine compliance check. In addition, the NCDEM may collect 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 Neuse

In the Neuse River Basin, there are 350 NPDES permitted dischargers. Of these, 30 are major facilities, 179 are purely domestic, 46 are municipalities, and 125 are industries. The discharge locations are presented in Figure 3.1. The size of the dots vary with the treatment capacity of the discharge. The largest discharges, or those with a flow greater than one million gallons per day (MGD), are represented by a circle with a number in it. The numbers identify the discharger and can be used to obtain more specific information in Table 3.4. Discharges ranging in size from 50,000 gallons per day to 1 MGD and those



Upper Neuse River Basin with NPDES Permitted Dischargers
Legend
26 Dischargers ≥ 1.0 MGD
Dischargers < 1.0 MGD but > 0.05 MGD
Dischargers ≤ 0.05 MGD
03-04-01
03-04-02
03-04-03
03-04-04
03-04-05
03-04-06
03-04-07
03-04-12
DURHAM
RALEIGH
FALLS RESERVOIR
WIGGINS MILL RES
CONTENTNEA
NEUSE
RIVER
CLIFFS OF THE NEUSE STATE PARK
North Carolina
Division of Environmental Management
Neuse River Basin–1
(Headwaters to Kinston Area)
Figure 3.2 Location Map of Dischargers in the Upper Neuse Basin
File No: 09–1


Lower Neuse River Basin with NPDES Permitted Dischargers
Legend
26 Dischargers ≥ 1.0 MGD
Dischargers < 1.0 MGD but > 0.05 MGD
Dischargers ≤ 0.05 MGD
03-04-08
03-04-09
03-04-10
03-04-11
03-04-13
03-04-14
NEW BERN
KINSTON
PAMLICO
SOUND
NEUSE
RIVER
North Carolina
Division of Environmental Management
Neuse River Basin--2
(Kinston Area to Portsmouth Island.
Figure 3.2 Location Map of Dischargers in the Lower Neuse Basin

Map #	Subbasin	Permit Number	Facility	*Design Flow
5	030401	NC0026336	Durham-Eno River WWTP	2.5
6	030401	NC0026310	Durham-Little Lick Creek WWTP	1.5
7	030401	NC0023841	Durham-Northside WWTP	10.0
30	030401	NC0026433	Hillsborough WWTP	3.00
87	030401	NC0026824	John Umstead Hospital	3.50
8	030402	NC0030716	Central Johnston County WWTP	4.50
15	030402	NC0001376	Burlington Industries/Wake Plant	5.00
36	030402	NC0029033	Raleigh-Neuse River WWTP	40.00
47	030402	NC0030759	Wake Forest WWTP	1.20
48	030402	NC0045896	Wakefield Farms, Inc.	1.00
59	030402	NC0048879	Cary - North WWTP	4.00
1	030403	NC0064050	Apex - Middle Creek WWTP	3.60
23	030403	NC0066516	Fuquay-Varina WWTP (proposed)	6.00
26	030403	NC0065102	Cary-South WWTP	6.40
2	030404	NC0020389	Benson WWTP	1.50
3	030405	NC0003760	E.I. DuPont	3.60
5	030405	NC0024236	Kinston-Northside WWTP	4.50
6	030405	NC0020541	Kinston-Peachtree WWTP	6.75
22	030407	NC0029572	Farmville WWTP	3.50
25	030407	NC0032077	Contentnea Metropolitan Sewage	2.00
28	030407	NC0023906	Wilson WWTP	12.00
13	030412	NC0003417	CP&L/Lee--001	1.40
15	030412	NC0023949	Goldsboro WWTP	6.37

Lower Neuse River Basin
Major NPDES Permitted Dischargers

Map #	Subbasin	Permit Number	Facility	Design Flow
4	030408	NC0003191	Weyerhaeuser	27.0
~~8~~	~~030408~~	~~NC0061191~~	~~Martin-Marietta-Aggregates~~	~~12.0~~
2	030410	NC0025348	New Bern WWTP	4.7
5	030410	NC0033111	Northeast Craven Utilities-001	1.0
5	030410	NC0033111	Northeast Craven Utilities-002	1.0
12	030410	NC0003816	Cherry Point WWTP	3.5
18	030410	NC0021253	Havelock WWTP	1.5

*Flows represented here are the amounts that the existing plants have been designed and constructed to handle. In some cases, permits have been issued to expand the plants beyond the listed design flow. The two most notable examples are Durham's North side WWTP (permitted to 20 MGD) and Raleigh's WWTP (Permitted to 60 MGD).

Table 3.4 Upper Neuse River Basin Major NPDES Permitted Dischargers less than 50,000 gallons per day are represented by correspondingly smaller unidentified dots. A complete list of all active dischargers in the basin is presented in Appendix V. This list includes the name, permit number, permitted flow, authorized flow and average actual flow for the past twelve months for each facility.

In the Neuse River Basin, most of the large point source discharges, particularly in the urban areas of Durham and Wake Counties, are municipal discharge facilities. These municipal dischargers are the primary sources of oxygen-consuming waste in the basin. A few subbasins have a large industrial flow. These include textile manufacturers in subbasin 030402, organic chemical manufacturers in 030405, mine dewatering and pulp and paper facilities in 030408 and stormwater flow from industrial facilities in 030410.

Table 3.5 includes a summary of the number of NPDES dischargers and their cumulative permitted and 1991 average daily flows for each subbasin and for the basin as a whole. It should be noted that the NPDES permits for some industrial discharges such as for cooling water or stormwater do not have a total flow limit specified. In such cases, they are classified as minor discharges and their permitted flow is considered to be zero in Table 3.5. Therefore, in Table 3.5 under "Industrial Facilities", the total average flows for 1991 would be expected to exceed the total permitted flow in subbasins which have these types of industrial dischargers. This is evident in subbasins 030401, 030404, 030405 and 030410. This also occurs under the "Minor Dischargers" category for subbasins 030405 and 030410, and under "Total Facilities" for subbasin 030410.

Table 3.6 lists the cumulative permitted flows for 38 types of NPDES facilities ranging from municipal plants, hospitals, drug manufacturers and car washes to mobile home parks, seafood or fishing packing plants and aquifer restoration.

3.4 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) refers to runoff that enters surface waters through stormwater or snowmelt. 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 (Raleigh and Durham) 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 pesticides, 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 interest.

3.4.1 Agriculture

There are a number of activities associated with agriculture that may serve as sources of water pollution. Land clearing and plowing render soils susceptible to erosion which in turn can cause stream sedimentation. Pesticides and fertilizers (including chemical fertilizers and animal wastes) can be washed from fields or improperly designed storage or

Table 3.5 Summary of Major/Minor Dischargers and Permitted Flows by Subbasin

	030401	030402	030403	030404	030405	030406	030407	030408	030409	030410	030411	030412	030413	030414	Basin
Total Facilities	87	115	17	6	17	14	28	8	6	31	6	8	5	2	350
Total Permitted Flow (MGD)	21.7125	61.5114	16.8691	1.5253	15.7142	1.8087	21.0842	39.7092	0.2304	13.2131	0.3620	8.2670	0.2040	0.1500	202.3611
Total Average Flow 1991** (MGD)	10.5632	37.9690	4.0718	1.1353	10.2462	1.7827	12.1579	33.6789	0.3838	37.4835	0.1735	6.2017	0.0755	0.0000	155.9230
Major Dischargers	5	6	3	1	3	0	4	1	0	4	0	2	0	1	30
Total Permitted Flow (MGD)	20.5000	54.7500	16.0000	1.5000	14.8500	0	19.3500	27.0000	0	9.3000	0	7.7750	0	0.1500	171.6750
Total Average Flow 1991 (MGD)	10.5632	35.7561	4.0313	1.0221	4.8881	0	10.8386	22.8132	0	4.0897	0	6.0816	0	0.0000	100.0839
Minor Dischargers	82	109	14	5	14	14	24	7	6	27	6	6	5	1	320
Total Permitted Flow (MGD)	1.2155	6.7614	0.8691	0.0253	0.8642	1.8087	1.7342	12.7092	0.2304	3.4131	0.3620	0.4920	0.2040	0.0000	30.6891
Total Average Flow 1991 (MGD)	1.5967	2.2128	0.0405	0.1132	5.3581	1.7827	1.3192	10.8656	0.3838	33.3938	0.1735	0.1201	0.0755	0.0000	57.4355
100% Domestic Wasterwater	66	64	10	3	8	5	8	4	1	8	2	0	0	0	179
Total Permitted Flow (MGD)	0.9991	4.8764	0.8619	0.0253	0.0892	0.3077	0.1792	0.0900	0.0160	3.2070	0.1820	0	0	0	10.8338
Total Average Flow 1991 (MGD)	0.0827	0.4533	0.0405	0.0070	0.0611	0.0060	0.1057	0.0045	0.0000	0.2059	0.0703	0	0	0	1.0370
Municipal Facilities	6	7	3	1	4	3	12	0	1	4	2	2	1	0	46
Total Permitted Flow (MGD)	20.5180	50.7000	16.0000	1.5000	12.0250	1.4950	20.8860	0	0.1000	6.3750	0.1700	6.7750	0.2000	0	136.7440
Total Average Flow 1991 (MGD)	10.5811	33.9124	4.0313	1.0221	5.3974	0.7259	12.0490	0	0.1557	4.1545	0.1032	6.1698	0.0747	0	78.3771
Industrial Facilities	15	44	4	2	5	6	8	4	4	19	2	6	4	2	125
Total Permitted Flow (MGD)*	0.1881	5.0935	0.0072	0.0000	3.6000	0.0060	0.0190	39.6192	0.1144	3.6311	0.0100	1.4920	0.0040	0.0150	53.7995
Total Average Flow 1991 (MGD)	1.4960	3.6029	0.0000	0.1062	4.7875	1.0507	0.0030	33.6743	0.2281	33.1231	0.0000	0.0319	0.0008	0.0000	78.1045

* Some industrial facilities have no permitted flow requirement. Wasteflow in this catagory will be underestimated.

**Total Average Flow is calculated from facility-reported flow for CY 1991.

Table 3.6 Summary of NPDES Permitted Dischargers Sorted by Primary Wastewater Code and Subbasin with Total Permitted Flows in Millions of Gallons per Day (MGD)

	030401	030402	030403	030404	030405	030406	030407	030408	030409	030410	030411	030412	030413	030414	Basin
Wastewater Type		0.0000*						0.0600		0.0250					0.0850
Apartments	0.0229	0.0262	0.0072				0.0190	0.1152	0.0144	0.0288	0.0100	0.0920			0.3357
Aquifer Restoration												1.4000			1.4000
Ash Pond and Coal Pile		0.0000		0.0000	0.0000	0.0000									0.0000
Boiler Blowdown									0.1000						0.1000
Car Wash	0.0155	0.3578													0.3733
Commercial	0.2500														0.2500
Condominiums												0.0000			0.0000
Contact Cooling Water						0.0000		0.5040							0.5040
Cooling Tower Blowdown		0.0010													0.0010
Drug Manufacture										3.5000					3.5000
Federal Institution										0.0000			0.0040	0.0500	0.0540
Fish or Seafood Packing		0.0000	0.0000	0.0000	0.0000		0.0000		0.0000	0.0000					0.0000
(Ground) Water Plant		0.0150													0.0150
Hospital	0.0300	0.0500								0.0750					0.1550
Hotel, Motel and Inn	0.0090	0.0024	0.0065	0.0187	0.0187		0.1000								0.1553
Institution	0.0000														0.0000
Metal Forming										0.1000					0.1000
Metal Plating	0.0500	0.5000		0.0000				12.0000		0.0000	0.0000				12.5500
Mine Dewatering	0.0000	0.0000				0.0000									0.0000
Mining and Material Processing	0.0752	0.4510	0.4650	0.0000		0.1500									1.1412
Mobile Home Park	20.5180	50.7000	16.0000	1.5000	12.0250	1.4950	12.8860		0.1000	6.3750	0.1700	6.7750	0.2000		128.7440
Municipal	0.0000	0.0000					0.0000			0.0005		0.0000			0.0005
Non-contact Cooling Water	0.0100	0.0000	0.0000		0.0000	0.0060									0.0160
Oil Separator		0.0000													0.0000
Oil Terminal					3.6000										3.6000
Organic Chemical Manufacture	0.0012														0.0012
Restaurant		0.0000													0.0000
Saltwater Corrosion Research		0.0000													0.0000
Sand Dredging	0.0132	0.0075	0.0034	0.0200	0.0705	0.0477	0.0792	0.0300	0.0160	0.0070	0.0120				0.3065
School										0.0018			0.0000	0.1000	0.1018
Seafood or Fish Processing	0.0177	0.0115													0.0292
Single Family Residence		0.0500													0.0500
Stormwater	0.6028	4.3390	0.3870			0.1100				3.1000	0.1700				8.7088
Subdivision	0.1000	0.0000				0.0000	0.0000								0.1000
(Surface) Water Plant		0.0000													0.0000
Swimming Pool Backwash	0.0000	5.0000													5.0000
Textile		0.0000						27.0000	0.0000	0.0000					27.0000
Wood Products					0.0000										0.0000
Wood Treatment															194.3775

* A zero value indicates the facility has no permitted flow limit.

disposal sites. Concentrated animal feed lot operations can be a significant source of both BOD and nutrients. The untreated discharge from a large operation would be comparable to the nutrient load in the discharge from a secondary waste treatment plant serving a small town. Animal wastes can also be a source of bacterial contamination of surface waters. Construction of drainage ditches on poorly drained soils enhances the movement of stormwater into surface waters.

In the Neuse Basin, the percent of land cover in agriculture is highest in the central portion of the basin (generally coinciding with the lower Piedmont and upper Coastal Plain regions). Those subbasins having at least 50% of their land area in agriculture include 07 (Contentnea Creek - 56%), 04 (Black and Mill Creeks - 56%), 05 (Neuse mainstem and tributaries just above Goldsboro - 54%), 06 (Little River in Wake and Johnston Counties - 53%) and 12 (Neuse mainstem and tributaries from Goldsboro to downstream of Kinston - 51%). However, agriculture is common throughout all of the Neuse subbasins except in those bordering the mouth of the river (subbasins 13 and 14).

The type and severity of water quality impacts from agriculture can vary widely with the type of farming activities, the terrain and hydrology, the implementation of best management practices and the expertise of the farmer. For example, water quality in the Little River subbasin (06), a subbasin with over fifty percent of its land area in agriculture, is rated as good to excellent; and the upper portion of the subbasin is classified as WS-II, which by definition is a category of high quality waters (Appendix I). By contrast, water quality in the Contentnea Creek subbasin (07) is rated considerably lower, due in part to agricultural activities.

One of the most important water quality concerns associated with agriculture in the Neuse basin is nutrient runoff. As shown in Figure 3.1, agriculture contributes approximately 57% of the phosphorus loading to the Neuse estuary with 20% of that total coming from the Contentnea Creek subbasin (07) alone. Nutrient-related problems are not always evident in the receiving stream adjoining a farm but may manifest themselves in a downstream impoundment, sluggish creek or estuary many miles away. Impacts associated with intensive livestock operations or pesticide use can be locally significant with the degree of impact tied largely to the concern and management capabilities of the farmer or operator. Sediment is also a widespread though moderate water quality problem associated with agriculture and one that can be minimized through appropriate BMPs. Fecal coliform contamination from farm animals can be a problem in coastal areas, particularly near shellfish waters. Chapter 5 discusses agricultural nonpoint source control programs.

3.4.2 Urban

Runoff from urbanized areas, as a rule, is more predictable and generally more severe than agricultural runoff although far fewer stream miles are actually impacted. The rate and volume of runoff in urban areas is much greater due both 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, also allow urban pollutants to reach surface waters quickly and with little or no filtering. These 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.

In the Neuse Basin, water quality impacts resulting from urban runoff will be most widespread in subbasins 01 and 02 which encompass much of the Raleigh and Durham areas. More localized impacts can also be expected in the smaller municipalities throughout the basin such as Smithfield, Wilson, Goldsboro, Kinston, New Bern and Havelock. The population density map (Figure 2.5) in Chapter 2 is a good indicator of where urban development and potential urban stream impacts are likely to occur.

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 activities are temporary in nature but the impacts, discussed under sediment, below, can be long lasting.

Construction activity tends to be concentrated in the more rapidly developing areas of the basin However, road construction is widespread and often involves stream crossings in remote or undeveloped areas of the basin.

3.4.4 Forestry

Forestry, a major industry in North Carolina, can impact water quality in number of ways. 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.

Timber harvesting occurs throughout the basin and is often done at the onset of clearing for site development. Commercial timber operations, however, involving intensive management techniques such as ditching and draining are located in the lower portion of the basin. Localized hydrologic impacts can be expected downstream of these operations.

3.4.5 Mining

Mining is a common activity in the Piedmont and upper 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.

The most prevalent type of mining activity in the Neuse basin is for sand and gravel. It is widespread and is commonly found in or near the floodplain of the river and its major tributaries.

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 when properly designed, constructed and maintained. 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.

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 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.

Onsite wastewater disposal is most prevalent in rural portions of the basin and at the fringes of urban areas. Fecal coliform contamination from failing septic systems poses a problem in some coastal waters where it can result in closure of shellfish waters. Nutrients from failing septic systems also contribute to eutrophication problems in some impoundments and coastal waters.

REFERENCES CITED - CHAPTER 3

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CHAPTER 4

WATER QUALITY STATUS IN THE NEUSE BASIN

Section 4.1 summarizes the various types of water quality and biological data collected by the NCDEM Water Quality Section within the Neuse River Basin. Information from other sources has been utilized to select sampling locations but is not summarized here. **Section 4.2** presents a narrative assessment of water quality for each of the 14 subbasins within the Neuse basin. **Section 4.3** discusses ambient monitoring system (AMS) water quality data collected from ambient sites along the mainstem of the Neuse from Falls Lake to the mouth of the river near Pamlico Sound. The data presented in sections 4.2 and 4.3, along with other relevant data, are then assessed using methods outlined in **Sections 4.4** to develop use support ratings. Use support ratings for evaluated streams are presented in **Section 4.5** along with a use support map of the basin.

4.1 SOURCES AND TYPES OF WATER QUALITY AND BIOLOGICAL DATA

NCDEM's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. Below is a brief summary of each of the primary program areas from which most of the data were drawn for this assessment of the Neuse River basin. A more complete review of this information and data summaries is included in Appendix II.

4.1.1 Benthic Macroinvertebrate Sampling

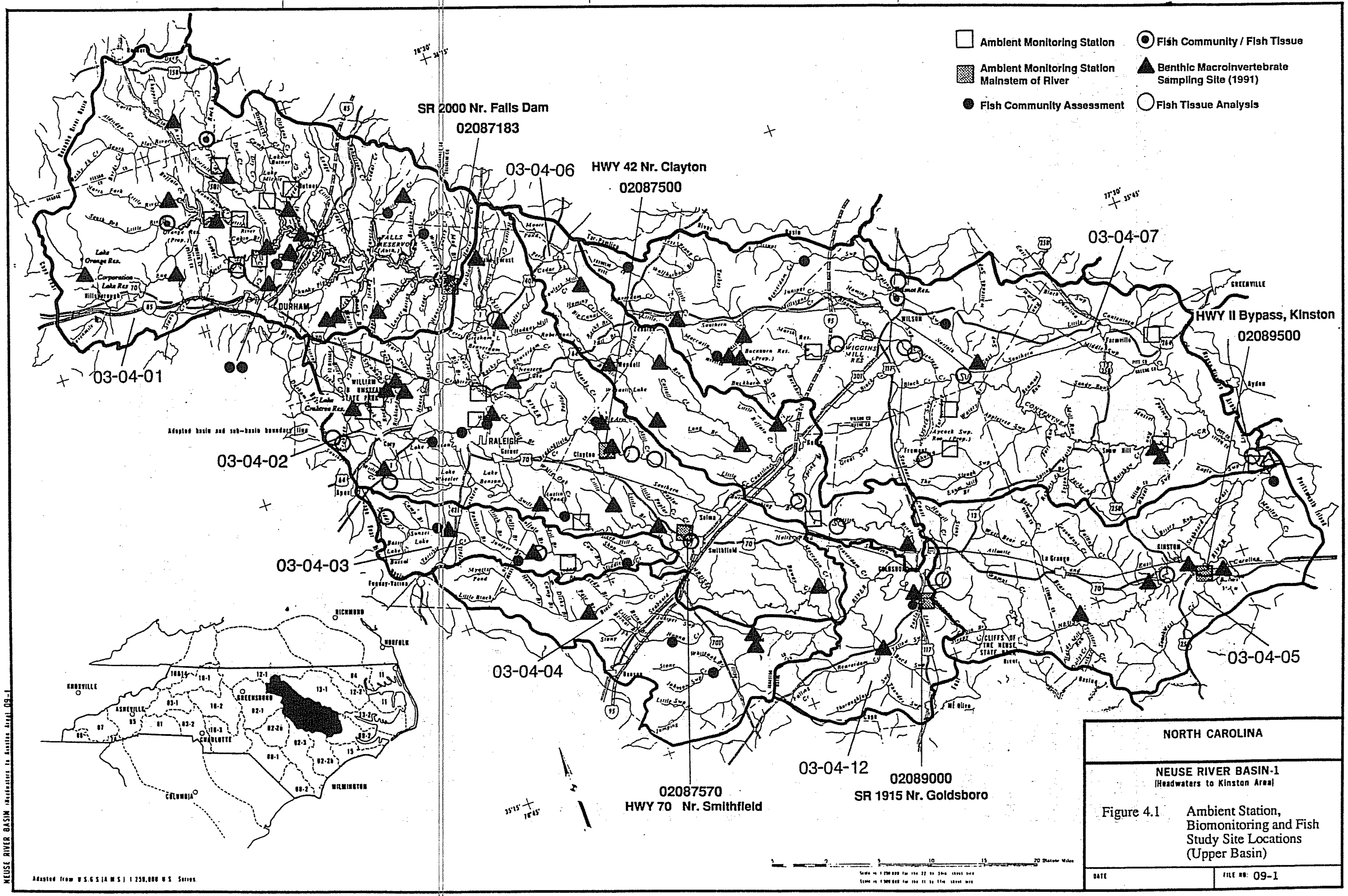
Benthic macroinvertebrates, or *benthos*, are predominantly aquatic insect larvae that live in and on the bottom of rivers and streams. Stream sampling, or *biomonitoring*, of the number, type and diversity of these organisms can be used to assess water quality. Those benthos that are most intolerant of pollution, and used most commonly in biomonitoring, fall into three taxonomic groups: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Water quality is rated from Poor to Excellent based on evaluation criteria presented in Appendix II. Biomonitoring information from over 70 sampling sites in the Neuse basin has been included in this plan (Figure 4.1).

4.1.2 Phytoplankton Sampling

Phytoplankton, are microscopic (free floating algae) plants found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton are especially useful as indicators of eutrophication (discussed under Nutrients in Chapter 3). Prolific growths of phytoplankton, often due to abundant nutrients, may result in surface "blooms" in which one or more species of algae may actually form a visible mat on top of the water. A statewide effort to document blooms associated with fish kills, discolored waters, taste and odor problems, or significant fluctuations in dissolved oxygen levels in surface waters was initiated in 1984. Identification and enumeration of phytoplankton is also an integral part of the ambient monitoring network in large rivers, estuaries and in special lake studies.

4.1.3 Aquatic Toxicity Monitoring (Whole Effluent Toxicity Testing)

Aquatic toxicity monitoring is used to determine the toxicity of treated effluent from a wastewater treatment facility. Under laboratory conditions, sensitive aquatic species (usually fathead minnows or the water flea, Ceriodaphnia dubia) are placed in a sample of the effluent that has been diluted to the same dilution ratio as occurs after the effluent is



NORTH CAROLINA

NEUSE RIVER BASIN-1
(Headwaters to Kinston Area)

Figure 4.1 Ambient Station, Biomonitoring and Fish Study Site Locations (Upper Basin)

DATE

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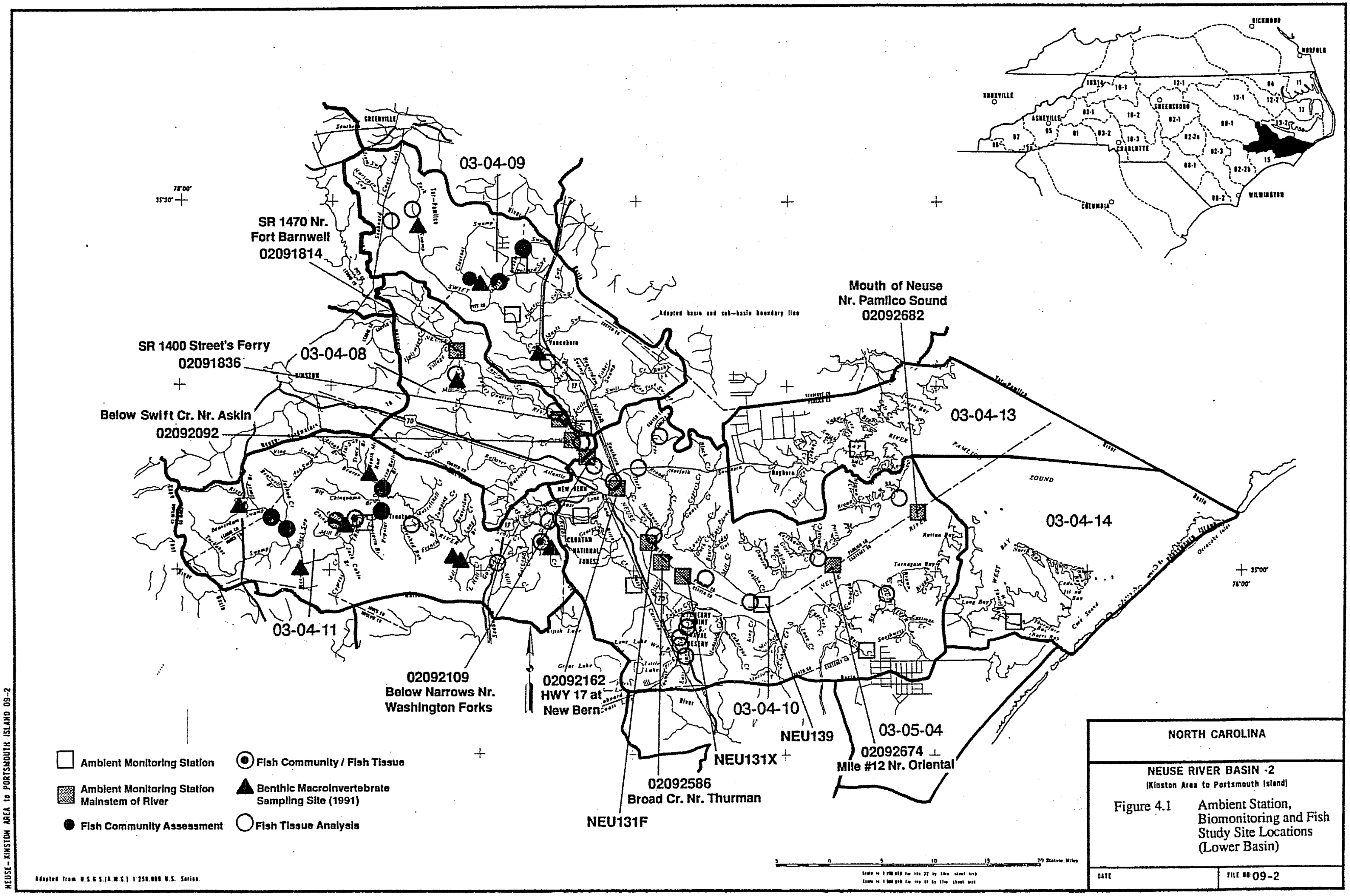

NORTH CAROLINA

NEUSE RIVER BASIN -2
(Kinston Area to Portsmouth Island)

Figure 4.1 Ambient Station, Biomonitoring and Fish Study Site Locations (Lower Basin)

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NEUSE-KINSTON AREA to PORTSMOUTH ISLAND 09-2

discharged to a receiving stream (e.g. if the effluent makes up 50% of the receiving stream's flow, then the sample will be diluted by 50%). Results of these tests have been shown by numerous researchers to be predictive of toxic discharge effects on aquatic life in receiving streams. NCDEM maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to NCDEM regional offices and NCDEM administration. This program is discussed further in Chapter 5.

4.1.4 Fish Studies

These studies include *fish community structure* to determine the water quality and habitat value of a stream, and *fish tissue analysis* primarily used in human health evaluations. In a fish community assessment, fish are collected from the stream and the number, type, size and general health of the fish are noted. This assessment results in assigning a biological integrity rating to the steam ranging from Poor to Excellent based on criteria presented in Appendix II. Fish tissue analyses entail measuring concentrations of parameters of concern that are contained in fish tissue such as heavy metals, pesticides, and other organic compounds from contaminated water or from the food they eat. Fish tissue analyses can serve as an important early warning indicator of contaminated sediments and surface water. The findings of these analyses are used as indicators for human health concerns, fish and wildlife health concerns, and the presence of various chemicals in the ecosystem.

4.1.5 Intensive Surveys and Sediment Oxygen Demand (SOD)

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, stream flow measurements, physical and chemical samples, long-term biochemical oxygen demand (BOD_{lt}) analysis, water body channel geometry, and effluent characterization analysis. If oxygen depletion from sediments is suspected, *sediment oxygen demand (SOD)* studies may be performed along with intensive surveys. Intensive surveys and SOD's are performed where there is insufficient in-stream field data to calibrate and verify a water quality simulation model for a specific wastewater discharge location or on a larger scale for basin modeling. Water quality simulation models, described in Appendix III and discussed in Chapter 6, are often used for the purpose of determining the potential impact of a point source discharge on receiving waters and to determine appropriate effluent limits as requirements in National Pollutant Discharge Elimination System (NPDES) permits.

4.1.6 Lakes Assessment Program

A North Carolina Lakes Assessment Program has been implemented to protect lake waters through monitoring, pollution prevention and control. 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 each lake's *trophic status*. Trophic status is a relative measure of nutrient enrichment and productivity. Data are also used to evaluate whether the lake's uses have been threatened or impaired by pollution (see Appendix III for trophic status ratings). More detailed studies are conducted to evaluate loading and system response where specific management strategies are necessary to restore a lake to full use support status (Sections 4.4 and 4.5).

4.1.7 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine water quality monitoring stations (about 350 statewide) strategically located for the collection of physical and chemical water quality data. There are 16 ambient stations in the Neuse River along the mainstem from Falls Lake to Pamlico Sound (Figure 4.1). 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 collection conducted at ambient stations. AMS data for the Neuse Basin are summarized in Section 4.3, below.

Table 4.1. Ambient Monitoring System Parameters

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

<u>NUTRIENT-SENSITIVE WATERS</u>
Chlorophyll <u>a</u> (where appropriate)

<u>WATER SUPPLY</u>
Chlorides, total coliforms, manganese, total dissolved solids

<u>SA WATERS</u>
Fecal coliforms (tube method where appropriate)

<u>SWAMP WATERS</u> - No changes or additions

<u>TROUT WATERS</u> - No changes or additions

PLUS any additional parameters of concern for individual station locations

4.2 NARRATIVE WATER QUALITY SUBBASIN SUMMARIES

This section summarizes by subbasin the water quality and biological data described in section 4.1. It points out areas of water quality impairment and those areas where water quality is higher than the standards by using results of water quality surveys. A detailed listing of in-stream water quality standards exceedances are not provided within the context of these summaries. More specific data and descriptions of information covered by these summaries will be available in a separate document and under the NCDEM 305(b) reporting requirements. **Please note that this information provides an assessment of instream conditions. Management actions to address some problems noted may already be in place, and are detailed in Chapter 6.**

4.2.1 Neuse Subbasin 01 (Falls Lake Watershed)

Neuse Subbasin 01 is experiencing pressure from increased urban development and population growth. Nutrient and organic enrichment, as evidenced by problems such as low dissolved oxygen , algal blooms, and fish kills, are notable causes of water quality degradation in this subbasin and result from both point and nonpoint source pollution. Point source problems have been especially pronounced in the upper reaches of Falls Lake Reservoir and its tributaries (Knap of Reeds Creek, Ellerbe Creek, and Little Lick Creek). Urban runoff from the City of Durham also affects Ellerbe Creek. Non-urban streams are affected by periods of intermittent or low flow, particularly in the Eno River basin which has been informally designated by the Environmental Management Commission as a capacity use area. They are also affected by siltation and habitat loss resulting from land development and agriculture. Several lakes and ponds have prolific growths of <u>Hydrilla</u>, a noxious non-native aquatic plant which has spread through the upper Neuse Basin in the last ten years.

The headwaters of Falls of the Neuse Reservoir are hypereutrophic with documented algal blooms and fish kills. While nutrients reaching the lake come from both point and nonpoint sources, municipal WWTPs, especially Butner and Durham-Northside, have been significant contributors to the extremely elevated nitrogen and phosphorus loading in the arms of the lake to which they discharge, especially during the low flow summer months. Both effluents have also had demonstrated toxicity problems. Exceedences of the copper and zinc action levels and the mercury standard have occurred downstream of both facilities. Biological assessment indicated some in-stream improvement in Knap of Reeds Creek in 1991, following upgrades in pretreatment efforts, but water quality is still considered Poor. Water quality in Ellerbe Creek downstream of the WWTP is rated Poor or Very Poor. It should be noted, however, that the City of Durham is in the process of enlarging and significantly upgrading the treatment level at the Durham-Northside plant. This upgrading will include tertiary waste treatment and a phosphorus limit of 0.5 mg/l, the most stringent required by the state.

Little Lick Creek is also degraded, as evidenced by Poor biological ratings, ambient toxicity, and high nitrogen concentrations. Unspecified nonpoint sources and the Durham-Little Lick Creek WWTP discharge are suspected to cause these problems. The Eno River near the headwaters of Falls Lake and below Durham-Eno River WWTP has elevated concentrations of nitrogen and phosphorus. Recurrent algal blooms and fish kills resulting from low dissolved oxygen levels have been observed. However, benthos data below the WWTP indicates a Good bioclassification. The Eno River and Little Lick Creek WWTPs are to be eliminated within the next several years with the flow being diverted to the Durham-Northside plant on Ellerbe Creek. The decision to eliminate these plants and divert the flow to the Northside plant was based in part on the findings and recommendations of a federally funded environmental impact statement.

Lake Rogers, the water supply for the City of Creedmoor, is infested with Hydrilla and is hypereutrophic. Water quality standards for manganese, total dissolved solids, and chlorophyll a were violated. Causes and sources of degraded water quality are not known but should be investigated.

Good to Excellent water quality is found throughout the Flat, Little, and upper Eno River systems except at the extreme headwaters of the South Flat River (which had a fair biological rating due to nonpoint source pollution) and at the downstream end of the Flat River near its confluence with Falls Lake (which had a number of substandard DO readings). Land in these drainages is relatively less disturbed than in other sections of the subbasin. The Little River watershed upstream of Little River Reservoir has already been classified HQW, and these waters continue to exhibit Excellent water quality.

Candidates for Reclassification:

Assessment of benthic macroinvertebrates indicates that sites on the Flat River and Deep Creek have Excellent water quality. This segment of the Flat River (from the site near Quail Roost to its upstream confluence with Deep Creek) and the entire Deep Creek drainage should be considered for reclassification to HQW.

4.2.2 Neuse Subbasin 02 (Neuse River - Falls Lake Dam to southern Johnston County, Swift and Crabtree Creeks)

This subbasin contains a large expanding urban area (Raleigh, Cary, and Garner). Most of the water quality problems in the upper section of the subbasin are associated with urbanization. Siltation and habitat loss, nutrient and organic enrichment, as evidenced by problems with dissolved oxygen stress, algal blooms, and fish kills are the primary causes of water quality degradation in this subbasin. Discharge from WWTPs, urban runoff, and land development are all sources of the degradation. The primary land use in the lower section of the subbasin shifts to farm and pasture land, and in addition to the upstream problems, water quality is affected by agricultural activities and related runoff.

Crabtree Creek, near the Raleigh area, reflects the challenges in maintaining and enhancing water quality. The creek and its tributaries receive input from multiple dischargers (Cary North WWTP is the largest), urban runoff, and siltation from land development. Biological assessments show Crabtree Creek to have only Fair water quality. Other streams and their tributaries such as Walnut Creek and Swift Creek have similar stresses, although fish community data on Walnut Creek and Swift had Good and Good-Excellent biological ratings, respectively. Since 1988, biological and chemical data have indicated water quality improvement for the Neuse River near Clayton. The 1991 biological assessment indicated that water quality for the Neuse River ranges from Good-Fair at US 401 to Good near Clayton and Princeton.

Ten lakes in this subbasin have been monitored with eight being eutrophic and two mesotrophic. Designated uses for the lakes are fully being met for two (Apex Reservoir and Reedy Creek Lake) of the ten. Chlorophyll a violations have been reported from both Lake Crabtree and Sycamore Lake. Turbidity violations were also reported from Lake Crabtree. Lakes Benson, Johnson, Raleigh, and Wheeler all have varying degrees of Hydrilla infestation. Algal blooms have been reported from many of these lakes in addition to many smaller ponds.

4.2.3 Neuse Subbasin 03 (Middle Creek - Wake and Johnston Counties)

Middle Creek and its tributaries are the only streams in this small subbasin. These streams receive both nonpoint and point source inputs. Water chemistry data from an ambient site on Middle Creek at NC 50 near Clayton show numerous dissolved oxygen violations during summer months. The Cary South WWTP (permitted flow 16 MGD) and the Apex WWTP (design flow 3.6 MGD) are currently the only major dischargers in this area. However, there is substantial pressure for urban growth to continue to expand into this watershed which is characterized with slow moving streams.

Macroinvertebrate sampling in the Middle Creek watershed in 1986, prior to discharge from the Cary WWTP, generally found Fair water quality throughout the watershed. Samples in 1991 indicated Good/Fair water quality at a site below the Cary WWTP and at the ambient site. Fish community sampling of Middle Creek in 1991 indicated NCIBI scores in the Fair-Good range near Fuquay Varina, in the Fair range near Benson, and in the Good-Excellent range near Smithfield.

Bass Lake and Sunset Lake, in the upper watershed, are the only lakes that have been monitored. Eutrophic conditions were found in Sunset Lake, below the Apex WWTP, in 1990. Bass Lake was monitored in 1988 and it use support was evaluated as threatened. Increased residential development has occurred since that time. Further monitoring of this lake appears warranted.

Candidates for Reclassification:

No waters in this subbasin qualify for HQW or ORW classifications based on excellent water quality.. However, mussel collections by the NC Wildlife Resources Commission (NCWRC) have noted the presence of the federally endangered dwarf wedge mussel (Alasmidonta heterodon). If these stream segments are officially designated by NCWRC as critical habitat for the mussel, they would be eligible for consideration for HQW reclassification by the Environmental Management Commission.

4.2.4 Neuse Subbasin 04 (Black and Mill Creeks, Neuse Mainstem - southern Johnston County)

Black Creek and Mill Creek and their tributaries are the only streams in this subbasin, and little water quality information is available for them. No ambient stations are located here. The Benson WWTP, which discharges to Hannah Creek, is the only major discharger. Macroinvertebrate samples in 1991 indicated Fair water quality for Black Creek and Hannah Creek, while Mill Creek had Good/Fair water quality. Fish sampling in 1991 indicated NCIBI scores in the Fair-Good range for Hannah Creek, and in the Fair range for Stone Creek. The only lake that has been monitored is Holt Lake which was found to be fully supporting its uses in 1990.

4.2.5 Neuse Subbasin 05 (Neuse Mainstem - Goldsboro to Craven County)

This subbasin encompasses the Neuse River and tributaries from below Goldsboro to below Kinston. The Neuse River in this subbasin has maintained Good-Fair to Good water quality since 1983.

The primary urban center in this area is Kinston. According to benthological analyses, water quality in the Neuse River at Kinston has gradually improved between 1983 and 1991 and is now rated Good. Ambient chemical monitoring indicates no significant water quality problems.

Fish tissue analyses from one location on the Neuse River have been conducted between 1980 and 1990. All fish tissue metals analyses at the US-70 bypass in Kinston were below FDA criteria. Low levels of chlordane and DDT were detected in fish in 1980 and 1981. Fish tissue dioxin analyses in 1984, 1987, and 1990 detected low levels in the first two years' samples, but dioxin was not detected in four samples analyzed in 1990.

Two lakes have been assessed in this subbasin. Cliffs of the Neuse Lake, located within the state park of the same name, has maintained its designated uses (recreation and aesthetic enjoyment). Nutrient levels in this lake are low. The second lake, Lake Wakena, is a privately-owned lake with high nutrient levels. Its designated uses are threatened.

4.2.6 Neuse Subbasin 06 (Little River - Wake, Johnston, Wayne Counties)

This subbasin consists of the entire Little River watershed, from Moore's Millpond in Franklin County to the Neuse River in Wayne County. The Little River in this subbasin has maintained primarily Good water quality, as determined by bioclassifications, since 1983. A few sites have measured in the "Poor" and "Excellent" ranges.

According to benthological analyses, water quality in Buffalo Creek is "Poor" in upper reaches and "Fair" in downstream locations. The Wendell WWTP discharges to this tributary and has been found to discharge high levels of nutrients (especially phosphorus).

Fish tissue analyses from two locations on the Little River have been conducted. All metals analyses at SR-2320 and SR-1234 were below FDA criteria. At SR-1234 fish analysis detected low levels of DDT.

One lake has been assessed in this subbasin. Wendell Lake had elevated to extremely high nutrient levels when sampled in 1991. Eutrophication has been documented, with bluegreen algae blooms occurring in 1987, 1989, and 1990. Chlorophyll a concentrations from 130-270 µg/l were measured during this time. Buffalo Creek, which flows from this lake, has had fish kills reported in its waters. The lake does not support its designated uses.

Candidates for Reclassification:

No waters in this subbasin qualify for HQW or ORW classifications based on excellent water quality. However, mussel collections by the NCWRC have noted the presence of the federally endangered dwarf wedge mussel. If these stream segments are officially designated by NCWRC as critical habitat for the mussel, they would be eligible for consideration for HQW reclassification by the Environmental Management Commission.

4.2.7 Neuse Subbasin 07 (Contentnea Creek)

This subbasin contains the entire Contentnea Creek watershed which is the largest tributary of the Neuse River containing approximately 849 square miles. Agriculture is the primary land use in the subbasin having approximately 56% of the total acreage. Streams in the western section of this subbasin (i.e. Moccasin Creek, Turkey Creek and Toisnot Swamp) are slightly higher gradient stream systems than streams in the eastern portion of this subbasin which have more swamp and pocosin-like characteristics. Wetlands, including bottomland hardwoods, account for about 3% of the total acreage of the watershed.

There are six ambient monitoring locations in this subbasin. Three of these six monitoring locations are on Contentnea Creek. Data from these three locations indicate that water quality conditions are being negatively affected by both point and nonpoint source pollution. Violations in the dissolved oxygen water quality standard were noted at each location, perhaps responding to the combined effects of municipal dischargers and swamp or pocosin tributary drainage. Median and maximum conductivity values increase progressively downstream indicating that effluent concentrations may be increasing. In addition, the water quality information from the ambient location at Little Contentnea Creek near Farmville clearly denotes impacts from the Farmville WWTP. This facility has an instream waste concentration of 98.7%. Numerous violations in the dissolved oxygen standard were noted and, in addition, conductivity and nutrient values were elevated above other data from monitoring locations in this subbasin.

Good, Good/Fair or Fair water quality conditions were noted at each of the ambient locations from which benthic macroinvertebrate samples were collected. Data from both Contentnea Creek at Stantonsburg and Grifton have indicated better water quality during recent investigations (1991). The better water quality at these locations is likely a result of the reduced influence of nonpoint sources during low flow periods. Benthic macroinvertebrate data from Contentnea Creek at Grifton noted a substantial improvement during surveys conducted there in 1987 and 1991 over conditions in previous investigation. Also, fish tissue data from this location in 1986 noted the presence of metals (mercury) and organics (chlordane, pentachlorophenol, and DDT). Regional water quality personnel have indicated that enforcement of illegal discharges from animal operations, particularly in Greene County, have been successful. These restrictions may be partially responsible for better water quality conditions at the Grifton location.

Several biological (biomonitoring and fisheries) investigations have been conducted at tributary locations in this subbasin. The benthos data indicate the water quality conditions of these tributaries to be Fair or Good/Fair. Generally, fish community structure analyses produced ratings of Good, suggesting a healthy fish population in this subbasin.

Water quality information has been collected from six reservoirs in this subbasin. In general, these data have indicated eutrophic conditions with phosphorus levels ranging from elevated to extremely high. Aesthetic problems and algal blooms and/or potential for blooms have been documented for each of these reservoirs. Point and/or nonpoint sources are contributing to the eutrophic conditions of these reservoirs. For example, discharge from the Zebulon WWTP into the headwater reaches of Taylor's Millpond is a significant contributor. In 1991, a special investigation was conducted to document the extent of eutrophication in Buckhorn and Wiggins Mill Reservoirs. Preliminary results indicate that agricultural land constitutes approximately 46% of the land use around Buckhorn Reservoir and is a primary contributor to the enrichment of this Reservoir. Wiggins Mill Reservoir is approximately 13 miles below Buckhorn Reservoir and received a 4.1 NC Trophic State Index value, which is the highest noted in this subbasin.

Candidates for Reclassification:

There do not appear to be any stream reaches in this subbasin that qualify for reclassification to High Quality Waters (HQW) based on excellent water quality. However, mussel collections by the NCWRC have noted the presence of the federally endangered dwarf wedge mussel from two streams in the catchment (Turkey and Moccasin Creeks). If these streams are officially designated by NCWRC as critical habitat for the mussel, they would be eligible for consideration for HQW reclassification by the Environmental Management Commission.

4.2.8 Neuse Subbasin 08 (Neuse Mainstem - Craven County)

This subbasin contains approximately 25 river miles of the Neuse River downstream to New Bern and several small tributary catchments including Core and Bachelor Creeks. The tributaries drain swamp and pocosin wetlands and are therefore black water (or tannin) streams typically having low dissolved oxygen and pH concentrations.

There are five riverine ambient water quality monitoring locations in this subbasin all of which monitor water quality conditions of the Neuse River. Saltwater intrusions have been detected as far up the Neuse River as Streets Ferry during periods of low flow. Therefore, freshwater classification and associated water quality standards apply only to the most upstream ambient location in this subbasin (Neuse River near Fort Barnwell) and saltwater water quality standards apply to all others. A review of these data indicate that there is a noticeable drop in the dissolved oxygen between Fort Barnwell and Streets Ferry, and a further, but less dramatic, drop in dissolved oxygen at the two ambient monitoring locations located below Weyerhaeuser. Sediment oxygen demand investigations at two locations near Fort Barnwell and Streets Ferry, did not detect elevated concentrations. The number of dissolved oxygen water quality standard violations was greatest in the Neuse River at and below the Swift Creek location, perhaps responding to swamp-like tributary flow. Very few additional violations were noted in other water quality parameters.

Investigations of dioxin in fish tissue samples from the Neuse River have been conducted below the Weyerhaeuser paper mill. In 1988, these investigations noted levels up to 14.1 parts per trillion (ppt) in the River at Marker 52 near New Bern. However, recent investigations (1990) have noted much lower concentrations. For example, in 1990, four samples were analyzed for dioxin. Only two of these had detectable concentrations of dioxin, 0.9 ppt and 0.2 ppt, levels well below a health criteria value of 3 ppt.

A limited number of benthic macroinvertebrate investigations have been conducted in this subbasin. Results from the ambient monitoring location near Streets Ferry noted Fair water quality conditions during all investigations prior to 1989. In 1989, a Good/Fair bioclassification was noted at this site. However, this increase in bioclassification seems to be due primarily to high flows preceding the collection. A Fair bioclassification was also assigned to Core Creek during the basinwide surveys conducted in 1991. Since 1989, phytoplankton communities have been analyzed from three ambient monitoring locations (Fort Barnwell, Streets Ferry and Narrows). These analyses indicate that water quality may have improved in these areas during the past decade.

4.2.9 Neuse Subbasin 09 (Swift Creek - Pitt and Craven Counties)

This subbasin includes Swift Creek and its tributaries where low dissolved oxygen and low flow are often noted. While much of this is natural outflow from the many swamps in the area, there is also a component of this degradation related to agricultural runoff. Fish tissue from both sample locations upstream of Vanceboro, the only urban area in this subbasin, were found to contain small amounts of DDT, a once popular pesticide.

Benthic macroinvertebrates rate the upper half of Swift Creek and Clayroot Swamp as Fair, while a site on Swift Creek above Vanceboro was given a Good-Fair rating. Fish community sampling rated Creeping Swamp as Fair and gave a Good-Excellent rating to a channelized portion of Clayroot Swamp.

4.2.10 Neuse Subbasin 10 (Neuse Estuary - New Bern to Pamlico Sound)

The freshwater portion of this subbasin lies within the Croatan National Forest and is largely unaffected by anthropogenic inputs. Two lakes within this area, Ellis Lake and Long Lake, were oligotrophic and fully supporting their designated uses. One benthos sample, collected from the West Prong of Brice's Creek, was rated Good (versus Excellent) due to stresses from naturally low pH. Fish tissue from the area had low levels of metals and organics.

In the Neuse estuary, the primary observed water quality problems are algae blooms and associated low dissolved oxygen conditions resulting from nutrient overenrichment. The majority of the nutrient loading comes from upstream although local point and nonpoint sources contribute to the problem (see Section 3.2.2). High nutrient levels and chronic algal blooms occur in the New Bern area. Chronic algal blooms and declining nutrient levels continue down the length of the river to near the Minnesott Beach area. These 30,000 acres of Neuse River have been found to only partially support their intended uses. East of this point the water quality in the river improves and only sporadic blooms have been observed, although the potential exists for nuisance algae conditions if nutrient levels are not held in check (Paerl, 1990).

Low levels of the pesticides Dieldrin, Chlordane and DDT have been found in the tissues of fish near New Bern although these levels were below standards for posing a health threat to human consumers. Independent research conducted under the sponsorship of the Albemarle-Pamlico Estuarine Study have found concentrations of heavy metals in the bottom sediments in and around New Bern, Slocum Creek and Oriental (Riggs, Bray, Powers and Hamilton, 1991). Fish tissue analyses in these areas have not indicated any significant uptake of these metals in the food chain although continued monitoring will be conducted.

4.2.11 Neuse Subbasin 11 (Trent River)

This subbasin is composed entirely of the Trent River and its tributary streams. The Trent River and most of the streams which were sampled in this subbasin are rated as Good. Only the Trent River at Trenton has been sampled multiple times.

Greatly reduced summer flows, which produce depressed dissolved oxygen levels, and nonpoint source impacts are notable causes of water quality degradation in this subbasin. The hydrology of the Trent River at Trenton is variable, with an average flow of 190 cfs and low flows of less than 5 cfs. Forty percent of the dissolved oxygen measurements at Trent River at Trenton were below 5.0 mg/l. These periods of low dissolved oxygen correlate with periods of extreme low flow. During the 1990 biomonitoring of the Trent River at Trenton, the measured flow was at 6 cfs but there was no "noticeable" flow. These low flow periods may stress both the fish and benthic macroinvertebrate communities. Biological assessment of the streams in this drainage indicate slight impacts from nonpoint source runoff.

4.2.12 Neuse Subbasin 12 (Neuse Mainstem - western Wayne County)

This subbasin is composed of a section of the Neuse River and its tributary streams above Goldsboro. Data from the Neuse River at the Goldsboro ambient monitoring station indicate no significant water quality problems. The benthic macroinvertebrate data from the Neuse River at Goldsboro site have indicated a slight improvement in bioclassification from Good-Fair to Good between 1984 and 1988.

4.2.13 Neuse Subbasin 13 (Bay River)

This estuarine subbasin includes Bay River and part of Pamlico Sound and does not have any ambient water quality monitoring stations. Currently, water quality monitoring by DEM is covering the more impacted areas such as the Pamlico River to the north and the Neuse River to the south. However, university researchers, funded under the Albemarle Pamlico Estuarine Study, have monitored waters in the Pamlico Sound near the mouth of Bay River and have concluded that water quality is similar to observations made at other Pamlico Sound water quality stations. While there are no major discharges in this somewhat remote subbasin, the 0.2 MGD Bay River Sewerage District WWTP is requesting to enlarge to 0.3 MGD in anticipation of strong population growth in this area.

4.2.14 Neuse Subbasin 14 (West Bay)

Most of the estuarine waters contained in this subbasin (Pamlico and Core Sound) are classified as Outstanding Resource Waters. There are no ambient water quality monitoring stations located within the subbasin. Additionally, because there are few freshwater streams within the area, there are little water quality data.

There are no major discharges in this subbasin. Nonpoint runoff from large agricultural and forestry operations remains the primary threat to water quality. A water quality study is currently underway for the South River. Assessment of benthic macroinvertebrates indicate that most sites in West Thorofare Bay had high taxa richness. Variations between sampling sites were dependent upon substrate size, not water quality.

Candidate for Reclassification

Excellent water quality was found in West Thorofare Bay. Assessment of benthic macroinvertebrates, combined with overall habitat characteristics may support a reclassification in this area to ORW.

4.3 NEUSE RIVER MAINSTEM - Ambient Monitoring System Data

Water quality data collected at Ambient Monitoring System (AMS) stations within the Neuse River basin have been evaluated for the period 1987-1991 to coincide with the five year basinwide permitting cycle. An example of the information available at each station can be found in Figure 4.2. This section contains a summary of some of the more important information from this evaluation. Basinwide assessment was accomplished by a review of the spatial representation of data collected from AMS stations on the main stem of the Neuse River. The effects of all significant point sources discharging directly into the river as well as nonpoint and tributary inputs should be reflected in the summarization of these data on a basinwide level.

At present, North Carolina has 16 AMS stations located on the main stem of the river (Figure 4.1 and Table 4.2). Three of these stations were initiated in June 1989 as part of the Albemarle-Pamlico Estuarine Study project. Since these stations have a relatively short period of record compared to the other Neuse mainstem stations they have not been included in subsequent analyses. A complete review of data associated with these stations can be found in the Albemarle-Pamlico Baseline Water Quality Monitoring Data Summary (NC DEHNR, 1992).

Table 4.2. Ambient Monitoring Stations on the Neuse River Mainstem from Falls Lake to Pamlico Sound

Primary Number	Location
02087183	Neuse River @ SR 2000 nr Falls
02087500	Neuse River @ Hwy 42 nr Clayton
02087570	Neuse River @ Hwy 701 nr Smithfield
02089000	Neuse River @ SR 1915 nr Goldsboro
02089500	Neuse River @ Hwy 11 Bypass @ Kinston
02091814	Neuse River @ SR 1470 nr Fort Barnwell
02091836	Neuse River @ SR 1400 nr Streets Ferry
02092092	Neuse River Below Swift Creek nr Askin
02092109	Neuse River Below Narrows nr Washington Forks
02092162	Neuse River @ Hwy 17 @ New Bern
02092586	Neuse River @ Mouth of Broad Creek nr Thurman
02092674	Neuse River @ Mile #12 nr Oriental
02092682	Neuse River @ Mouth nr Pamlico
*NEU131F	Neuse River @ Light 22 nr Fairfield Harbor
*NEU131X	Neuse River @ Light 11 nr Riverdale
*NEU139	Neuse River @ Light 9 nr Minnesott Beach

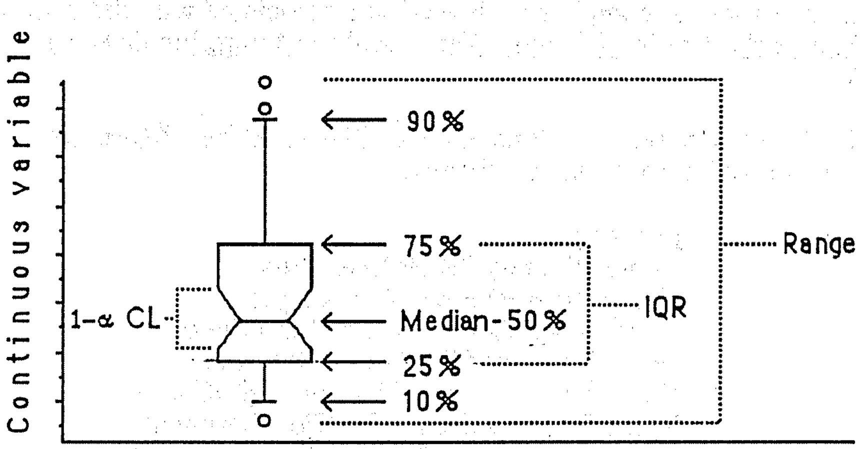
* A/P Stations not part of this analysis

Evaluation included the following parameters: *dissolved oxygen, dissolved oxygen % saturation* (April through October), *conductivity, total phosphorus, total nitrogen, chlorophyll a* (April through October), *turbidity*, and *salinity*. All data evaluated were from surface samples. Conductivity was not evaluated below station 02092092, Swift Creek near Askin, because of the influence of periodic occurrences of salinity and salinity was not evaluated above station 02092109, Narrows near Washington Forks, because of the infrequency of measuring salinity above this point. Box and whisker (Figure 4.2) plots have been used to show distribution of data for the period of record of each station (1987 through 1991). The data used in the line graphs are annual medians for the various stations.

Throughout the remainder of this section, there are two main types of figures included in this summary for some of the evaluated water quality parameters. One type uses the *box and whisker* method (see Appendix II for explanation) to show the distribution of data for the period of record 1987 through 1991. The second set of figures uses line charts to

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 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-a 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 boxplots can be used to roughly perform hypothesis testing. If the boxplots 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.

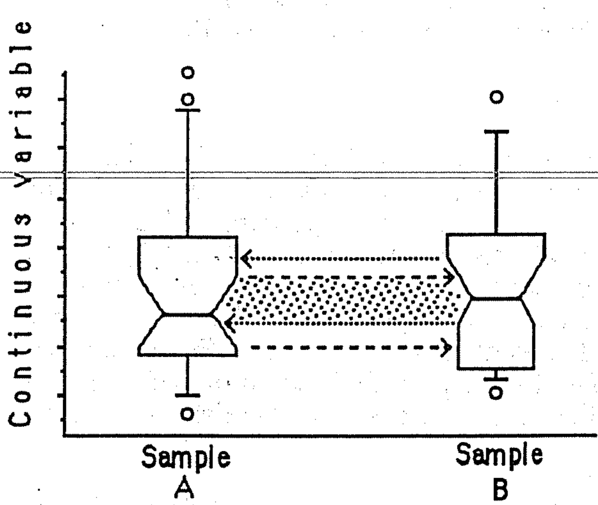


Figure 4.2 Explanation of Box and Whisker Plots

illustrate the data both spatially and temporally by plotting annual medians for various mainstem AMS stations.

4.3.1 Dissolved Oxygen

Figure 4.3 shows surface dissolved oxygen concentrations in the Neuse mainstem gradually declining from Falls Lake Dam to New Bern before abruptly increasing again as the river configuration broadens from a relatively narrow channel to the open waters of the estuary.

Dissolved oxygen levels stayed above the 5.0 mg/l standard from just below Falls Lake to Goldsboro. At the Kinston and Fort Barnwell stations there were several readings that fell just below the standard. Then from Streets Ferry to Washington Forks (above New Bern), dissolved oxygen readings below the standard were more common. The lower river is slow-moving and narrow from Streets Ferry to New Bern and concentrates oxygen-demanding wastes coming from further upstream. The low readings are attributed primarily to BOD loadings from wastewater treatment plants as well as the flow from *swamp* tributaries that have naturally low dissolved oxygen levels. BOD impacts on dissolved oxygen are discussed more fully in Chapter 3 and recommended management measures are presented in Chapter 6.

The increase in surface dissolved oxygen readings at and below New Bern is attributed to algal blooms. Figure 4.4, which presents percent dissolved oxygen saturation at the water's surface, shows concentrations above 100 percent. In a study conducted by NCDEM to provide baseline water quality monitoring data for the Albemarle-Pamlico Estuarine Study, supersaturated conditions (greater than the state standard of 110 percent saturation) occurred in as much as 41 percent of the surface samples from the middle Neuse River station, NEU131X, during 1989 to 1990 (NCDEM, 1992). These high concentrations result from algal photosynthesis during daylight. Bottom readings in the estuary, however, are sometimes much lower than the surface waters due to lack of reaeration, sediment oxygen demand, algal decomposition and differences in surface and bottom temperatures and salinities. An example of the difference between surface and bottom concentrations is shown in the bottom half Figure 4.5. This figure presents five-year bottom and surface salinity and dissolved oxygen concentrations at the ambient station at the mouth of Broad Creek near Thurman. In February of 1988, the surface concentration was about 9 mg/l while the bottom was at zero. Ironically, however, in January of 1988, the bottom concentration exceeded that of the surface waters at that station thus demonstrating the dynamic nature of these waters.

4.3.2 Nutrients

The concentration of phosphorus in the Neuse mainstem decreased dramatically over the 1987 to 1991 study period, especially in the upper river (Figure 4.6), while nitrogen concentrations stayed about the same over the period (Figure 4.7). The phosphorus reduction is attributed, in part, to a statewide phosphate detergent ban (implemented 1988), which resulted in less phosphorus going into and being discharged from wastewater treatment plants. It also resulted from improved nutrient removal at Raleigh's wastewater treatment plant (Figure 4.8).

Figures 4.6 and 4.7 are interesting in several other respects. First, the low nutrient level reading at the left side of the graph (SR 2000 near Falls) is taken from an ambient station located just below Falls Lake. The lake, in effect, has assimilated most of the nutrients from upstream. The nutrient concentrations in the water released from the lake is therefore

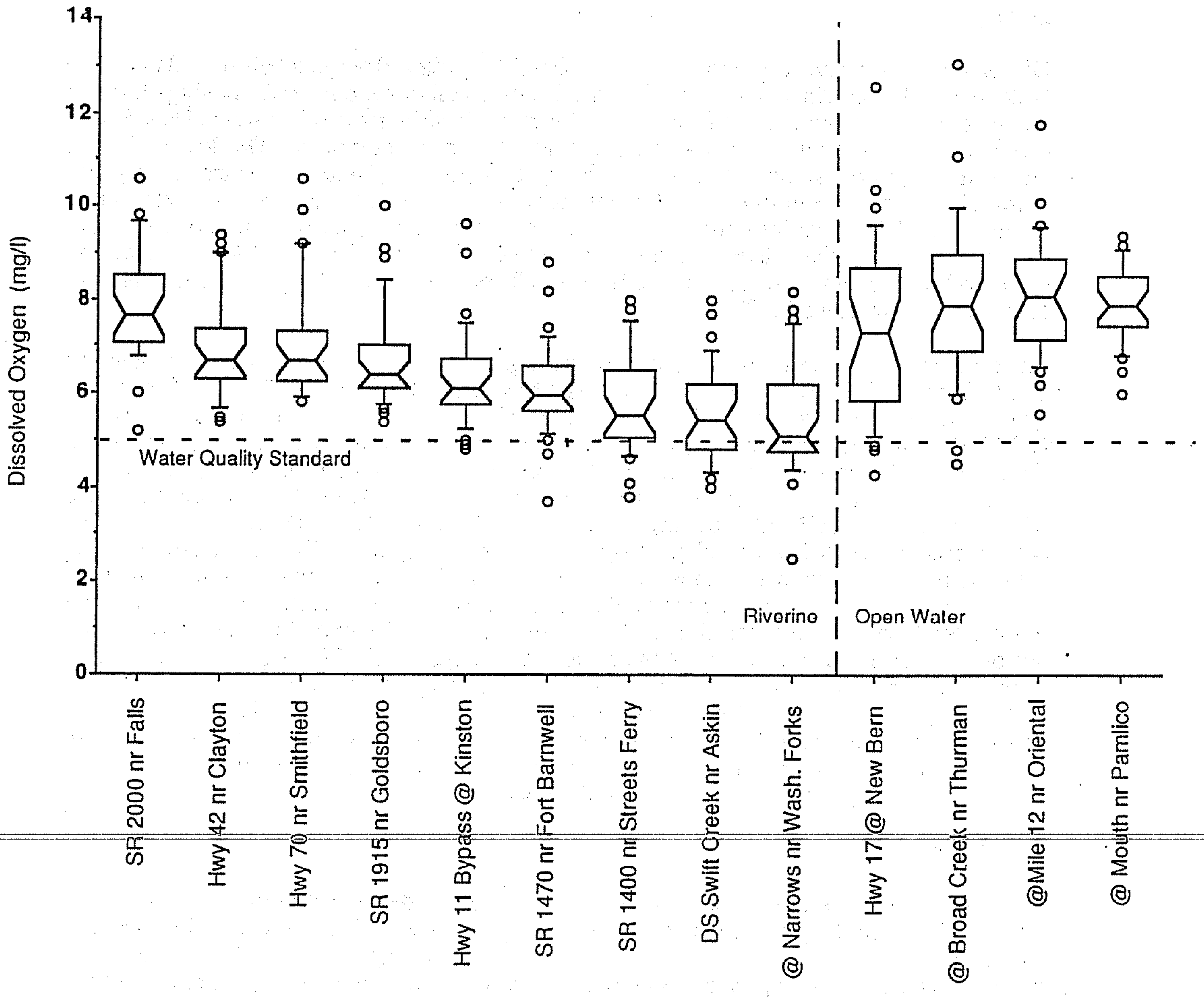


Figure 4.3 Dissolved Oxygen Concentrations (Surface Readings)
Summer Season - April Through October - 1987 through 1991
Neuse River - Falls Lake to Pamlico Sound

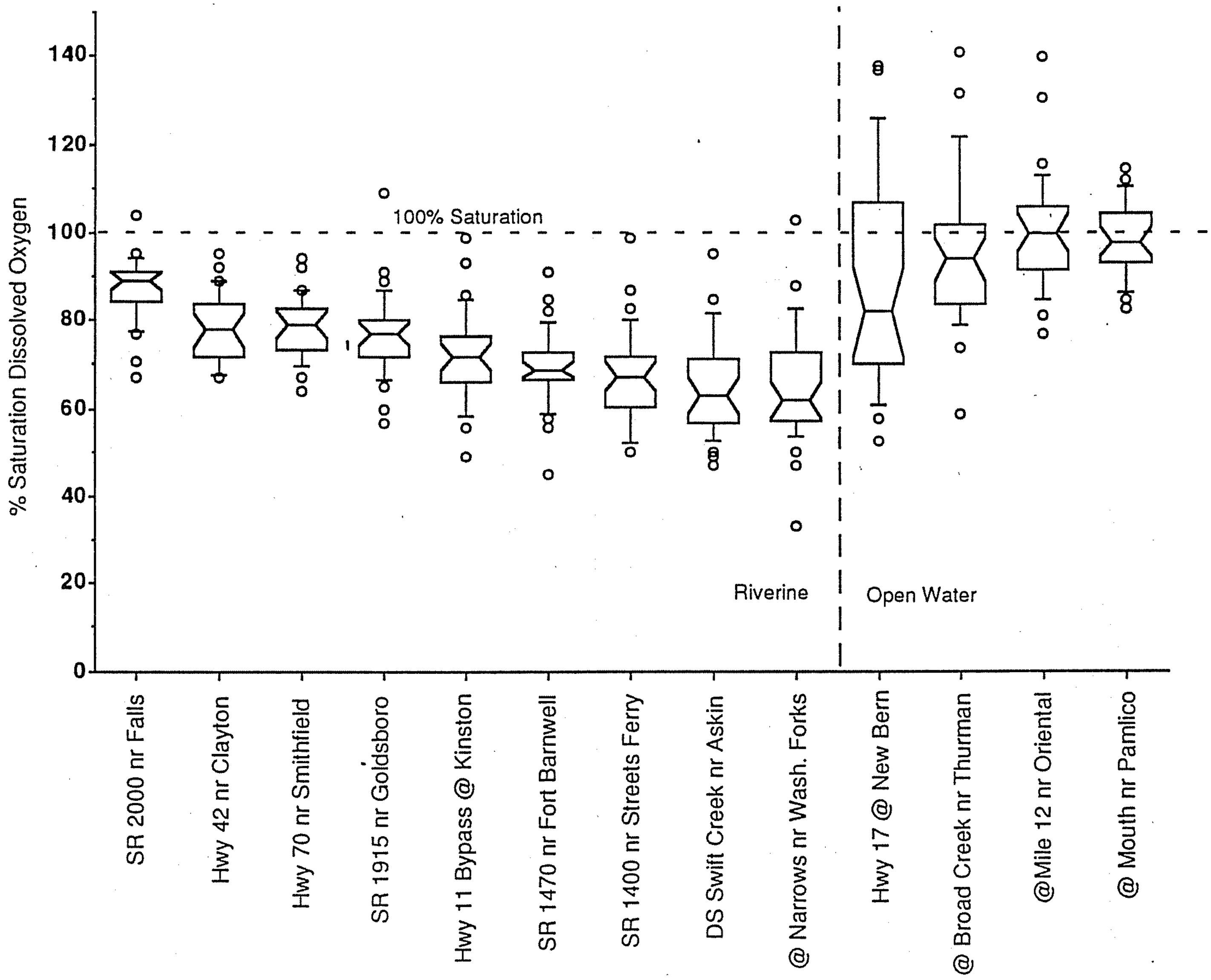


Figure 4.4 Percent Saturation - Dissolved Oxygen
Summer Season - April Through October - 1987 through 1991
Neuse River - Falls Lake to Pamlico Sound

Figure 4.5 Salinity and Dissolved Oxygen, Bottom and Surface Profiles Neuse River at Mouth of Broad Creek near Thurman

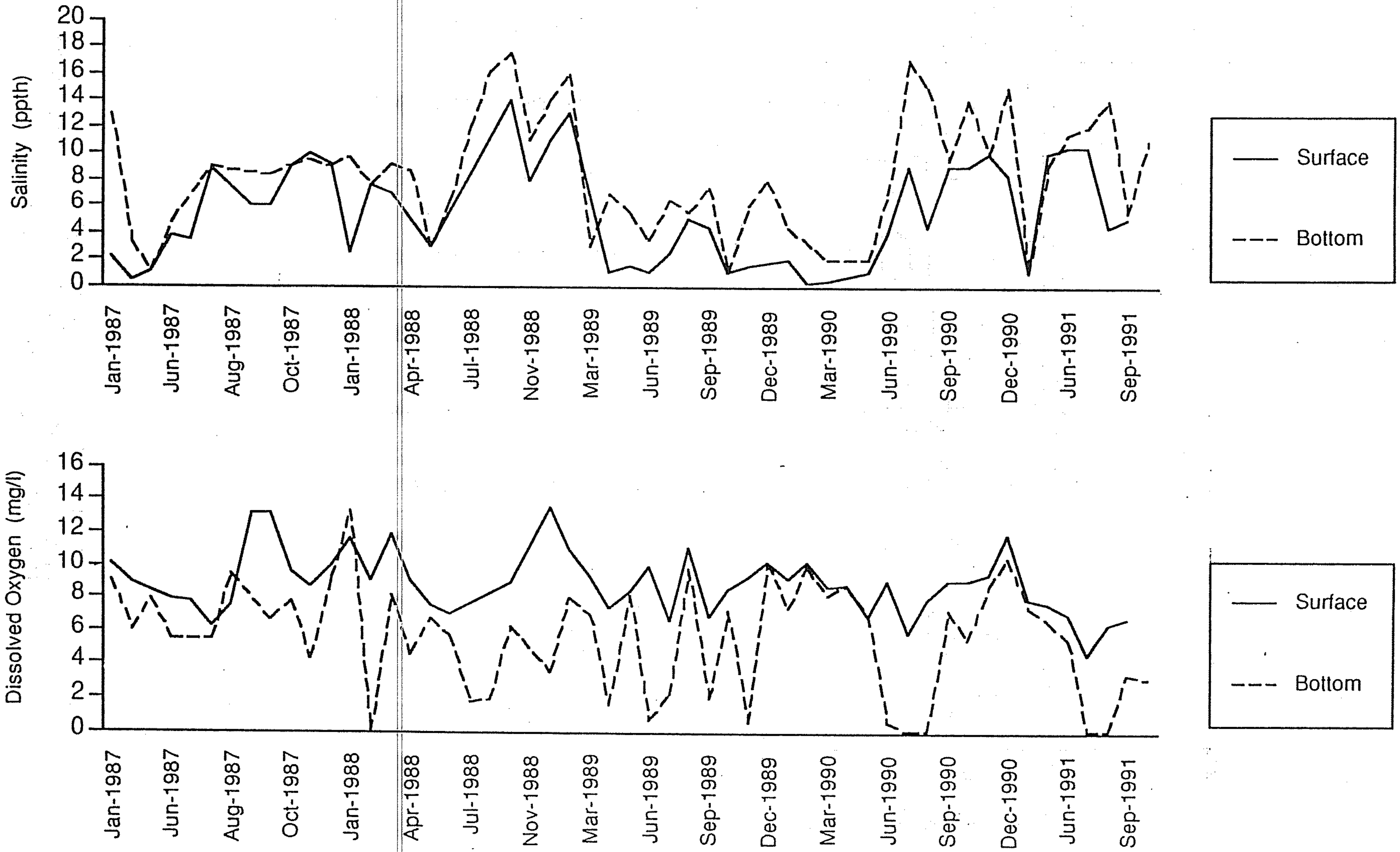


Figure 4.6 Median Annual Total Phosphorus - 1987 through 1991
Neuse River - Falls Lake to Pamlico Sound

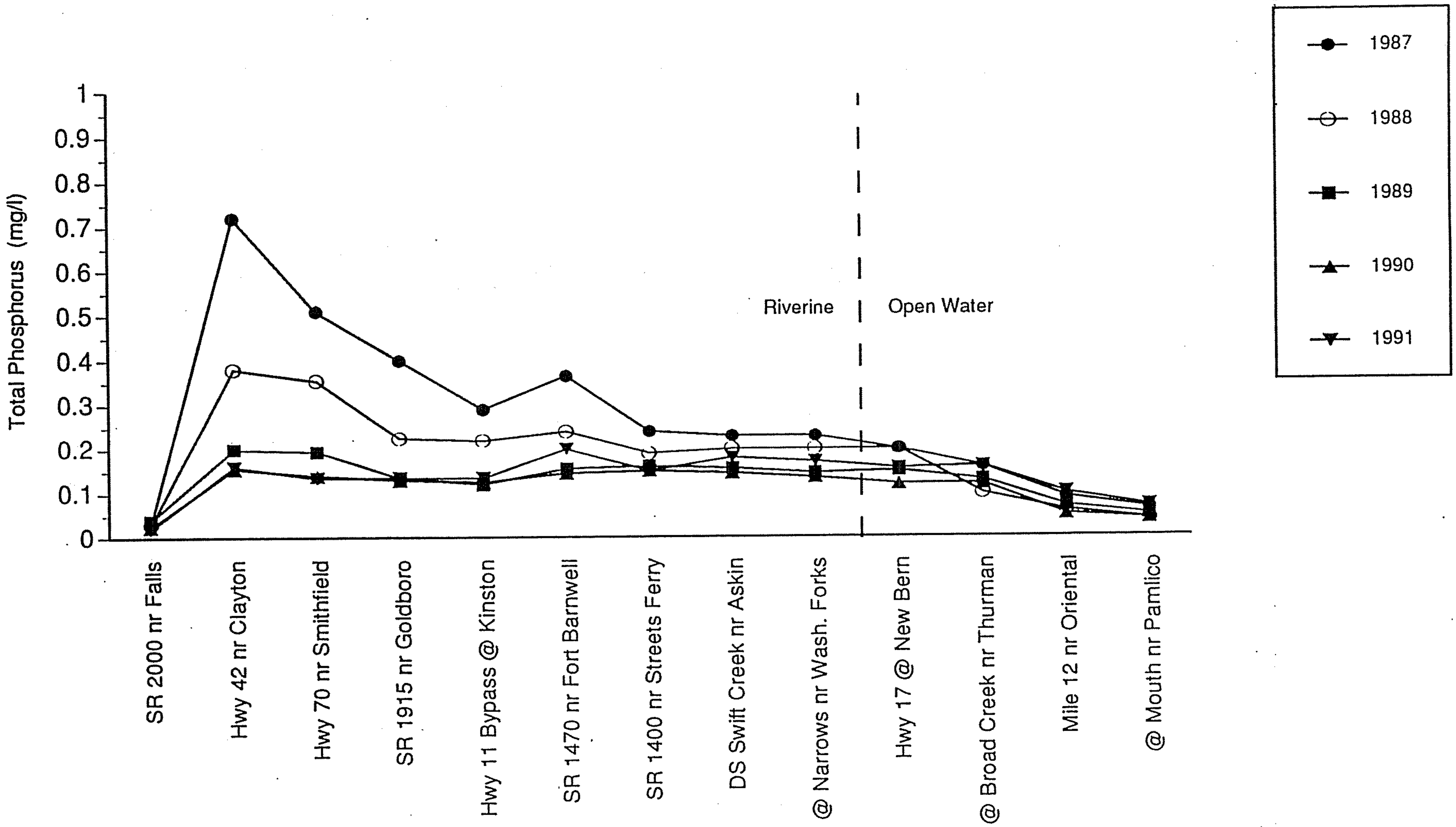


Figure 4.7 Median Annual Total Nitrogen - 1987 through 1991
Neuse River - Falls Lake to Pamlico Sound

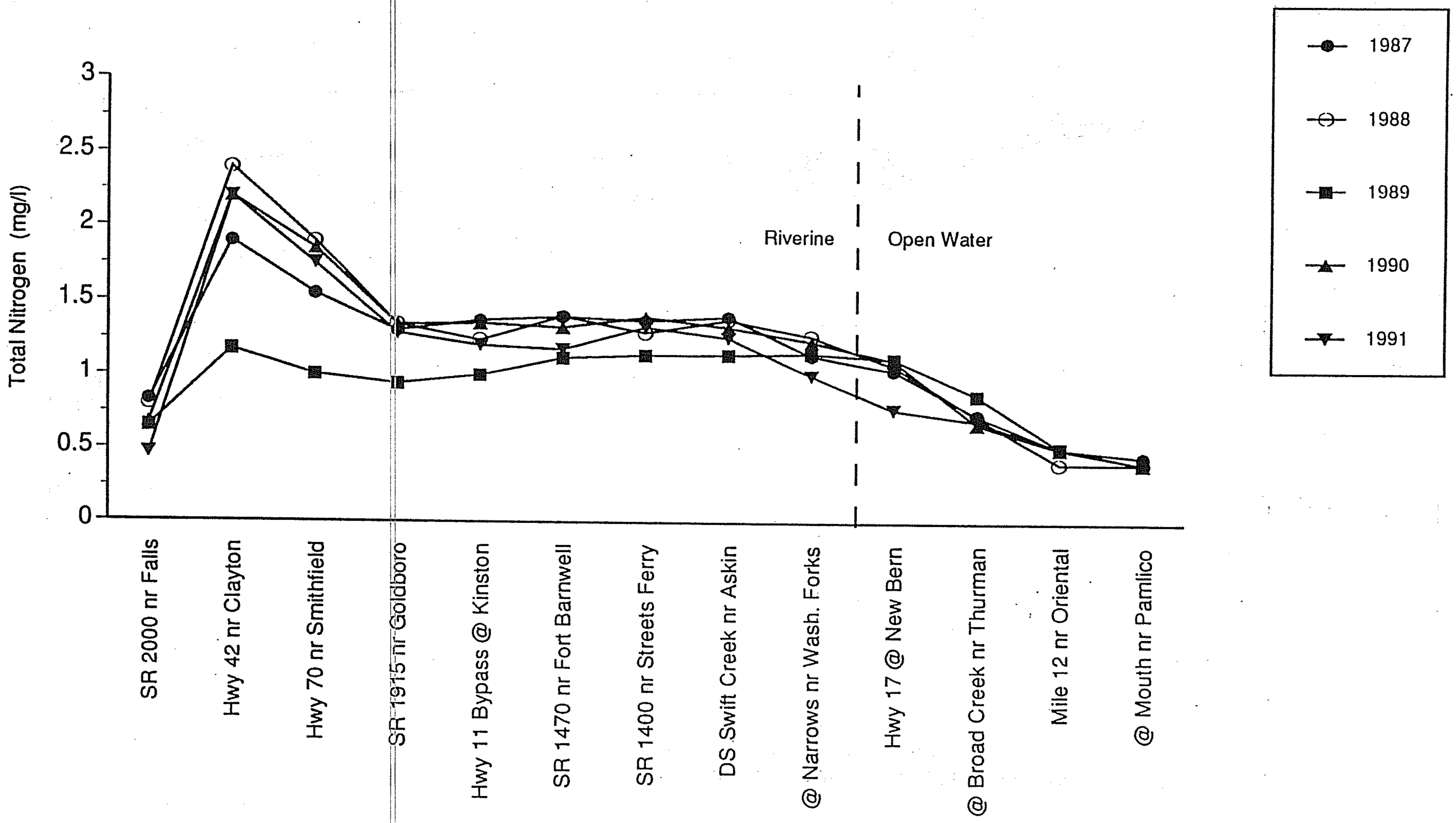
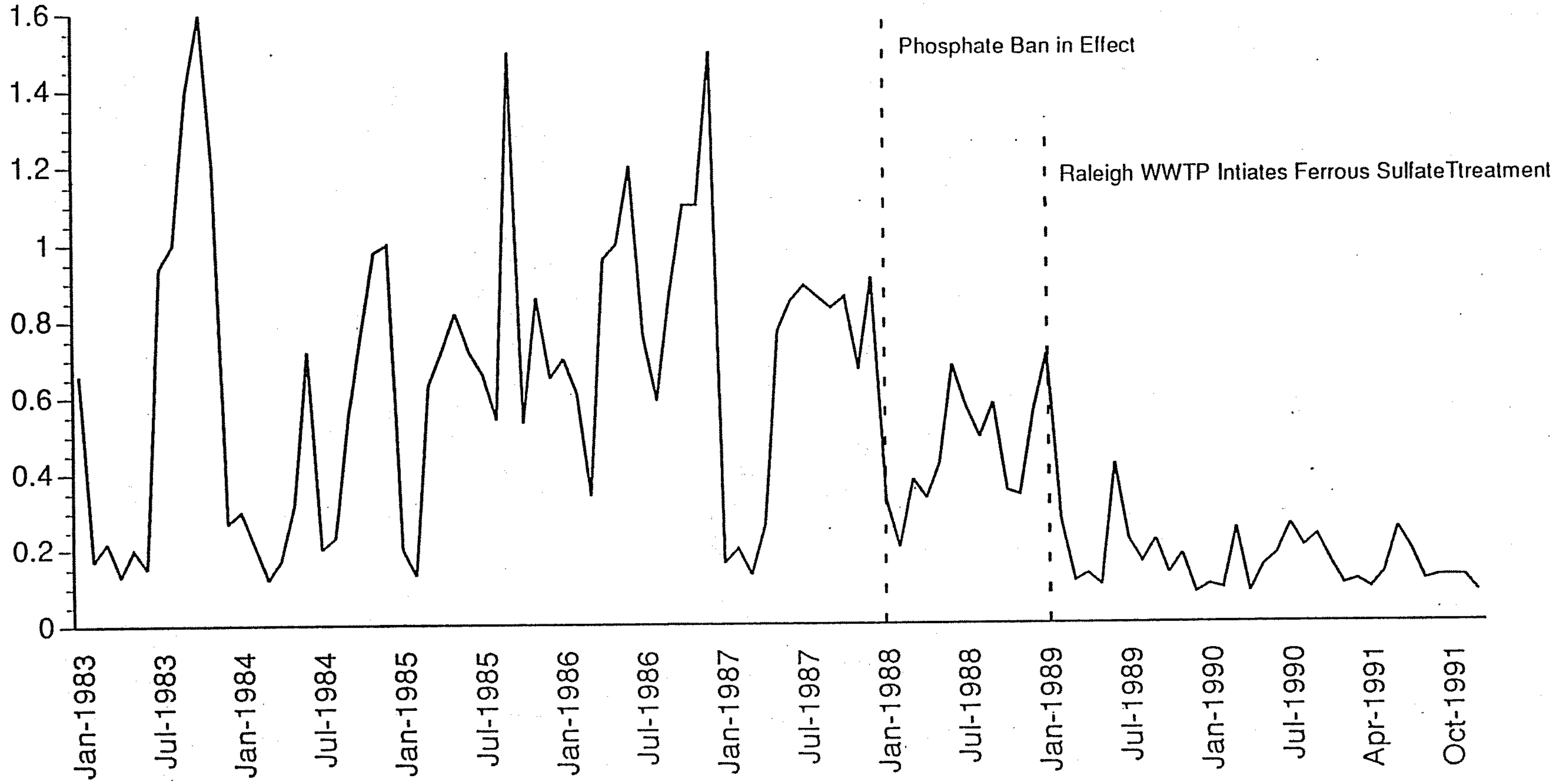


Figure 4.8 Total Phosphorus Over Time - Neuse River Near Clayton
January 1983 through December 1991



very low. Second, the increase in nutrients at the next station near Clayton demonstrates the effects of Raleigh's Neuse River WWTP on nutrient levels. The plant discharges at a point approximately two thirds of the distance downriver from the Falls AMS site toward the Clayton AMS site. Third, the influence of the river changing from riverine to estuarine above New Bern can also be seen as nutrient concentrations trend downward below New Bern. Interestingly, the large decrease in phosphorus concentration in the upper river is not reflected in the estuary.

4.3.3 Chlorophyll a

The box and whisker plot in Figure 4.9 shows that chlorophyll a is generally not a problem above New Bern with median values well below the 40 mg/l standard and only a few isolated readings above the standard. Below New Bern, standard violations are much more common. Chlorophyll a is used as an indicator of algal growth. High chlorophyll a values are generally indicative of excessive algal growth which can be stimulated by nutrient overenrichment. Reducing chlorophyll a concentrations is therefore tied to nutrient controls which are addressed in Chapter 7.

4.3.4 Metals

In general, there does not appear to be a problem with elevated metals concentrations in the Neuse Basin based on the AMS data. As in other parts of the state, iron, aluminum, copper, manganese, and zinc show up above detection level in the monitoring data. However, the more toxic metals, arsenic, cadmium, chromium, lead, mercury, and nickel are not found above detection level with any regularity The exception is the Knap of Reeds station which has data showing three mercury water quality violations and some elevated lead concentrations.

Because of the paucity of metals data found above detection level, it is not appropriate to calculate summary statistics or construct box and whisker plots as these would present skewed interpretations of the data.

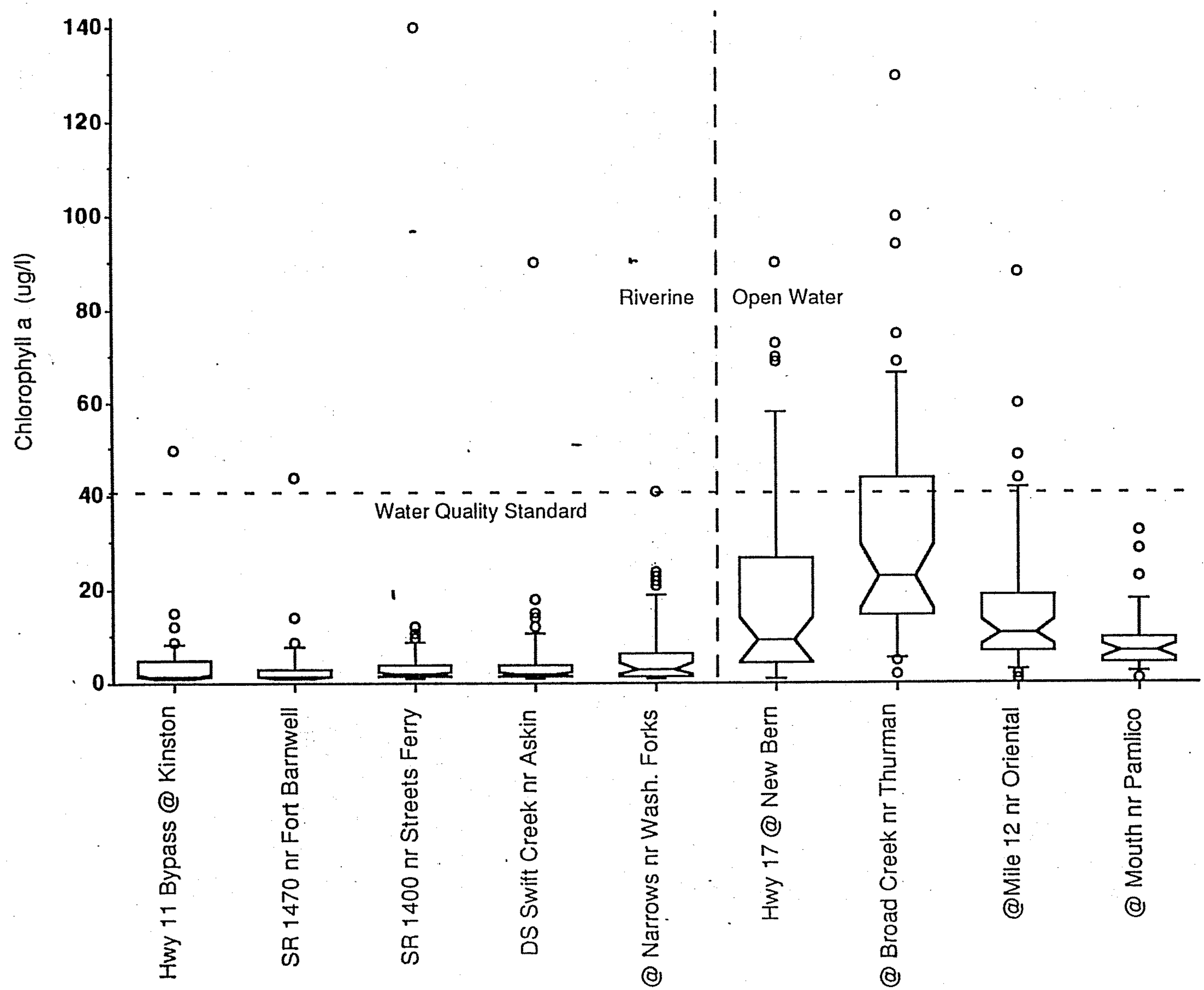
4.3.5 Salinity

Measurable salinity extends upstream from New Bern to the reach between the ambient stations at the Narrows, near Washington Forks, and the mouth of Swift Creek, near Askin. Downstream from the Narrows AMS station, salinity rises slowly to the Broad Creek station near Thurman. The average salinity in this area is about 5 parts per thousand (ppth). Below Thurman, salinities rise more rapidly reaching an average of 15 ppth at the mouth of the river. Salinities in the upper estuary vary considerably. High rainfalls depress salinity while drought allows higher salinities to move further upstream. The upper half of Figure 4.5 shows salinities at the AMS station near Thurman ranging from nearly zero to almost 18 ppth. Bottom salinities are somewhat higher than those at the surface as saline waters are denser than freshwater.

4.4 METHODS FOR DETERMINING WATER QUALITY "USE SUPPORT" RATINGS

Determining the *use support* status of a waterbody, that is how well a waterbody supports its designated uses, is another method of interpreting water quality data. This process involves compilation and evaluation of existing data to determine whether a waterbody *fully supports*, *partially supports* or does *not support* its designated use. A rating of *support-threatened* is also available for waters which fully support their designated uses but that

Figure 4.9 Chlorophyll a - 1987 through 1991
Neuse River - Kinston to Pamlico Sound



may not fully support uses in the future. A general discussion of stream classifications and designated uses can be found in Section 2.3 (and Appendix I).

4.4.1 Methodology for Determining Use Support

The methodology of interpreting water quality data to determine use support status is discussed below. In general, chemical and biological data as well as NPDES compliance records and aquatic toxicity data were used in determining use support status. Before the use support assessment was made, each data point was tracked to a specific stream segment to determine its classification, since the use support rating of a stream revolves around its designated use (e.g. aquatic life, swimming, fishing, water supply). After all data were tracked to their stream segments, a composite use support assessment was made for each stream segment.

Ambient chemical data for a specific station were first analyzed. This was done by comparing each sample from the ambient station to the water quality standard associated with the appropriate stream classification to determine the percentage of samples which exceeded the standard. An overall chemical rating was then determined for the segment by using the highest percentage of violations from the group of parameters analyzed.

Benthic macroinvertebrate and fisheries data, phytoplankton blooms, and fish kills were then tracked to the stream segment, along with NPDES dischargers significantly non-compliant with their permitted effluent limits or toxicity limits. Benthic macroinvertebrate classifications were linked to use support ratings as follows: a bioclassification of Excellent or Good related to supporting, Good-Fair related to support-threatened, Fair related to partially supporting, and Poor related to not supporting. An additional data source which was used for determining use support ratings for saltwater segments classified SA was the Division of Environmental Health's (DEH) Sanitary Shellfish Surveys published for the coastal region (Figure 4.14).

All data for a particular stream segment were then assessed to determine the overall use support rating. When the chemical and biological data led to different use support determinations, biological data were relied upon more heavily since they are a direct measurement of aquatic life support. In addition, when an NPDES permit was in significant non-compliance (SNC) with its effluent or toxicity limits, but there was no instream water quality data justifying an impaired use support, the stream was rated as support-threatened. SNC is a term used for management purposes and contains those violations that USEPA believes merit priority management and special attention. The impact of a facility in SNC on water quality can vary greatly depending on the type of non-compliance. Examples of SNC range from submitting daily monitoring reports (DMR) 30 or more days late to being out of compliance with a permit parameter four months out of six. However, two out-of-compliant violations in six months may qualify for SNC depending on the magnitude of the violations.

4.4.2 Determining Causes of Impairment

The term *causes* refers to parameters such as nutrients, sediment, and low dissolved oxygen (Chapter 3). *Causes* or *likely causes* of use support impairment are determined for waters rated as partially supporting or not supporting. Probable causes for each stream segment included those which exceeded the water quality standard frequently enough to change the use support rating from supporting to partially or not supporting, those observed by the Section's field staff through their instream monitoring activities, and professional judgment. If a water is affected by several different causes, its size (i.e., miles or acreage) is counted in each relevant cause category. This means that the total number of stream miles impaired by the collection of identified causes will exceed the total number of impaired stream miles.

4.4.3 Determining Sources of Impairment

This category refers to potential point and nonpoint sources of pollution such as industrial and municipal point sources, or agricultural, urban, and construction-related nonpoint sources. This *source* information was obtained from NCDEM's field staff through their local knowledge or instream surveys, staff from other agencies familiar with the watershed of a particular stream, best professional judgments based on land cover analyses, erosion analyses, aerial photography or pollutant loading analyses. Point sources were identified as a source of impairment if records had shown them to be significantly out of compliance with their permitted limits or if they had failed aquatic toxicity testing.

4.5 WATER QUALITY USE SUPPORT RATINGS FOR THE NEUSE BASIN

Use support ratings with corresponding sources and causes of impairment for streams rated partially, or not supporting their uses were summarized by subbasin. The purpose of this summary analysis was to provide information concerning the relative mix of supporting and impaired waterbodies as well as the relative contributions of different causes and sources of use support impairment. More specific waterbody information is contained in Table 4.3 and the use support maps presented in Figures 4.10 and 4.11. The table lists individual stream segments by subbasin which were monitored during the 1989 to 1991 time period. For each monitored segment, information is presented on the chemical and biological data, overall use support, and causes and sources of impairment.

Freshwaters Streams and Rivers

Of the 3,293 miles of freshwater streams and rivers in the Neuse basin, use support ratings were determined for 93% or 3,053 miles. The average length of these stream segments was five miles. Of the total freshwater stream miles in the Neuse basin, 22% were rated fully supporting, 41% support-threatened, 25% partially supporting, 5% not supporting, and 7% nonevaluated. Table 4.4 and Figure 4.12 present the use support determinations by subbasin. In general, subbasins 01, 02, 03, 05, 06, 07, 08, 09 and 12 had a majority of their streams which were either supporting or support-threatened. In contrast subbasins 04, 10 and 11 had a larger percentage of streams which were partially supporting or not supporting.

Probable causes and sources of impairment were determined for about 75% of the impaired streams with the information summarized in Table 4.5. 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 4.4. As an example, if a 10-mile long steam 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 4.5 (Probable Sources...). Where the source of impairment could not be identified, no mileage for that segment was entered into the table. Sediment was the most widespread cause of impairment, followed by low dissolved oxygen/biochemical oxygen demand, bacteria and metals. In general, sediment and low dissolved oxygen/biochemical oxygen demand were clearly the most widespread causes of impairment in the freshwater segments.

TABLE 4.3 NEUSE RIVER BASIN MONITORED FRESHWATER SEGMENTS 1987-1991 (3 pages)

Station Number	Station Location	Classification	Index Number	Miles	1989-91 Chemical Rating	Biological Rating 1987	1988	1989	1990	1991	Overall Rating Problem Parameters	Use Support	Source
SUBBASIN 030401													
	Eno River at SR-1336, Orange Co.	WS-III NSW	27-2-(1)	7.1						Good-Fair	Flow	ST	NP
	Sevenmile Creek at SR-1120, Orange Co.	WS-III NSW	27-2-6	7.5						Good-Fair		ST	
	Eno River at Hwy 86, above WWTP	C NSW	27-2-(7)a	2.5			Good-Fair	Good			Flow	S	NP
	Eno River at Hwy 70, below WWTP	C NSW	27-2-(7)b	3.1			Good-Fair	Good			Flow	ST	NP,P
	Eno River at Cabes Ford, SR-1569, Orange Co.	WS-III NSW	27-2-(10)	14.9			Good			Excellent	Flow	S	
02085070	Eno River near Durham, US Hwy 501	WS-III&B NSW	27-2-(16)	1.6	ST		Good		Good		Flow	ST	NP
02085079	Eno River at SR-1004, Durham Co.	C NSW	27-2-(19.5)	9.3	S					Good	Flow	ST	NP,P
02085220	Little River near Orange Factory (0208521324)	WS-III NSW HQW	27-2-21-(1)b	1.0	PS	Excellent		Good	Good/Excel	Excellent	Fecal	S	NP
	North Fork Little River at SR-1461, Durham Co.	WS-III NSW HQW	27-2-21-3	19.2						Excellent		S	
02085477	Flat River near Quail Roost, SR-1614, Durham Co.	WS-III NSW	27-3-(1)b	7.0	S		Good			Excellent		S	P,NP
	Flat River at SR-1737, Person Co.	WS-III NSW	27-3-(1)a	7.0					Good			S	NP
	North Flat River at SR-1715, Person Co.	WS-III NSW	27-3-2	12.7						Good		S	NP
	South Flat River at SR-1109, Person Co.	WS-III NSW	27-3-3a	3.0					Fair			PS	
	South Flat River at Hwy 157, Person Co.	WS-III NSW	27-3-3b	15.5					Good			S	
	Brushy Fork Creek at SR-1108, Person Co.	WS-III NSW	27-3-3-1	6.2					Good			S	
	Deep Creek at SR-1715, Person Co.	WS-III NSW	27-3-4	16.4					Excellent			S	
02086501	Flat River near Willardsville, SR-1622	C NSW	27-3-(8)	6.0	NS						DO	NS	NP, P
	Knap of Reeds Creek above discharge, Granville Co.	C NSW	27-4-(6)c	3.1						Fair		PS	
	Knap of Reeds Creek below discharge, Granville Co.	C NSW	27-4-(6)d	1.7						Fair		PS	NP,P
02086624	Knap of Reeds Creek near Butner, SR-1121/1004, Granville Co.	C NSW	27-4-(6)a	2.7	S							ST	P
02086849	Ellerbe Creek near Durham, SR-1636/1709, Durham Co.	C NSW	27-5	15.5	S					Poor		NS	NP,P
	Little Lick Creek at SR-1815 above discharge, Orange Co.	C NSW	27-9a	6.5						Poor		NS	
0208700780	Little Lick Creek near Durham, SR-1814 below disch.	C NSW	27-9b	4.5	PS		Poor			Fair	Turb	PS	NP,P
	Smith Creek at SR-1710, Granville Co.	WS-III NSW	27-12-2	8.5						Good-Fair		ST	
	Upper Barton Creek at Hwy 50, Wake Co	C NSW	27-15	8.8						Good	Sed	S	
SUBBASIN 030402													
	Richland Creek at Hwy 1, Wake Co.	C NSW	27-21	8.6						Good-Fair		ST	NP
02087216	Neuse River at Wake Crossroads, Hwy 401, Wake Co.	C NSW	27-(22)a	5.6		G-F/Good		Good-Fair		Good-Fair	Fecal	ST	NP
	Neuse River at Hwy 64, Wake Co.	C NSW	27-(22)c	7.7						Good-Fair	Fecal	ST	NP,P
	Toms Creek at SR-2044, Wake Co.	C NSW	27-24	4.0						Good-Fair		ST	
	Crabtree Creek at Hwy 54 above Moorisville WWTP, Wake Co.	C NSW	27-33-(1)a	4.9			Fair/Poor			Fair		PS	NP
02087251	Crabtree Creek at SR-1795 near Umstead Park, Wake Co.	B NSW	27-33-(6)a	0.3	PS						DO	PS	NP
0208725115	Crabtree Creek at Reedy Creek State Park, Wake Co.	B NSW	27-33-(6)d	2.0	PS						Fecal, Sed	PS	NP
	Crabtree Creek at Ebenezer Church Road	B NSW	27-33-(6)e	0.7		Good-Fair				Fair		PS	NP
	Sycamore Creek below Turkey Creek, Wake Co.	B NSW	27-33-9	9.4						Good-Fair	Sed, Nutr	ST	NP,P
02087323	Crabtree Creek at Raleigh, Old Farmer's Market, Wake Co.	C NSW	27-33-(10)	16.0	ST			Fair				PS	NP
	Richland Creek at Ebenezer Church Rd, SR-1649, Wake Co.	C NSW	27-33-11	5.4						Fair		PS	
0208732544	Pigeon House Branch at Raleigh, Dortch Street, Wake Co.	C NSW	27-33-18	2.9	NS						Sed,Cu	NS	NP
	Walnut Creek at SR-1730, Wake Co.	WS-III NSW	27-34-(1)	3.5						Fair		PS	NP
	Walnut Creek at SR-1348, Wake Co.	WS-III NSW	27-34-(1.7)	3.4						Good (fish)		S	
02087500	Neuse River near Clayton, NC Hwy 42	WS-III NSW	27-(36)a	7.5	S		Good/Fair		Good			S	
02087570	Neuse River at Smithfield, SR-1201, Johnston Co.	WS-III NSW	27-(36)b	42.9	S					Good		S	NP,P
	Neuse River near Princton, Johnston Co.	WS-III NSW	27-(36)c	24.9						Good		S	P
	Marks Creek at SR-1714, Johnston Co.	C NSW	27-38	11.7						Good-Fair		ST	
	Swift Creek at Old Raleigh Road, Wake Co.	WS-III NSW	27-43-(1)a	2.4				Poor			Sed, Nutr	NS	NP,P
	Swift Creek at US 1, Wake Co.	WS-III NSW	27-43-(1)b	3.0				Fair		Fair	Sed, Nutr	PS	NP
	Swift Creek at Hemlock Bluffs, Wake Co.	WS-III NSW	27-43-(1)c	0.6						Good-Fair		ST	

TABLE 4.3 NEUSE RIVER BASIN MONITORED FRESHWATER SEGMENTS 1987-1991 (3 pages)

Station Number	Station Location	Classification	Index Number	Miles	1989-91 Chemical Rating	<------ 1987	------Biological 1988	Rating------ 1989	1990	------> 1991	<----Overall Rating----> Problem Parameters	Use Support	Source
SUBBASIN 030402 Continued													
	Swift Creek at Holly Springs Road, Wake Co.	WS-III NSW	27-43-(1)d	2.4						Fair		PS	
	Williams Creek at Old Raleigh Road, Wake Co.	WS-III NSW	27-43-2	4.8				Poor				NS	NP
0208772185	Swift Creek near Clayton, NC Hwy 42	C NSW	27-43-(8)a	6.0	S			Fair		Fair		PS	NP
	Swift Creek at SR-1501, Johnston Co.	C NSW	27-43-(8)b	25.0						Good-Fair		ST	
	Little Creek at SR-1562, Johnston Co.	C NSW	27-43-12	12.0						Fair	Sed	PS	NP,P
	Moccasin Creek at SR-1007, Johnston Co.	C NSW	27-53	22.3						Fair		PS	
SUBBASIN 030403													
	Middle Creek at SR-1375, Wake Co.	C NSW	27-43-15-(4)b	2.3						Good-Fair		ST	NP,P
02088000	Middle Creek near Clayton, Hwy 50, Johnston Co.	C NSW	27-43-15-(4)e	28.6	S					Good-Fair	Sed	ST	P
	Middle Creek at SR-1504, Johnston Co.	C NSW	27-43-15-(4)f	11.3						G/Ex (Fish)		S	
SUBBASIN 030404													
	Black Creek at SR-1330, Johnston Co.	C NSW	27-45-(2)	26.1						Fair		PS	
	Mill Creek at SR-1009, Johnston Co.	C NSW	27-52	16.1						Good-Fair		ST	NP
	Stone Creek at SR-1138, Johnston Co.	C NSW	27-52-5	11.4						Fair (Fish)		PS	
	Hannah Creek at SR-1009, Johnston Co.	C NSW	27-52-6	20.5						Fair		PS	
SUBBASIN 030405													
02089500	Neuse River near Kinston, NC Hwy 58, Lenoir Co.	C NSW	27-(56)b	42.8	S	Good-Fair	Good		Good	Good-Fair		ST	NP
	Bear Creek at SR-1311, Lenoir Co.	C Sw NSW	27-72	15.8						Good-Fair	Sed	ST	NP
	Falling Creek at SR-1340, Lenoir Co.	C Sw NSW	27-77	13.9						Good-Fair	Sed	ST	NP
	Southwest Creek at SR-1804, Lenoir Co.	C Sw NSW	27-80	21.8						Fair		PS	NP
	Mosley Creek at SR-1475, Craven Co.	C Sw NSW	27-84	10.5						Good (Fish)		S	
SUBBASIN 030406													
	Little River at Hwy 96, Wake Co.	WS-I NSW	27-57-(1)a	9.3			Fair/Poor			Good-Fair		ST	NP
02088500	Little River near Princeton, SR-2320, Johnston Co.	WS-I NSW	27-57-(8.5)e	14.2	S	Good-Fair		Good-Fair				ST	P
	Little River at SR-1722, Johnston Co.	WS-I NSW	27-57-(8.5)b	9.7						Good-Fair		ST	NP
	Little River at SR-2130, Johnston Co.	WS-I NSW	27-57-(8.5)c	19.4			Excellent			Good		S	NP
	Buffalo Creek at SR-1007, Wake Co.	B NSW	27-57-16-(2)	5.6						Poor	Sed,DO	NS	NP
	Buffalo Creek at SR-1941, Johnston Co.	C NSW	27-57-16-(3)	20.9						Fair	Sed	PS	NP
	Mill Creek below Kenly WWTP, Johnston Co.	C NSW	27-57-18	1.3			Poor			Poor		NS	P
	Little River at Hwy 581, Wayne Co.	WS-III NSW	27-57-(21.7)	0.5						Good		S	NP
SUBBASIN 030407													
02090380	Contentnea Creek near Lucama, Wilson Co.	WS-III NSW	27-86-(1)	20.6	PS						Sed, DO	PS	NP,P
	Moccasin Creek at SR-1131/Hwy 231, Nash Co.	C NSW	27-86-2-(1)	21.5			Good-Fair			Good-Fair	Sed	ST	NP,P
	Little Creek at Hwy 97, Nash Co.	C NSW	27-86-2-4	4.5						Poor		NS	
	Turkey Creek at SR-1101, Nash Co.	C NSW	27-86-3-(1)	20.2			Fair			Fair	Sed	PS	NP
	Beaverdam Creek at SR-1111/SR-1112, Nash Co.	C NSW	27-86-3-8	5.7			Fair			Fair/G-Fair	Sed	ST	NP
	Turkey Creek at SR-1128, Wilson Co.	WS-III NSW	27-86-3-(9)	2.3						Good-Fair	Sed	ST	NP
0209634	Contentnea Creek near Stantonsburg, Hwy 58, Wilson Co.	C Sw NSW	27-86-(7)c	14.4			Fair/Poor		Fair	Good-Fair	Sed, Fecal Nutr, Tox	ST	NP, P
02091500	Contentnea Creek at Hookerton, Hwy 58, Greene Co.	C Sw NSW	27-86-(7)a	34.4	S						Sed	S	NP
0209176690	Contentnea Creek at Grifton, SR-1800, Pitt Co.	C Sw NSW	27-86-(7)b	19.6	S	Good				Good	Sed	S	NP,P
02090625	Tumer Swamp near Eureka, SR-1505, Wayne Co.	C Sw NSW	27-86-9.5	4.6	PS						DO	PS	
	Toisnot Swamp at Hwy 222, Wilson Co.	C Sw NSW	27-86-11-(5)	13.2						Fair		PS	
02091000	Nahunta Swamp near Shine, SR-1058, Greene Co.	C Sw NSW	27-86-14b	7.8	S		Fair		Fair/G-Fair			ST	
	Wheat Swamp at SR-1091, Greene C.	C Sw NSW	27-86-24	13.0						Poor		NS	NP
02091700	Little Contentnea Creek near Farmville, Greene Co.	C Sw NSW	27-86-26b	4.3	NS						DO	NS	NP,P

TABLE 4.3 NEUSE RIVER BASIN MONITORED FRESHWATER SEGMENTS 1987-1991 (3 pages)

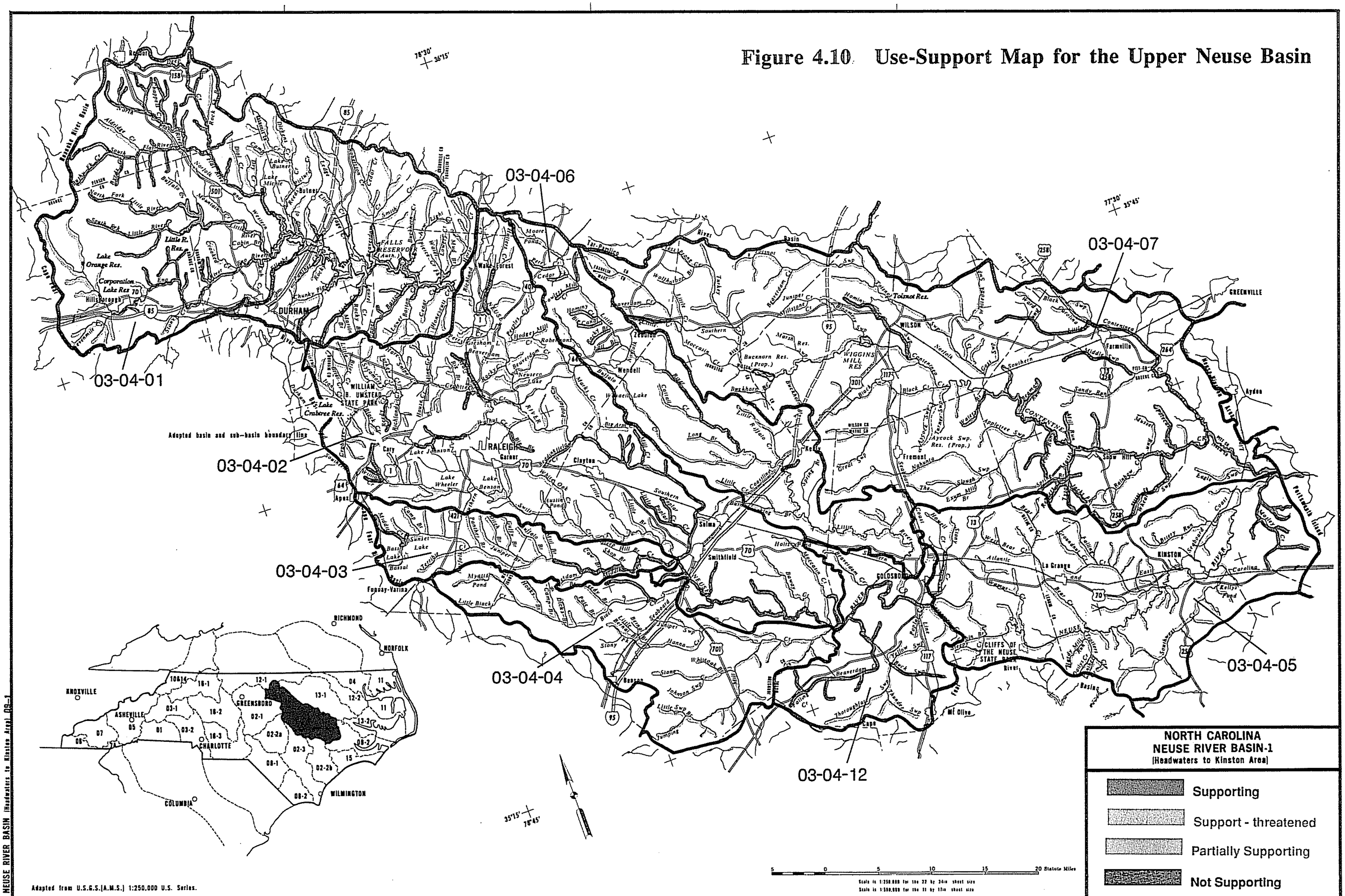
Station Number	Station Location	Classification	Index Number	Miles	1989-91 Chemical Rating	Biological Rating 1987	1988	1989	1990	1991	Overall Rating Problem Parameters	Use Support	Source
SUBBASIN 030408													
	Neuse River near Fort Barnwell, SR-1470, Craven Co.	C Sw NSW	27-(85)a	18.6	S							S	
02091836	Neuse River at Streets Ferry, SR-1423, Craven Co.	C Sw NSW	27-(85)b	1.5	ST	Good-Fair		Good-Fair				ST	
	Core Creek at Hwy 55, Craven Co.	C Sw NSW	27-90	18.5						Fair	Sed	PS	NP
SUBBASIN 030409													
	Swift Creek at Hwy 102, Pitt Co.	C Sw NSW	27-97a	4.0						Fair		PS	NP
02092000	Swift Creek near Vanceboro, SR-1478, Craven Co.	C Sw NSW	27-97b	20.4	ST	Good					Sed	ST	NP,P
	Swift Creek near Vanceboro, Hwy 118, Craven Co.	C Sw NSW	27-97c	12.4						Good-Fair		ST	NP
	Clayroot Swamp at SR-1941, Pitt Co.	C Sw NSW	27-97-5	12.6						Fair		ST	NP
02091970	Creeping Swamp near Vanceboro, Hwy 43, Craven Co.	C Sw NSW	27-97-5-3	6.6	NS					Fair (Fish)	DO	PS	NP
SUBBASIN 030410													
0209257120	Brice Creek near Riverdale, SR-1101, Craven Co.	C Sw NSW	27-101-40-(1)	21.4	NS						pH, DO	PS	NP
SUBBASIN 030411													
02092500	Trent River near Trenton, Hwy 58, Jones Co.	C Sw NSW	27-101-(1)a	32.4	ST	Good		Good/Fair	Fair			PS	NP
	Beaverdam Swamp, US Hwy 258, Lenoir Co.	C Sw NSW	27-101-3	4.7						Fair		PS	
	Reedy Branch at Hwy 41, Jones Co.	C Sw NSW	27-101-7	2.8						Good-Fair		ST	NP
	Little Chinquapin Creek at SR-1131, Jones Co.	C Sw NSW	27-101-11	4.4						Fair		PS	NP
	Beaver Creek at SR-1316, Jones Co.	C Sw NSW	27-101-15	8.0						Fair		PS	NP
	Mill Run at Hwy 58, Jones Co.	C Sw NSW	27-101-23	4.2						Good		S	NP
	Island Creek at SR-1004, Jones Co.	C Sw NSW	27-101-33	5.8						Good		S	NP
SUBBASIN 030412													
	Buck Swamp at SR-1120, Wayne Co.	C NSW	27-54-5-2	7.2						Poor		NS	NP
02089000	Neuse River near Goldsboro, SR-1915/Hwy 117, Wayne Co.	C NSW	27-(56)a	5.4	S		Good		Good	Good		S	

Note: This table lists just those freshwater stream segments where DEM has conducted biomonitoring since 1987 and has developed a biological rating.
Therefore, Table 4.3 provides background information for only a portion of the freshwater streams rated in the Use Support Maps (Figures 4.10 and 4.11).

ABBREVIATIONS and TERMS

Biological Rating: Stream quality rating based on benthic macroinvertebrate sampling (biomonitoring). See Section 4.1 and Appendix II for explanation.
Chemical Rating: Based on chemical water quality data collected at ambient monitoring stations. See Section 4.1.7 and Appendix II for explanation.
Cu = Copper
DO = Dissolved oxygen
Fecal = Fecal coliform bacteria
Flow = Low flow conditions resulting in reduced biological ratings
Hg = Mercury
NP = Nonpoint Source
NS = Not supporting
Nutr = Nutrients (e.g. phosphorus or nitrogen)
P = Point source
PS = Partially supporting
S = Supporting
Sed = Sediment (from 1985 Assessment Report)
Tox = Toxicants (from 1985 Assessment Report, not NC Aquatic Toxicity Data)

Figure 4.10 Use-Support Map for the Upper Neuse Basin



FRESHWATER USE SUPPORT STATUS FOR FRESHWATER STREAMS (MILES) (1989-1991)						
Subbasin	S	ST	PS	NS	NE	Total Miles
030401	182	275	53	38	14	563
030402	139	204	174	34	23	574
030403	11	104	0	9	1	125
030404	8	36	116	0	35	194
030405	18	205	49	4	10	286
030406	50	139	32	7	0	228
030407	107	262	108	66	58	600
030408	47	20	22	0	5	95
030409	37	37	57	0	18	150
030410	38	0	53	0	6	98
030411	50	3	152	0	61	265
030412	47	45	8	7	9	116
TOTAL	735	1328	825	165	240	3293
PERCENTAGE	22	40	25	5	7	

Table 4.4 Use Support Ratings for Freshwater Streams by Subbasin

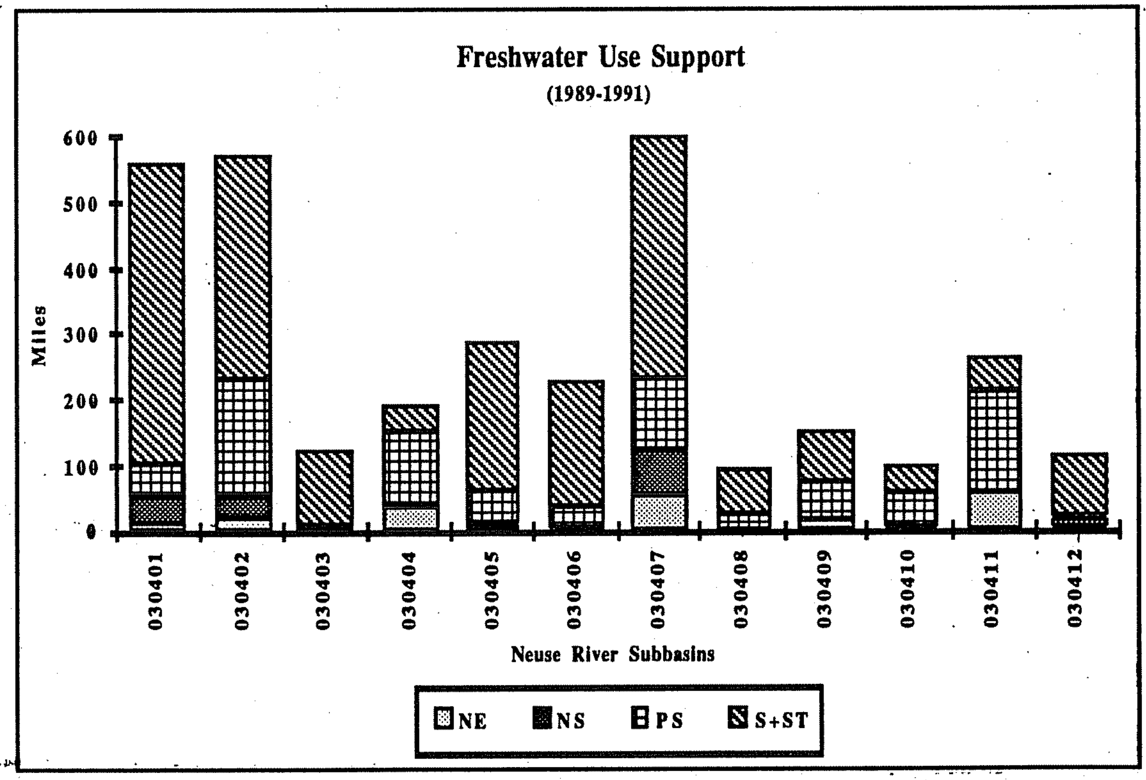


Figure 4.12 Bar Graph Showing Freshwater Use Support by Subbasin

In terms of sources of use support impairment, of the stream miles rated as partially or not supporting, the overwhelming majority were impaired by nonpoint rather than point sources. Point sources accounted for 11% of the impaired stream miles where the source of impairment was identifiable. Agriculture was the most widespread nonpoint source, followed by urban and construction activities. Subbasins 07 and 11 had the highest number of streams thought to be impaired by agriculture and subbasin 02 had the highest number attributed to urban and construction activities. While agricultural sources were identified throughout the river basin, urban and construction sources were for the most part concentrated in the upper part of the basin. This relative mix and distribution of nonpoint sources makes sense when one considers the pattern of existing land use and is consistent with nonpoint source pollution discussions in Chapter 3.

Salt (Estuarine) Waters

Use support determinations were made for all of the 328,700 acres of saltwater in the Neuse Basin. Eighty-six percent of the saltwaters were rated as fully supporting, 5 percent support-threatened, 9 percent partially supporting and 0 percent not supporting. Table 4.6 and figure 4.13 present the use support determinations by Division of Environmental Health (DEH) area (Figure 4.14), and probable causes and sources of use support impairment are presented in Table 4.7

Chlorophyll a was the most widespread probable cause of impairment followed by fecal coliform bacteria. Both of these causes are indicators of water quality degradation, the first related to nutrient overenrichment and the second to elevated bacterial levels that require the closure of shellfishing areas. The majority of partially supporting waters were in the upper part of the Neuse River estuary, from New Bern to Minnesott Beach. These waters were mainly impacted by nutrient overenrichment (chlorophyll a violations and algal blooms). Waters rated as partially supporting in the lower part of the estuary were related to closed shellfish waters.

Nonpoint source pollution is estimated to be the primary pollution source in 89% of the impaired waters, while point source impacts were identified in 11%. Waters were impacted primarily by multiple nonpoint sources including agriculture, urban runoff, septic tanks and marinas. Like nonpoint sources to freshwaters, the relative mix and distribution makes sense given the existing land use and its influence on pollutant export.

Lakes

There are nearly 100 named lakes and ponds in the Neuse basin and an innumerable number of unnamed farm ponds and other impoundments. Most of these are considered eutrophic, meaning that they are enriched with nutrients and may have an overabundance of algae and aquatic plants. Thirty of the named lakes, totaling 20,586 acres, were monitored and assigned use support ratings (Table 4.9). Of these 30, eleven fully supported their uses, eleven were support-threatened, five were partially supporting, and three were not supporting. Major causes of impairment included nutrient enrichment, noxious aquatic plants (Hydrilla and algal blooms), and siltation. Major sources of impairment include municipal point sources and runoff from construction, urban and agricultural areas.

Major causes of impairment included nutrient enrichment, noxious aquatic plants (Hydrilla and algae blooms), and siltation. Major sources of impairment include municipal point sources and runoff from construction, urban and agricultural areas. These are summarized in Table 4.9

PROBABLE SOURCES OF USE SUPPORT IMPAIRMENT (MILES)								
Subbasin	Point Source	Agriculture	Urban	Construct	Hydro Mod	Forestry	Land Disposal	Other
030401	28	19	29	26				3
030402	18	35	86	65			2	5
030403			9	9			2	
030404		6						
030405		22						
030406	1	21		21				
030407	34	86				27		
030408		19			19			19
030409	20	27			21			
030410	5	21	19	5	8		9	32
030411		84				12		
030412								
Total Miles	107	339	143	126	47	39	14	59
% of PS and NS	11	34	14	13	5	4	1	6

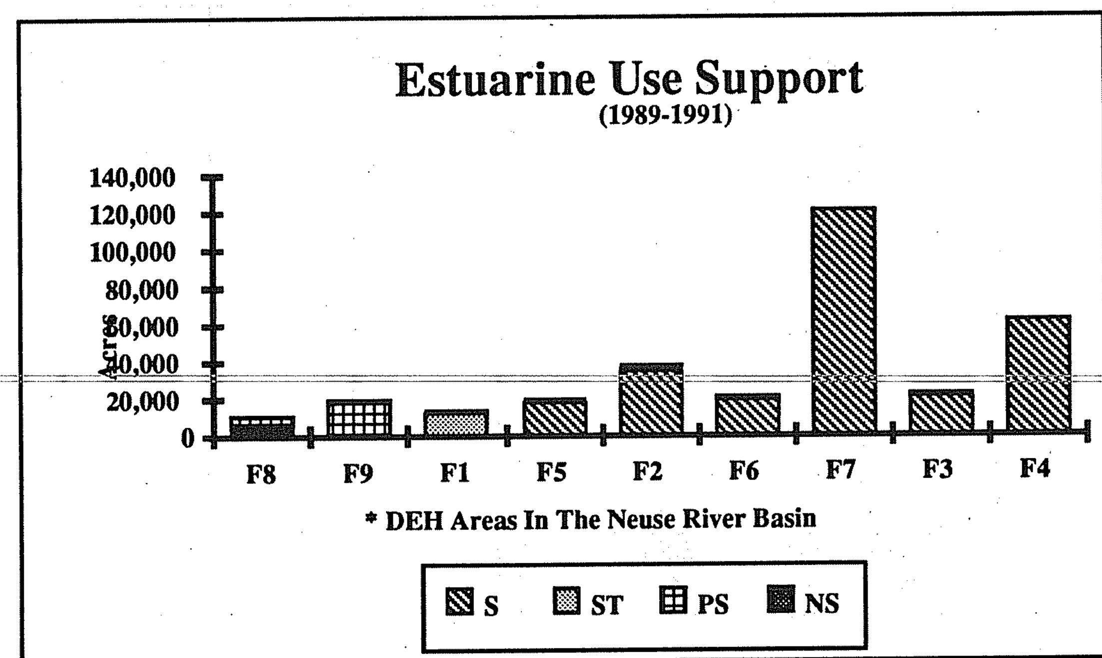
CAUSES OF USE SUPPORT IMPAIRMENT (MILES)						
Subbasin	Sediment	Low DO	Bacteria	Nutrients	Turbidity	Metals/ Toxicants
030401	22	6	10		5	
030402	65		2	5		16
030403	9		2			
030404	6					
030405	12					
030406	38	6				
030407	84	63	11	33		
030408	19					
030409	38	7			27	
030410		29				
030411		39	39			32
030412	8					
Total Miles	300	149	65	39	32	48
% of PS and NS	30	15	7	4	3	5

Table 4.5 Sources and Causes of Use Support Impairment in Freshwaters

Neuse River Estuarine Waterbodies Use Support Status (Acres)						
			<---------Overall Rating (Acres)---------->			
Area Name	Total Acres	*DEH Area	S	ST	PS	NS
Neuse River	10,500	F8	1,700	3,267	5,533	0
Neuse River	19,500	F9	0	0	19,500	0
Neuse River	13,700	F1	0	12,500	1,200	0
Oriental	19,000	F5	18,149		851	0
South River	39,000	F2	35,465	1,000	2,535	0
Bay River	20,000	F6	19,796	0	204	0
Pamlico Sound	122,000	F7	122,000	0	0	0
West Bay	22,000	F3	21,513	0	487	0
Cedar Island	63,000	F4	62,987	0	13	0
TOTAL ACRES	328,700		281,610	16,767	30,323	0
PERCENTAGE			86	5	9	0

* *DEH Area* refers to shellfish water areas designated by the Division of Environmental Health (DEH). See Figure 4.14 for DEH shellfish area boundaries.

Table 4.6 Neuse River Estuarine Waterbodies Use Support Status (Acres)



* *DEH Area* refers to shellfish water areas designated by the Division of Environmental Health (DEH). See Figure 4.14 for DEH shellfish area boundaries.

Figure 4.13 Bar Graph of Estuarine Use Support Status (1989-1991)

Neuse River Estuarine Waterbodies Causes and Probable Sources of Use Support Impairment (1989-1991) (PS and NS waterbodies only)						
	DEH	Causes		Sources		
Area Name	Area	Chl a	Bacteria	Point	NPS	Source Descriptions
Neuse River	F8	5,533	0	1,950	3,583	wwtp,ag,urban, swamp
Neuse River	F9	19,500	0	1,100	18,400	wwtp,ag,urban, swamp
Neuse River	F1	0	1,200	100	1,100	wwtp,urban,septic tanks,
Oriental	F5	0	851	50	801	wwtp,septic tanks,ag, urban,marina
South River	F2	0	2,535	0	2,535	ag, septic tanks
Bay River	F6	0	204	100	104	septic, wildlife,marina, wwtp
Pamlico Sound	F7	0	0	0	0	
West Bay	F3	0	487	0	487	boat ramps
Cedar Island	F4	0	13	0	13	ferry,marina
TOTAL ACRES		25,033	5,290	3,300	27,023	
PERCENTAGE		83	17	11	89	

Table 4.7 Neuse River Estuarine Waterbodies Causes and Sources of Use Support Impairment

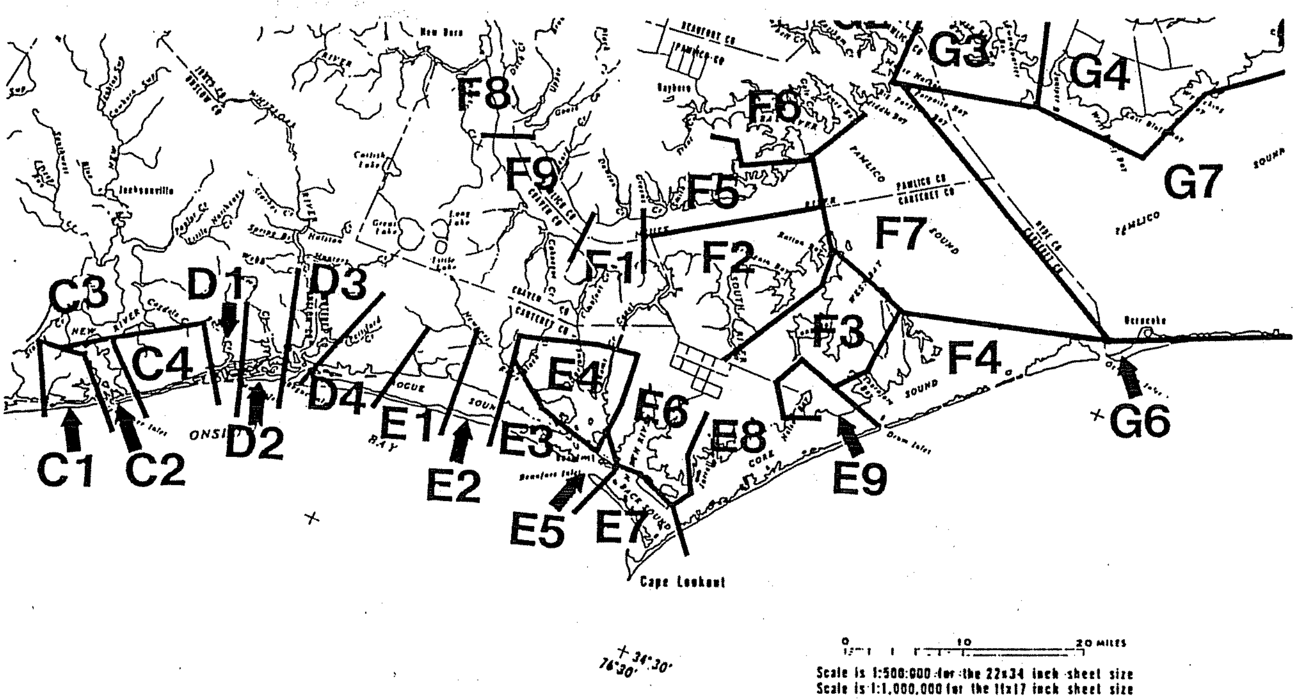


Figure 4.14 Division of Environmental Health (DEH) Shellfish Areas for the Neuse River

LAKE NAME	INDEX NUMBER	SIZE (ACRES)	CLASS	OVERALL USE STATUS	FISH CONSUMP	AQ. LIFE & SEC. CONT.	SWIMMING	DRINKING WATER SUPPLY	TROPHIC STATUS	PROBLEM PARAMETERS	SOURCES
Subbasin 030401											
CORPORATION LAKE	27-2-5-(1)	28	WS-NSW	FULL	FULL	FULL	n/a	FULL	EUTROPHIC		
FALLS OF THE NEUSE RESERVOIR	27-10	12490	WS,B,C-NSW	FTH	FULL	FTH	FULL	FULL	EUTROPHIC		
LAKE BEN JOHNSON	27-2-5	30	WS-NSW	FTH	FULL	FTH	n/a	FULL	MESOTROPHIC		
LAKE BUTNER (LAKE HOLT)	27-4-(1)	374	WS-NSW	FTH	FULL	FTH	n/a	FULL	OLIGOTROPHIC		
LAKE MICHIE	27-3-(1)	480	WS-NSW	FULL	FULL	FULL	n/a	FULL	MESOTROPHIC		
LAKE ORANGE	27-2-3	155	WS-NSW	FULL	FULL	FULL	n/a	FULL	MESOTROPHIC		
LAKE ROGERS		140	WS,C	NOT	FULL	NOT	n/a	NOT	HYPEREUTROPHIC	NOX AQ WEEDS, NUTR, SALIN/TDS/CHLORIDES	
LITTLE RIVER RESERVOIR	27-2-21-(1)	530	WS-NSW	FULL	FULL	FULL	n/a	FULL	MESOTROPHIC		
Subbasin 030402											
APEX RESERVOIR		75	WS-NSW	FULL	FULL	FULL	n/a	FULL	EUTROPHIC		
BIG LAKE	27-33-9	62	B-NSW	NOT	FULL	NOT	NOT	n/a	EUTROPHIC	SILTATION, NOX AQ WEEDS, FILL & DRAIN	NP
LAKE BENSON	27-43-(1)	440	WS-NSW	PART	FULL	PART	n/a	FULL	EUTROPHIC	NOX AQ PLANTS, SILTATION	NP
LAKE CRABTREE	27-33-(1)	500	C-NSW	PART	FULL	PART	n/a	n/a	EUTROPHIC	NUTRIENTS, SILTATION, NOX AQ PLANTS	NP
LAKE JOHNSON	27-34-(1)	174	WS-NSW	FTH	FULL	FTH	n/a	FULL	EUTROPHIC		
LAKE RALEIGH	27-34-(1)	90	WS-NSW	PART	FULL	PART	n/a	FULL	EUTROPHIC	NUTRIENTS,NOX AQ WEEDS	NP
LAKE WHEELER	27-43-(1)	550	WS-NSW	FTH	FULL	FTH	n/a	FULL	MESOTROPHIC		
REEDY CREEK LAKE	27-33-8	20	B-NSW	FULL	FULL	FULL	FULL	n/a	MESOTROPHIC		
SYCAMORE LAKE	27-33-9	20	B-NSW	FTH	FULL	FTH	FULL	n/a	EUTROPHIC		
Subbasin 030403											
BASS LAKE	27-43-15-3	95	B-NSW	FTH	FULL	FTH	FULL	n/a	EUTROPHIC		
Subbasin 030405											
CLIFFS OF THE NEUSE LAKE	27-69-1	10	B-NSW	FULL	FULL	FULL	FULL	n/a	OLIGOTROPHIC		
Subbasin 030406											
WENDELL LAKE	27-57-16-(3)	100	C-NSW	NOT	FULL	NOT	n/a	n/a	EUTROPHIC	ORG ENRICH/DO, NUTR, NOX AQ PLANTS	P
Subbasin 030407											
BUCKHORN RESERVOIR	27-86-(1)	750	WS-NSW	PART	FULL	PART	n/a	FULL	EUTROPHIC	NUTRIENTS, NOX AQ PLANTS	NP,P
LAKE WILSON		81	WS,C-NSW	FTH	FULL	FTH	FULL	FULL	EUTROPHIC		
SILVER LAKE		75	WS,C-NSW	FULL	FULL	FULL	n/a	n/a	EUTROPHIC		
TOISNOT RESERVOIR	27-86-11-(1)	10	WS-NSW	FTH	FULL	FTH	n/a	n/a	EUTROPHIC		
WIGGINS MILL RESERVOIR	27-86-(1)	200	WS-NSW	PART	FULL	PART	n/a	n/a	EUTROPHIC	NUTRIENTS	NP

Table 4.8 Lakes Assessment Information

Use Support Status For Lakes (Acres)				
Subbasin	Fully Support	Support-Threatened	Partially Support	Nonsupport
030401	1193	12894	0	140
030402	95	744	1030	62
030403	0	95	0	0
030405	10	0	0	0
030406	0	0	0	100
030407	75	91	950	0
Total	1373	13824	1980	302
% of Total	8	79	11	2

Causes of Use Support Impairment (Acres)						
Subbasin	Nutrients	Siltation	Organic Enrich/DO	Salinity/ TDS/ Chlorides	Noxious Aquatic Plants	Filling and Draining
030401	140			140	140	
030402	590	1002			1092	62
030403						
030405						
030406	100		100		100	
030407	950				750	
Total	1780	1002	100	140	2082	62
% of PS & NS	78	44	4	6	91	3

Sources of Use Support Impairment (Acres)					
Subbasin	Municipal Pt Source	Agriculture	Urban RO/ Stm Sewers	Construc	Unknown
030401					140
030402	590		590	562	
030403					
030405					
030406					
030407		1290			
Total	590	1290	590	562	140
% of PS & NS	26	57	26	25	6

TABLE 4.9 Lakes Use Support Status and Causes and Sources of Impairment

REFERENCES CITED - CHAPTER 4

North Carolina Division of Environmental Management, 1992, Albemarle-Pamlico Baseline Water Quality Monitoring Data Summary 1988-1991, NCDEM, Raleigh, NC.

Paerl, H., 1990, The Potential for Eutrophication and Nuisance Algal Blooms in the Lower Neuse River Estuary, Albemarle-Pamlico Estuarine Study, Report No. EPA-CE 00470601, North Carolina Department of Environment, Health and Natural Resources, Raleigh, NC.

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CHAPTER 5

EXISTING POINT AND NONPOINT SOURCE POLLUTION CONTROL PROGRAMS TO BE USED IN BASINWIDE MANAGEMENT

5.1 INTRODUCTION

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

5.2 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 US Environmental Protection Agency (USEPA) has developed a means to help accomplish these objectives called *total maximum daily loads (TMDL)*. A TMDL is a tool or 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 Neuse basin, nutrients (phosphorus and nitrogen) and biochemical oxygen demand (BOD) 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. For example in Chapter 6, BOD and nutrient TMDLs have been developed for both relatively small streams as well as for a 185-mile segment of the Neuse river from Falls Lake Dam to Streets Ferry (upper limits of tidal influence in the Neuse Basin). TMDLs for smaller streams may 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 NCDEM'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 Neuse 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 NCDEM 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.

5.3 NORTH CAROLINA'S POINT SOURCE CONTROL PROGRAM

5.3.1 Introduction

Point source discharges, which are described in Chapter 3, are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the authority of N.C.G.S. 143.215.1 and the National Pollution Discharge Elimination System (NPDES) program which was delegated to North Carolina from the USEPA. 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 permitting, enforcement, wasteload allocation modeling, pretreatment, aquatic toxicity testing, operator training and consideration of nondischarge alternatives. Below is a brief summary of key components of North Carolina's NPDES program

5.3.2 Review and Processing of NPDES Permits

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 Neuse basin, for example, all of the existing permits will expire and be renewed over a twelve month period from April 1993 to April 1994, beginning with subbasin 01 and ending with subbasin 14. The permitting schedule for the Neuse is presented in Table 1.1 on page 1 - 3. Permits may not be issued for a period of 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.

NCDEM 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. A site inspection is conducted and a wasteload allocation is performed in order to establish permitted waste limits (described in the following section). 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 period in which to comment and a public hearing may be held if there is sufficient interest. Copies of the Notice 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 NCDEM on whether to issue to 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.

5.3.3 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 NCDEM 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 III, 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 NCDEM'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 NCDEM'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 NCDEM is implementing.

5.3.4 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 (Monday through Friday) for major facilities. The sampling results (contained in a *discharge monitoring report* or *DMR*) are then submitted each month to NCDEM 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, the permitted waste limits assigned to the facility may be temporarily relaxed until the improvements can be made. These interim limits, however, are still required to protect instream water quality standards.

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

5.3.5 Aquatic Toxicity Testing

There are literally thousands of chemicals or compounds in use today which may enter wastewater systems and eventually be discharged to surface waters. Monitoring the concentration of each of these chemicals individually would be impossible due both to cost/time considerations as well as the inability of current analytical technique to detect a majority 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 August 1992, there were 530 permitted NPDES discharges in North Carolina required to perform whole effluent toxicity monitoring, and over 9,000 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 quality 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 August, 1992, 21 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.

5.3.6 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 nondomestic (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.

5.3.7 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.

5.3.8 Nondischarge and Regionalized Wastewater Treatment Alternatives

As discussed in section 5.3.2, 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, NCDEM 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, NCDEM will take into consideration the amount of flow accepted by them from the smaller discharges.

5.4 NONPOINT SOURCE CONTROL PROGRAMS

Land use control as well as 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 BMP's 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.

One of the first waterbody classifications for impacted waters that included nonpoint source pollution controls was the upper Neuse River Basin (above Falls Lake) as Nutrient Sensitive Waters (NSW) in 1983. This waterbody was experiencing eutrophication to the extent that designated uses were impaired or likely to be impaired if no steps for protection were taken. Following the passage of the NSW classification by the North Carolina Environmental Management Commission, the General Assembly appropriated funds to share the cost of BMP implementation for agricultural and silvicultural practices in the Falls Lake watershed. Since 1988, the entire Neuse basin has been designated NSW.

Other priorities exist for nonpoint source pollution control in the Neuse River Basin. Strategies for urban runoff are in place for coastal waters and surface water supply watersheds. Agricultural priorities have spread from the Falls Lake watershed to any waters in the basin which are impacted or potentially impacted by agriculture.

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 NCDEM. 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. NCDEM 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 Neuse River Basin to address nonpoint source pollution. Table 5.1 lists these programs by categories based on the type of activity. Each program is described in Appendix IV. Below is a brief

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	DEM, DSW, CES	SCS
Laboratory Testing Services		NCDA	
Watershed Protection (PL-566)			SCS
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	DEM	
Coastal Stormwater Program		DEM	
ORW, HQW, NSW Management Strategies		DEM	
Stormwater Control Program	city, county	DEM	EPA
CONSTRUCTION			
Sedimentation and Erosion Control	ordinance	DLR, DOT	
Coastal Area Management Act	ordinance	DCM	
Coastal Stormwater Program		DEM	
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, DEM	COE
Rivers and Harbors Act of 1899			COE
Dam Safety Permit		DLR	
WETLANDS			
Clean Water Act (Sections 401 and 404)		DEM	COE
Wetland Reserve Program			USDA

(ABBREVIATIONS: **COE**, US Army Corps of Engineers; **DCM**, Div. of Coastal Mgmt.; **DEM**, Div. of Environ. Mgmt.; **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.; **SCS**, Soil Conservation Service; **SWCC**, Soil and Water Conservation Commission; **SWCD**, Soil and Water Conserv. District; **USDA**, US Dept. of Agric.)

overview of existing nonpoint source control efforts for various categories of land use activities.

5.4.1 Agricultural Nonpoint Source (NPS) Control Programs

Agricultural BMPs have been developed largely to control the four major agriculturally-related causes of pollution: sediment, nutrients, pesticides 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 oil testing. BMPs may be administered through one or more of the agricultural programs described below.

Table 5.2, compares the percentage of BMPs installed by county for the Neuse basin. This table is based on information provided by the Division of Soil and Water Conservation and other agricultural agencies. These agencies agreed to assist NCDEM with basinwide planning by obtaining best professional judgments on the percentage of BMP installation which has occurred to date through the many different agricultural programs such as the 1985 and 1990 Farm Bills and the Agriculture Cost Share Program. The percentages of BMPs installed were categorized into farms or acres with 0 percent installed, less than 50 percent, between 50 and 90 percent, and greater than 90 percent. This was done for BMPs installed as of June 1992. An effort was also made to project the level of BMPs which could be expected to be installed by July 1996, when the Neuse Basin plan is to be revisited. The BMP information was not compiled according to subbasins because of time constraints, but this will be done for subsequent basinwide plans.

Table 5.2. BMP Installation Priority List by County for the Neuse River Basin*

Rank	Swine	Poultry	Dairy	Cattle	Horses	Cropland
1	Johnston	Wayne	Orange	Wayne	Durham	Wayne
2	Greene	Greene	Wayne	Johnston	Johnston	Craven
3	Lenoir	Johnston	-	Durham	-	Johnston
4	Wayne	Lenoir	-	Lenoir	-	Wake
5	Wilson	Nash	-	Wake	-	Greene

* Based on number of farms or acres and percentage of BMPs in place.

This information provides a better understanding of counties which have excelled in implementing BMPs and counties which need to target locations for additional BMP work. The results from the county worksheets do not allow for a detailed plan to be developed for targeting BMP implementation. However, some degree of ranking can be done at the county level based on animal populations, cropland acreage and the number of farms or acres where less than 50 percent of the needed BMPs are utilized for one reason or another. A high priority ranking does not necessarily imply a county is doing a poor job in nonpoint source pollution control. For example, although Wayne County is identified as a priority county for more BMPs to be installed at swine farms, Wayne County also has the largest percentage of swine farms in the basin where more than 50 percent of the BMPs are in place. In other words, the number of farms and acres may be so large that the technical, educational and financial resources may have limited the ability of a county to address many of the problems. Despite the reasons for a high ranking, Table 5.2 provides a priority ranking for additional BMP installation based on the worksheets received from the agricultural agencies. Because the BMP information was not collected on a subbasin basis, these rankings have not been linked directly to water quality impacts, but the results point to general areas where more BMPs are needed and may provide some direction for allocating technical, educational, and financial resources.

North Carolina Agriculture Cost Share Program

The *North Carolina Agriculture Cost Share Program for Nonpoint Source Pollution Control* (NCACSP) will provide a farmer with 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 NCACSP has been a statewide program since 1989 and is carried out through local Soil and Water Conservation District Boards under the administration of the North Carolina Soil and Water Conservation Commission (SWCC). Appendix IV discusses administration, funding criteria and the present NCACSP budget for the both the state and the Neuse basin.

According to the Division of Soil and Water Conservation, approximately $6.5 million has been expended in the Neuse River Basin to implement BMPs through the ACSP as of February 1992. In addition, approximately $1 million has been spent through programs administered by the USDA, Agricultural Soil Conservation Service (ASCS). The BMPs have generally been used to control erosion, sediment, and nutrients from cropland and pastureland and to manage animal waste storage and land application at feeding operations.

NC Pesticide Law of 1971 and NCDA Pesticide Disposal Program

The 1971 state pesticide law and the North Carolina Department of Agriculture (NCDA) Disposal Program govern the use, application, sale, registration and disposal of pesticides in North Carolina. Their purpose is to avoid misuse and ensure proper disposal of pesticides in order to protect human health and the environment.

NC Cooperative Extension Service and Agricultural Research Service

The N.C. Agricultural Research Service and the N.C. 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.

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 NCDEM is not required. The rule applies to new, expanded 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 waste management plan certification are submitted to DEM by the appropriate deadlines.

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.

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-Soil Conservation Service in cooperation with the N.C. 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.

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 Soil Conservation Service. Other cooperating agencies include the N.C. Cooperative Extension Service, N.C. 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 United States 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 Soil 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, Farmers Home Administration 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 Soil 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 Soil 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 Farmers Home Administration 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.

5.4.2 Urban NPS Programs

Federal Urban Stormwater Discharge Program

The goal of the urban stormwater discharge permitting program being developed in North Carolina is to prevent pollution from stormwater runoff by controlling the source(s) of pollutants. This program is based on passage of 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* and specific *municipal separate storm sewer systems*. These regulations became effective in December 1990. Authority to administer them and require discharge permits for industrial and municipal stormwater systems has been delegated to NCDEM.

The municipal permit application requirements are designed to lead to the formation of site-specific stormwater management programs for Charlotte, *Durham*, Greensboro, *Raleigh*, Winston-Salem, and Cumberland County. The municipalities will develop application reports which will formulate 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.

Water Supply Protection Program

The North Carolina Environmental Management Commission adopted statewide minimum management requirement rules on February 13, 1992 for surface water supply watershed protection. The Water Supply Watershed Protection Act (NCGS 143-214.5) also required the Commission to reclassify each surface water supply to its appropriate classification. On May 14, 1992, the Commission reclassified 208 water supply watersheds after taking into consideration comments received during the August 1991 public hearings. The water supply watershed protection rules and reclassifications became effective for state implementation on August 3, 1992. The Act requires each local government that has land use authority to adopt and implement land use ordinances that meet or exceed the state requirements. The deadlines for local governments to adopt and implement the ordinances is July 1, 1993 for municipalities of 5,000 or more in population, October 1, 1993 for municipalities less than 5,000 and January 1, 1994 for affected counties.

Implementation of the act and adoption of the rules has entailed developing a new set of water supply surface water classifications: WS-I to WS-V. Watersheds draining to waters classified WS carry some restrictions on point source discharges and on many land use activities including urban development, agriculture, forestry and highway sediment control.

NC Coastal Stormwater Management Regulations

In November 1986, the EMC adopted rules to control stormwater for new development in the coastal region of the state. Perhaps the most important measure accomplished with the regulations has been the applicability of stormwater controls to development activities within the 20 coastal counties covered by the Coastal Area Management Act (CAMA). This wide area coverage helps provide better protection of both shellfish waters and general coastal water quality from the cumulative impact of stormwater runoff throughout the coastal zone. NCDEM administers these regulations in the 20 coastal counties. The regulations require either development density limitations or stormwater treatment systems.

Coastal Nonpoint Pollution Control Programs

As part of the Coastal Zone Act Reauthorization Amendments of 1990, Congress enacted a new section 6217 entitled "Protecting Coastal Waters". This provision requires states with coastal zone management programs (which includes North Carolina) that have received Federal approval under section 306 of the Coastal Zone Management Act (CZMA) to develop and implement Coastal Nonpoint Pollution Control Programs. These coastal nonpoint programs are to be used to control sources of nonpoint pollution that impact coastal water quality.

Section 6217 requires coastal states to submit their coastal nonpoint source programs to the National Oceanic and Atmospheric Administration (NOAA) and the U.S. EPA for approval. Failure to submit an approvable program will result in a state losing a portion of its Federal funding under section 306 of the CZMA and section 319 of the Clean Water Act. These programs will be developed and administered by the NC Division of Coastal Management.

ORW and HQW Stream Classifications

All Outstanding Resource Waters (ORWs) and High Quality Waters (HQWs) have a management strategy that includes provisions for handling urban stormwater runoff. Controls for urban stormwater, either through development density limitations or stormwater treatment systems, are required by NCDEM. Other NPS management agencies are expected to place priority on protecting these valuable resources 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.

5.4.3 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 N.C. Sedimentation Control Commission.

The sediment control program requires the submission and approval of erosion control plans on all projects disturbing one or more acres prior to construction. On-site inspections are conducted to determine compliance with the plan and to evaluate the effectiveness of the BMPs which are used. Sedimentation control rules require more stringent erosion control measures for projects draining to HQWs.

5.4.4 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. It is estimated that 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. 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 of Environmental Health.

5.4.5 Solid Waste Disposal NPS Programs

The following programs have provided strong impetus for reuse and recycling of wastes.

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.

State Program

States are given a major role in solid waste management by RCRA. The Division of Solid Waste Management (DSWM) in the Department of Environment, Health, and Natural Resources (NCDEHNR) is authorized as the single state agency for the management of solid waste. The NC 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. In 1991, the Act 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.

Local Programs - Municipal and County Waste Disposal

Solid waste collection and disposal has long been a municipal function. Municipalities are also authorized to regulate the disposal of solid waste within their corporate limits and many have begun recycling programs. 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.

5.4.6 Forestry NPS Programs

Forest Practice Guidelines Related to Water Quality

In 1989 the Sedimentation Pollution Control Act (SPCA) was amended to limit forestry sediment control exemptions to operations that adhere to forest practice guidelines. The forestry amendment to the SPCA required the NC Division of Forest Resources to develop performance standards known as the Forest Practices Guidelines Related to Water Quality. The Guidelines consist of nine performance standards for activities such as maintaining streamside management zones and applying fertilizer and pesticide applications. The Guidelines were developed in October 1989 and were put into effect on January 1, 1990.

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 economic and environmental aspects of forest resources be considered in preparation of land management plans. 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.

5.4.7 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 Program requires submission and approval of a mining permit application prior to initiating land disturbing activity that would affect one or more acres in surface area. 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.

5.4.8 Wetlands Regulatory NPS Programs

The importance of wetlands for wildlife habitat, water quality protection, flood control, and many other values has become widely recognized over the past 20 years. The sediment trapping and soil stabilization properties of wetlands are particularly important to nonpoint source pollution control. Several important state and federal wetland protection programs are described below.

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, utility and power transmission lines and bank stabilization.

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.

North Carolina Coastal Area Management Act (CAMA) Of 1974

This act is aimed at controlling development pressures in North Carolina's coastal region in order to preserve the region's economic, aesthetic and ecological values. The program, which applies to 20 coastal counties, is administered by the NC Division of Coastal Management under the oversight of the Coastal Resources Commission (CRC), a 15-member board. Under CAMA, permits are required for projects that may cause damage to Areas of Environmental Concern (AECs). A joint permitting process allows a CAMA-permitted project to simultaneously receive a Section 404 permit.

Section 401 Water Quality Certification (from CWA)

The Division of Environmental Management is responsible for the issuance of 401 Water Quality Certifications (as mandated under Section 401 of the Clean Water Act). A 401 certification is required for the discharge of pollutants into surface waters and wetlands for projects that require a section 404 federal permit. The 401 certification indicates that the discharged pollutant will not violate state water quality standards. A federal permit cannot be issued if a 401 certification is denied. 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).

CHAPTER 6

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

6.1 BASINWIDE MANAGEMENT GOALS

The Neuse basin has experienced significant population growth and development over the past 20 years and that growth is expected to continue. From an economic standpoint, this is viewed very positively by businesses, local governments and others. However, as the population grows, so will the volume of wastewater that will need to be treated. In addition, land development accompanying population increases will generate additional nonpoint source pollution.

Chapter 4 has documented that many streams, lakes and estuarine areas in the basin are not fully supporting their uses. Problems with excessive nutrients, limited waste assimilative capacity and threats to highly valued and biologically sensitive resource waters have been identified. Continued population growth and development will only exacerbate these problems unless effective point and nonpoint source control measures are put in place.

The long-range goal of basinwide management is to provide a means of addressing the complex problems of planning for increased development and economic growth while protecting and/or restoring the quality and intended uses of the Neuse Basin's surface waters.

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

- identify and restore the most serious water quality problems in the basin (**Section 6.2.1**)
- protect those waters known to be of the highest quality or supporting biological communities of special importance (**Section 6.2.2**) and
- management of problem pollutants, particularly biological oxygen demand and nutrients in order to correct existing water quality problems and to ensure protection of those waters currently supporting their uses (**Sections 6.2.3, 6.3, 6.4** and **6.5**)..

6.2 MAJOR WATER QUALITY CONCERNS AND PRIORITY ISSUES

6.2.1 Identifying and Restoring Impaired Waters

Impaired waters are those rated in Chapter 4 as partially supporting or not supporting their designated uses. A list of those impaired waters has been compiled in Table 6.1. The table includes the current and planned water quality management strategies for these waters.

Current Management Strategies , as presented in the table, are those that have either been implemented or those that are currently underway but have not yet reached full implementation. For example, there are plans in place to remove or upgrade existing wastewater treatment plants but the plants have not yet been removed or the upgrades not completed (subbasins 01, 06, 07, 10, 13 and 14). The NSW strategy has been in place for several years but not all plants are required to meet the nutrient reduction requirements until 1993. And even where nutrient reductions have been achieved, it may take some time for the effects to be measurable, particularly in the Neuse estuary.

Table 6.1 Management Strategies for *Impaired Waters in the Neuse Basin

Subbasin	Name	Current Management Strategy	Planned Management Strat.
01	South Flat River	NSW, NPS	CEP, WS, PS
	Flat River	NSW, NPS	CEP, WS, Lake Michie min. release, PS
	Knap of Reeds Creek	NSW, NPS, Butner WWTP Upgraded	CEP, PS
	Ellerbe Creek	NSW, NPS, Upgrade of Durham Northside	CEP, PS, U
	Little Lick Creek	NSW, NPS, Durham WWTP to be removed	CEP, PS
	Lake Rogers	NSW, NPS	CEP, IS
02	Crabtree Creek	NSW, NPS	CEP, PS, U
	Lake Crabtree	NSW, NPS	CEP, PS, U
	Big Lake	NSW, NPS	CEP, Fed Clean Lakes Grant in 1993
	Richland Creek	NSW, NPS	CEP, U
	Pigeon House Branch	NSW, NPS	CEP, U
	Walnut Creek	NSW, NPS	CEP, U
	Lake Raleigh	NSW, NPS	CEP, U
	Swift Creek	NSW, NPS	CEP, PS, U, WS
	Lake Benson	NSW, NPS	CEP, WS
	Williams Creek	NSW, NPS	CEP, PS, U, WS
	Little Creek	NSW, NPS	CEP, U, Evaluate impact of Clayton WWTP
04	Black Creek	NSW, NPS	CEP, PS
	Stone Creek	NSW, NPS	CEP
	Hannah Creek	NSW, NPS	CEP
05	Southwest Creek	NSW, NPS	CEP
06	Buffalo Creek	NSW, NPS, Wendell WWTP targeted for removal	CEP, PS
	Lake Wendell	NSW, NPS, Wendell WWTP targeted for removal	CEP, PS
	Mill Creek	NSW, NPS, Kenly's discharge moved	CEP
07	Contentnea Creek	NSW, NPS, Upgrade of Zebulon WWTP	CEP, IS, PS, WS
	Little Creek	NSW, NPS	CEP, IS
	Mocassin Creek	NSW, NPS	CEP, IS
	Turkey Creek	NSW, NPS	CEP, IS
	Buckhorn Reservoir	NSW, NPS	CEP, IS, PS, WS
	Wiggins Mill Res.	NSW, NPS	CEP, IS, PS, WS
	Turner Swamp	NSW, NPS	CEP, IS
	Toisnot Swamp	NSW, NPS	CEP, IS
	Wheat Swamp	NSW, NPS	CEP, IS
	L. Contentnea Creek	NSW, NPS	CEP, IS
08	Core Creek	NSW, NPS	CEP, IS
09	Swift Creek	NSW, NPS, W. Craven H.S. ceased discharge	CEP, IS
	Creeping Swamp	NSW, NPS	CEP, IS
11	Trent River	NSW, NPS	CEP, IS
	Beaverdam Swamp	NSW, NPS	CEP, IS
	L. Chinquapin Ck	NSW, NPS	CEP, IS
	Beaver Creek	NSW, NPS	CEP, IS
12	Buck Swamp	NSW, NPS	CEP, IS
10, 13, 14	Neuse R. Estuary	NSW, NPS, Est.	CEP, CZMA, PS, Develop water quality model
	Oriental Area	NSW, NPS, Est.	CEP, CZMA
	South R. Area	NSW, NPS, Est.	CEP, CZMA
	Bay R. Area	NSW, NPS, Est.	CEP, CZMA
	West Bay Area	NSW, NPS, Est.	CEP, CZMA
	Cedar Island Area	NSW, NPS, Est.	CEP, CZMA

	DEFINITIONS
NSW	Nutrient Sensitive Waters classification requires TP limitations on specified discharges (see Section 6.4.2)
WS	NC Water Supply Protection Program requires local implementation and enforcement of NPS management within defined watersheds (see Section 5.4.2).
U	Urban. Federal Stormwater requirements for large and medium municipalities apply to at least a portion of these watersheds.
NPS	Includes all existing agricultural, urban, and local NPS control programs, summarized in Table 5.1.
CZMA	Coastal Zone Management Act, requires nonpoint source control plans to be developed.
PS	Point Source Controls. Areas where specific point source control strategies are needed to address water body impairment (See Table 6.2).
CEP	Continue Existing Programs. Many programs are in their initial phases. More time is needed to monitor their effectiveness toward restoring these waters.
IS	Investigate Sources. Involves cooperative efforts between government agencies to identify and prioritize where BMPs need to be implemented. The Contentnea Creek basin (subbasin 07) has been designated the highest priority for these investigations due to the severity of impairment.
Est.	New and expanding facilities in the estuary area are receiving NPDES limits reflecting advanced wastewater treatment.
*Note	This list of impaired waters is derived from the basin water quality summary in Chapter 4 of this report.

Nonpoint source programs also constitute an extremely important set of management strategies that are in various stages of implementation. These programs, described briefly in Chapter 5 and Appendix IV are wide-ranging and are grouped under general nonpoint source categories such as urban development, construction, agriculture, forestry, mining, onsite wastewater treatment, and wetlands protection. Agricultural programs such as the NC Agricultural Cost Share Program, which provides farmers with financial assistance to install BMPs, and the Farm Bill (Food, Agriculture, Conservation and Trade Act of 1990), which among its provisions reduces government funding subsidies for farming on highly erodible land, are examples of potentially effective ongoing programs which will should reduce water quality impacts.

Planned Management Strategies fall into two major categories. The first is continuation of ongoing programs that for reasons stated above have not yet reached full effectiveness. Water quality monitoring will be an important component of this strategy. The second category includes several other initiatives. 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. Source investigation has been identified for subbasins 07 - 09, 11 and 12.

In other waters where the causes of impairment have been identified, new programs are expected to be implemented in the next several years. The state is now in the process of developing an NPDES permit program for urban runoff in large and mid-size municipalities that will apply to Raleigh and Durham. Many streams impaired by urban runoff in subbasins 01 and 02 are expected to benefit from this program. The state has also adopted new water supply watershed regulations which will require local governments to develop watershed protection ordinances for portions of the watersheds that fall within their jurisdiction. Municipalities with a population of 5,000 or more are to develop ordinances by July 1, 1993. Smaller municipalities have until October 1993, and counties have until January 1, 1994. The water supply rules will apply to impaired waters in subbasins 01 through 07 (excluding 05).

In the coastal counties in subbasins 10, 13 and 14, the federal government, pursuant to the Coastal Zone Act Reauthorization Amendments of 1990, is requiring the state to develop new coastal nonpoint pollution control programs. Such programs will take time to develop and will require action on the part of local governments, but their eventual implementation should help reduce nonpoint source pollution in these areas. Finally, there are a number of specific planned strategies identified in Table 6.1. Specific point source control strategies, discussed more fully in Sections 6.2.3, 6.3, 6.4 and 6.5, will be applied in subbasins 01 - 04, 06, 07, 10, 13 and 14.

6.2.2 Identification and Protection of High Resource Value or Biologically Sensitive 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 permit conditions. 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 habitat 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 or SC(Appendix I). Possible ORW/HQW candidates in the Neuse basin, based on water quality assessments presented in Chapter 4, include the following: 1) Portions of Flat Creek and the entire Deep Creek drainage in Subbasin 03-04-01 (both qualify for HQW based on excellent water quality and Deep Creek further supported by fish community analysis) and 2) West Thorofare Bay in Subbasin 03-04-14 that was found to have excellent water quality and would be a viable HQW or ORW candidate.

In addition, where waters are known to support state or federally listed endangered or threatened species or species of concern, but where water quality is not 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. The federally endangered dwarf-wedge mussel (Alasmidonta heterodon) is known to occur in subbasins 02, 03, 06 and 07 and most subbasins provide habitat for threatened species or species of concern. 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.

6.2.3 Managing Problem Pollutants

Restoration of impaired waters and protection of other waters rests on NCDEM's ability to control the causes and sources of water pollution. *Nutrients* and *oxygen-demanding wastes* are the most important problem pollutants targeted for management in the Neuse basin. Metals, fecal coliforms and sediment are other important pollutants highlighted for management.

Table 6.2 and Figure 6.1 summarize existing and planned TMDL management strategies for problem pollutants throughout the basin. Included are streams and lakes, grouped by subbasin, for which modeling has been accomplished (Figure 6.2) or where specific wasteload strategies (TMDLs) have been developed. Information provided for each waterbody includes the management strategy for each of the problem pollutants, and any additional recommendations. Oxygen-demanding wastes are further addressed in section 6.2. Nutrients are addressed in section 6.3, and toxics (including metals, ammonia and chlorine) are addressed in section 6.4.

The management strategies outlined below are the results of comprehensive evaluations of all previously summarized data, and they incorporate the effects of interaction between impacts of point and nonpoint sources. It is the intention of NCDEM 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. Point source controls are implemented through limiting wastewater parameters in NPDES permits.

6.3 RECOMMENDED MANAGEMENT STRATEGIES FOR OXYGEN DEMANDING WASTES

Oxygen demanding wastes were described in Chapter 3. BOD and ammonia nitrogen (NH_3) are generally the types of oxygen-consuming wastes of greatest concern. Therefore, NPDES permits generally limit BOD_5 (or $CBOD_5$) and NH_3 in point source discharge effluents to control the effects of oxygen depletion in receiving waters.

The lowest concentrations of dissolved oxygen usually occur during summertime conditions when temperature is high and streamflow is low. During these periods point source discharges have their greatest impact, while nonpoint input is generally low. Nonpoint loads are typically delivered at high flow during and after storm events, but may have residual effects on water quality through runoff and sediment oxygen demand. Modeling of oxygen-consuming wastes is performed under low flow scenarios, accounts for the residual effects of nonpoint sources and is used to establish appropriate NPDES permit limits. Where the residual BOD is significant, management of nonpoint sources to reduce loading is recommended by implementation of best management practices. The control strategies for oxygen-demanding wastes are described below and are summarized in Table 6.2.

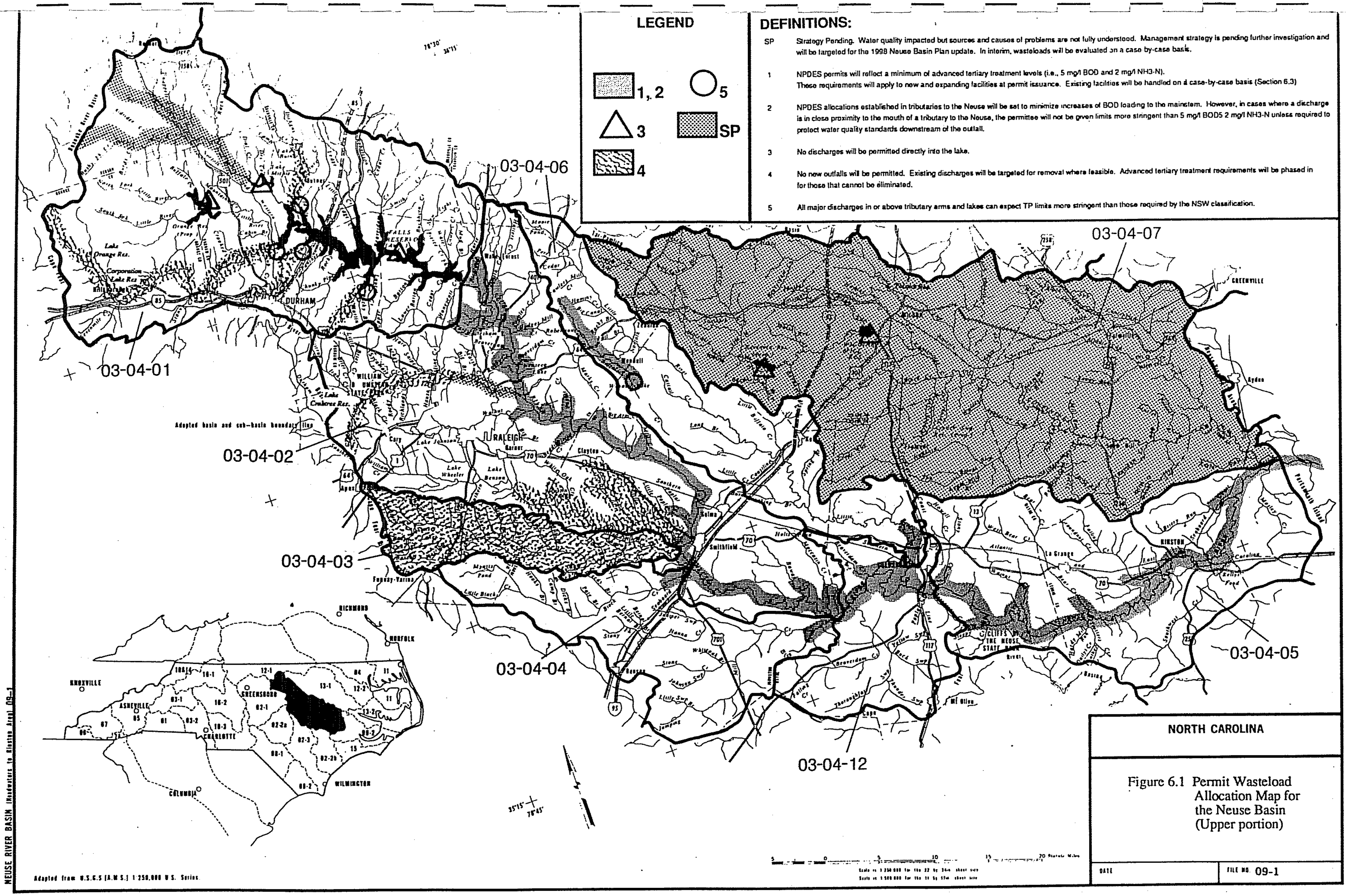


Figure 6.1 Permit Wasteload Allocation Map for the Neuse Basin (Upper portion)

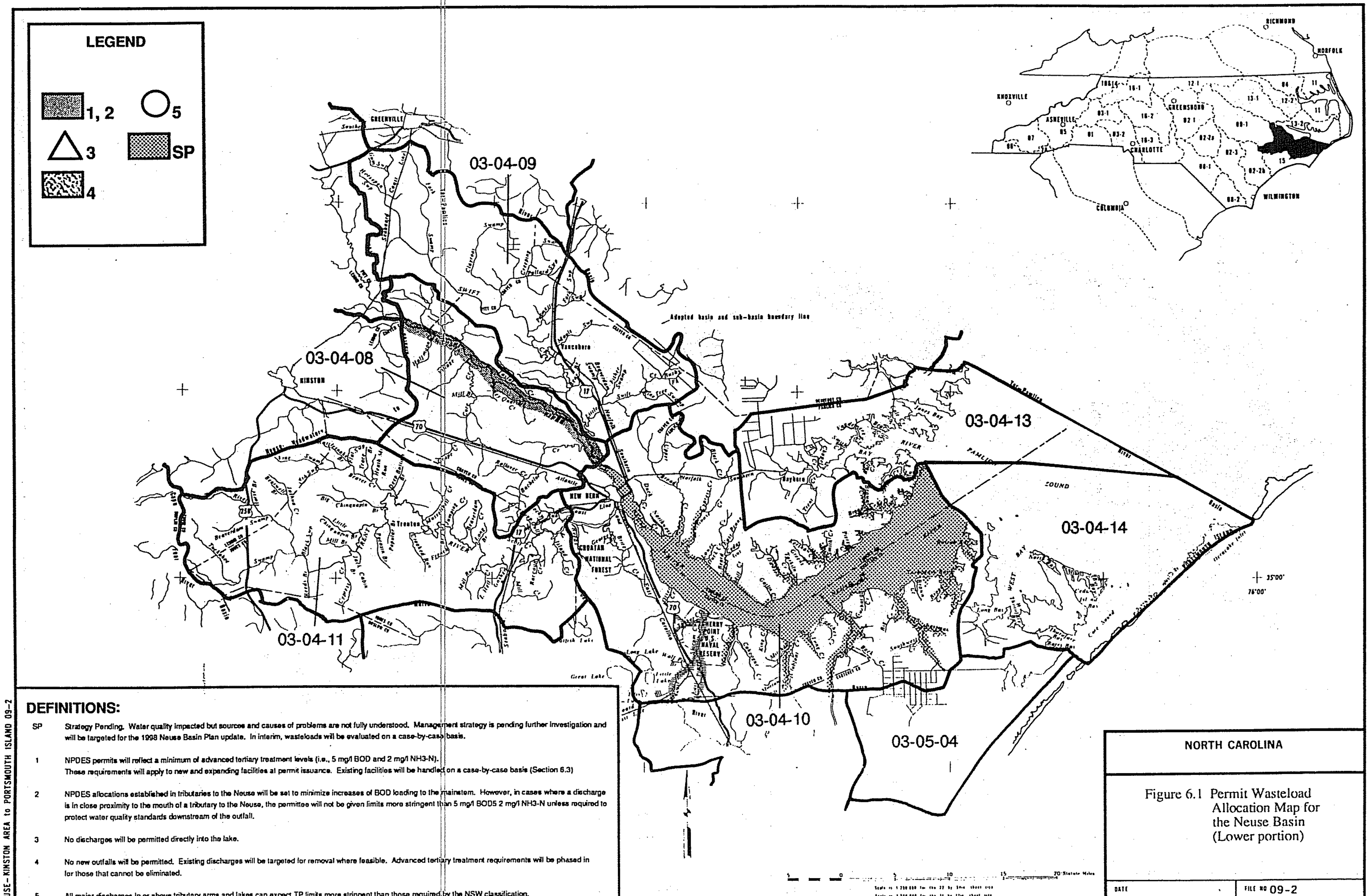


Figure 6.1 Permit Wasteload Allocation Map for the Neuse Basin (Lower portion)

DEFINITIONS:

SP — Strategy Pending. Water quality impacted but sources and causes of problems are not fully understood. Management strategy is pending further investigation and will be targeted for the 1998 Neuse Basin Plan update. In interim, wasteloads will be evaluated on a case-by-case basis.

1 — NPDES permits will reflect a minimum of advanced tertiary treatment levels (i.e., 5 mg/l BOD and 2 mg/l NH3-N). These requirements will apply to new and expanding facilities at permit issuance. Existing facilities will be handled on a case-by-case basis (Section 6.3)

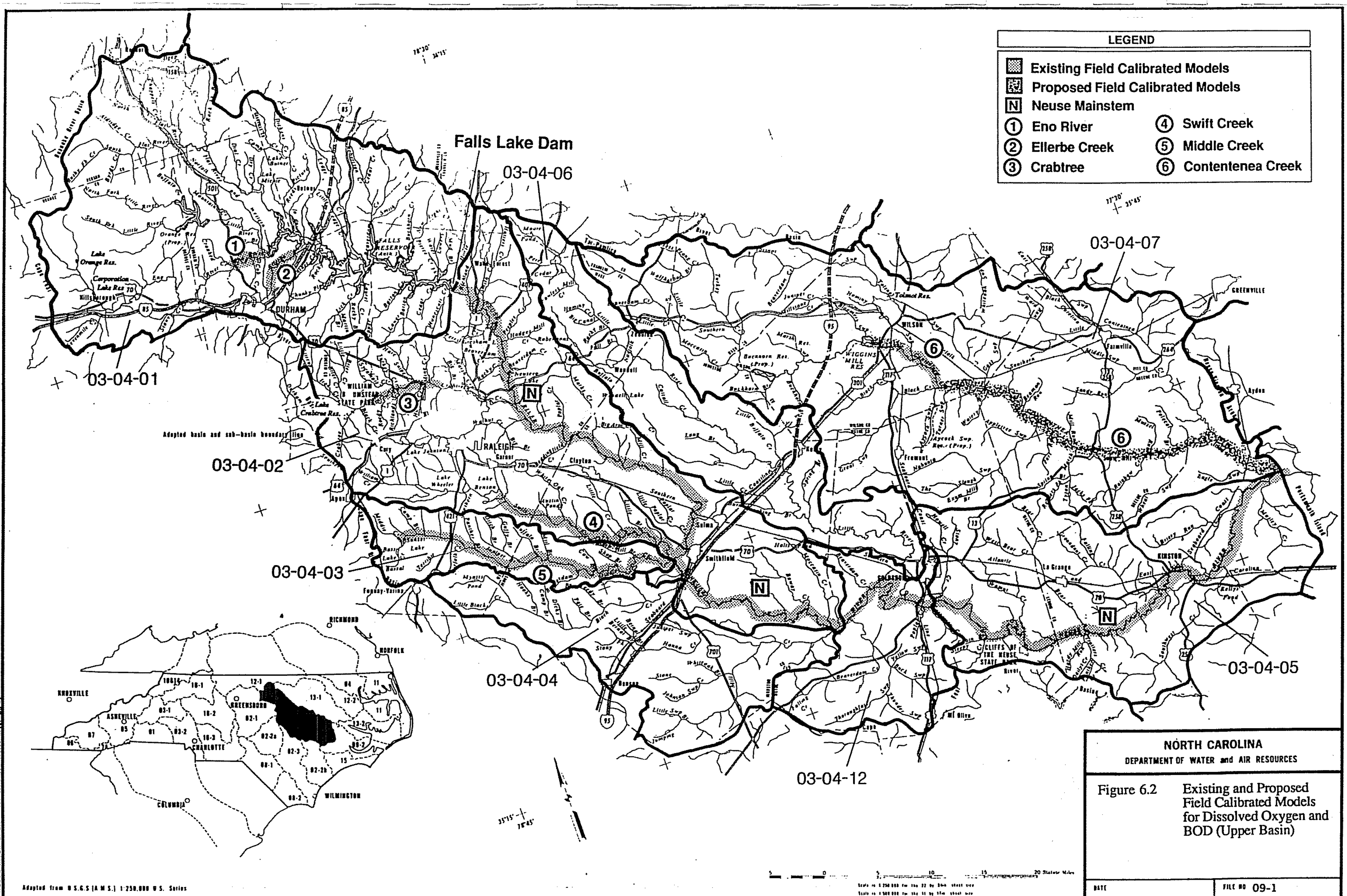
2 — NPDES allocations established in tributaries to the Neuse will be set to minimize increases of BOD loading to the mainstem. However, in cases where a discharge is in close proximity to the mouth of a tributary to the Neuse, the permittee will not be given limits more stringent than 5 mg/l BOD5 2 mg/l NH3-N unless required to protect water quality standards downstream of the outfall.

3 — No discharges will be permitted directly into the lake.

4 — No new outfalls will be permitted. Existing discharges will be targeted for removal where feasible. Advanced tertiary treatment requirements will be phased in for those that cannot be eliminated.

5 — All major discharges in or above tributary arms and lakes can expect TP limits more stringent than those required by the NSW classification.

NEUSE-KINSTON AREA to PORTSMOUTH ISLAND 09-2



NORTH CAROLINA
DEPARTMENT OF WATER and AIR RESOURCES

Figure 6.2 Existing and Proposed Field Calibrated Models for Dissolved Oxygen and BOD (Upper Basin)

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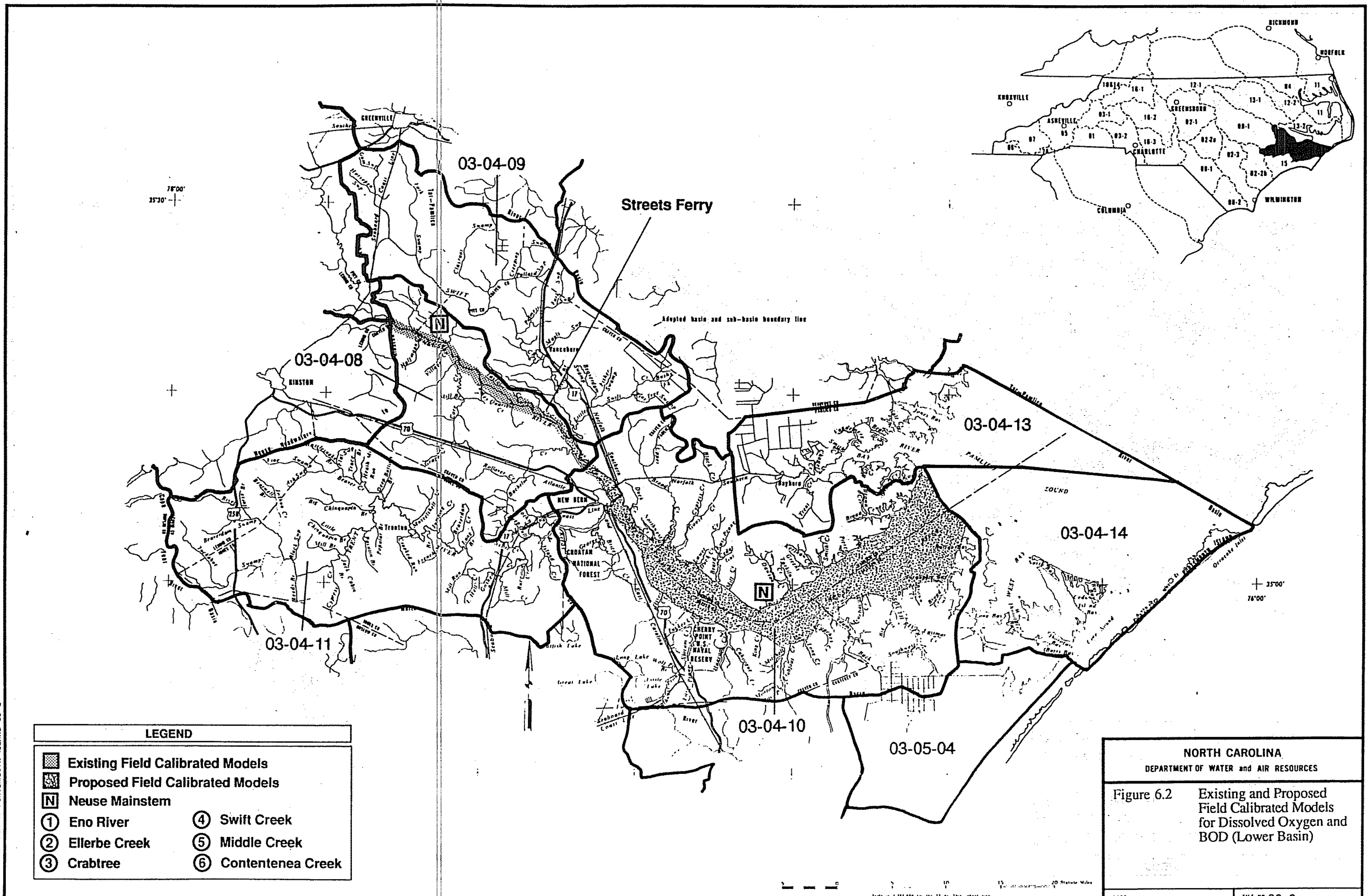

NORTH CAROLINA
DEPARTMENT OF WATER and AIR RESOURCES

Figure 6.2 Existing and Proposed Field Calibrated Models for Dissolved Oxygen and BOD (Lower Basin)

DATE | FILE NO 09-2

Adapted from U.S.G.S.(A.M.S.) 1:250,000 U.S. Series

NEUSE-KINSTON AREA to PORTSMOUTH ISLAND 09-2

Table 6.2 Permit Wasteload Allocation Table for the Neuse River Basin

Note: Below is a list of areas within the Neuse Basin where NPDES limits are governed by other than standard operating procedures, or that have been targeted for further study and management policies. If a stream is not included in this table, standard wasteload allocation procedures will be applied and permit limits will depend on dilution, stream characteristics, water quality characteristics, discharge interaction, waterbody classification, and NC and Federal water quality rules and regulations. NPDES permits in this case will likely be renewed with existing limitsunless the facility is being expanded or if new standards must be applied.

Subbasin	Stream Reach	BOD	Nutrients	Toxics	Nonpoint Mgmt	Comments
02,12,05, 09,10	Neuse Mainstem from Falls Dam to Streets Ferry	1	NSW	WLA	E, WS	Reduce permitted BOD loads to assimilative capacity
02 - 10, 12	Neuse tributaries	2	NSW	WLA	E	BOD allocation plan affects discharges close to mouth of the tributary
01	Flat River (including North and South)	SP	NSW	WLA	E, WS	Target point sources and failing septic systems for removal
	Lake Michie and UTs	3	3	3	E, WS	Target pt. sources for removal or upgrade to adv. treatment
	Orange Reservoir and UTs	3	3	3	E, WS	
	Eno River from source to Falls Lake	4	5	WS	E, WS, U	Monitor impact of eliminating Durham WWTP
	Knap of Reeds Cr: source to Falls Lake	4	5	WS	E	Monitor impact of Butner WWTP upgrade
	Ellerbe Cr from Source to Falls Lake	4	5	WS	E, U	Monitor impact of Durham WWTP upgrade and expansion
	Lick Creek from source to Falls Lake	4	5	WLA	E	Removal of Durham WWTP should improve stream
	Falls Lake and UTs	3	3	3	E, WS	Eutrophication Model update scheduled for 1998
02	Crabtree Creek above Lassiter Mill Dam	4	NSW	WLA	E, U	BOD/DO Modeling analysis is to be extended to the mouth
	Crabtree Creek below Lassiter Mill Dam	SP	NSW	WLA	E, U	Modeling analysis, and stormwater BMPs for 1998
	Swift Creek below Lake Benson Dam	4	NSW	WLA	E, U	Target restoration of DO below Lake Benson
	Perry Creek from source to mouth	1	NSW	WLA	E, WS	Perry Creek Interceptor will remove most discharges
03	Middle Cr: source to Sunset Lake Dam	4	NSW-SP	WLA	E	Monitoring eutrophication in Sunset Lake
	Middle Cr: Sunset Lake Dam to mouth	4	NSW	WLA	E	Establish Cary S., Fuquay-Varina and Apex as regional plants
04	Black Creek	2	NSW	WLA	E	
	Mill Creek	2	NSW	WLA	E	
06	Buffalo Cr: source to Lake Wendell dam	1	5	WLA	E	Wendell WWTP will relocate discharge
	Little River	2	NSW	WLA	E, WS	Permit decisions depend on impact to endangered species
07	Contentnea Cr above Buckhorn Reservo	SP	NSW-SP	WLA	E	Nutrient management strategy pending further investigation
	Wiggins Mill and Buckhorn Reservoirs	3	3	3	E	Targeting nonpoint source reductions
	Contentnea Cr below Buckhorn Reservo	SP	NSW	WLA	E	BOD/DO model to be completed for 1998 update
10	Slocum Creek	4	NSW	WLA	E	Targeting point source relocation to the Neuse River.
10,13,14	Neuse River Estuary below Streets Ferry	SP	NSW	WLA	E	Modeling analysis for 1998, Advanced tertiary treatment likely required

Key to NPDES Permit Allocation Table

Note: Tributaries are included with mainstems unless specifically mentioned.

WLA Wasteload allocations are established in accordance with Division standard operating procedures, and NC water quality regulations. Specific NPDES limits are dependent on the amount and characteristics of the wastewater along with the stream classification and characteristics of the receiving water (e.g. flow, background loading, and assimilative capacity). Interaction with other sources, point and non-point, may affect limits.

SP Strategy Pending. Water quality impacted but sources and causes of problems are not fully understood. Mgmt. strategy is pending further investigation and will be targeted for the 1998 Neuse Basin Plan update. In interim, wasteloads will be evaluated on a case-by-case basis.

1 NPDES permits will reflect a minimum of advanced tertiary treatment levels (i.e., 5 mg/l BOD and 2 mg/l NH3-N). These requirements will apply to new and expanding facilities at permit issuance. Existing facilities will be handled on a case-by-case basis (Section 6.3)

2 NPDES allocations established in tributaries to the Neuse will be set to minimize increases of BOD loading to the mainstem. However, in cases where a discharge is in close proximity to the mouth of a tributary to the Neuse, the permittee will not be given limits more stringent than 5 mg/l BOD5 and 2 mg/l NH3-N unless required to protect water quality standards downstream of the outfall.

3 It is recommended that no discharges will be permitted directly into the lake.

4 No new discharges should be permitted. Existing discharges will be targeted for removal where feasible. Advanced tertiary treatment requirements will be phased in for those that cannot be eliminated (See subbasin descriptions in Section 6.3 for more details).

5 All major discharges in or above tributary arms and lakes can expect TP limits more stringent than those required by the NSW class.

E Includes existing nonpoint source programs that apply to all areas of the state (See Section 5).

NSW Nutrient Sensitive Water Classification requires TP limitations on specified discharges (See Section 6.4.2).

WS North Carolina's Water Supply Protection Program applies to these waterbodies (see Section 5.4.).

U Federal Stormwater requirements for large and medium municipalities apply to at least a portion of these watersheds.

Neuse River Mainstem

Low DO concentrations in the Neuse between Kinston and New Bern are well documented through NCDEM's ambient monitoring network (Chapter 4 Figures 4.3-4.5) and by NPDES instream self-monitoring data. In the lower basin, below Streets Ferry, the channel widens and the river's velocity decreases dramatically. Unassimilated oxygen-demanding wastes from upstream discharges and nonpoint source runoff become concentrated in this area and depress dissolved oxygen levels. While some of the DO deficit in this transition area is natural, the cumulative effect of all the upstream sources of BOD is increasingly recognized.

To evaluate the river's water quality, a Level-C model (Appendix III) was calibrated from Falls Dam to Streets Ferry, a reach of about 185 miles. The results of the modeling analyses indicate that oxygen-consuming wastes are currently over allocated in the Neuse River (NCDEM 1992a). This over-allocation is not a recent phenomenon, but is the result of many factors including: use in the past of less accurate models confined to small segments of the basin; inability in the past to examine pollutant interaction on a large scale because of the lack of a proper analytical framework; and the practice in North Carolina of giving away 100 percent of the assimilative capacity in a given location to a single discharge. While over-allocation had been suspected by NCDEM staff for some time, validation of this hypothesis required an appropriate basinwide modeling framework. The level C analysis of the Neuse from Falls Dam to Streets Ferry allowed staff to use available water quality data throughout the basin better and to examine the interaction of pollutants on a much broader scale such that their fate and transport are more accurately represented. Thus, through this larger scale analysis, the over-allocation of the Neuse River was confirmed. Complete and specific model documentation can be obtained from NCDEM's Technical Support Branch. A summary of the model results as they pertain to recommended TMDLs is provided below.

Management strategies for BOD were developed using allocation procedures of a field-calibrated QUAL2E water quality model. Allocation scenarios include:

- critical low flow conditions represented by minimum flow release from Falls Lake (needed to meet the Corps of Engineers' target flow of 254 cfs at Smithfield) plus 7Q10 flow from runoff below Falls Lake (7Q10 equals the minimum average flow for a period of seven consecutive days that has an average recurrence of once in ten years),
- warm water temperatures, and
- design characteristics of all point source discharges on the Neuse mainstem.

To evaluate the impact of the discharges, several varying scenarios were modeled. Predicted DO profiles from the model runs are shown in Figure 6.3.

The top graph in Figure 6.3 depicts the predicted DO profile when critical low flow and temperature regimes are modeled with average existing discharge characteristics (from 1991 NPDES self-monitoring data). It shows the expected DO if a 7Q10 drought were to occur at the current loading rates. Box plots of observed DO concentrations are included for comparison (explanation of box plots can be found in Appendix II). The shaded box plots are from facility self monitoring data from July through October 1990 and 1991, and the unshaded box plots are from the State ambient monitoring data from July through October 1987 - 1991. The July through October time period was chosen because these are the months in which critical conditions (i.e., low flow and high temperature) are most likely to occur. The top graph shows a good fit between the model predictions and observed data; the shape of the DO profile is parallel to the observed data. Because the 7Q10 flow and water quality characteristics are more extreme than average conditions, the DO profile predicted for those conditions is at the low end of the observed data. The graph shows that substandard (<5 mg/l) DO concentrations occur regularly in the lower Neuse basin.

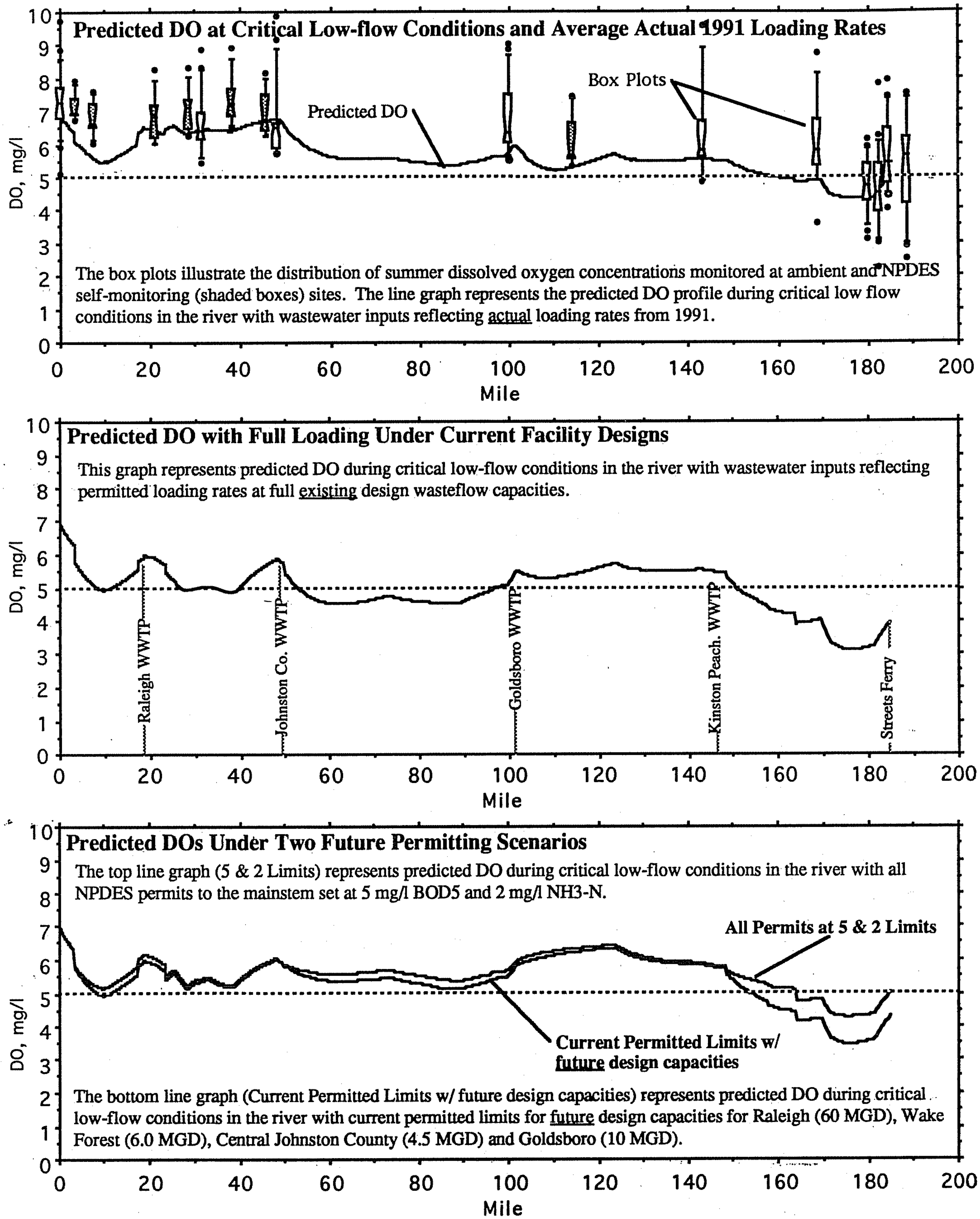

Figure 6.3 Results of Neuse River Dissolved Oxygen (DO) Modeling Analysis
(See Section 6.3 for further explanation)

The average and 7Q10 DOs would be expected to become more similar in the lower reaches of the river, since hydraulic characteristics of the river/estuary transition zone make the DO less sensitive to small flow differences and more dependent on temperature, total BOD loading, tide, and wind.

The second (middle) graph in Figure 6.3 illustrates the over-allocation of oxygen-consuming wastes that exists at discharge facilities on the mainstem. This chart shows the predicted DO profile under what could be considered worst case conditions. That is, it presents the DO profile that would occur if all NPDES facilities on the mainstem were to discharge at their current (as built) maximum design flows and waste loadings during critical low flow and warm temperature conditions. Several of the existing facilities were not built to achieve levels now deemed necessary to protect DO at permitted flows due to inaccurate allocations by NCDEM at the time the plants were constructed. DO would be expected to be less than 5 mg/l for a substantial portion of the river under these conditions. Fortunately, most of the discharges to the Neuse are currently discharging considerably less than their permitted loads (as noted in Chapter 4 and in Appendix V).

The bottom graph shows two future permitting management scenarios. The lower of the two DO profiles simulates current permitted loading of the Neuse River discharges. This is slightly different from the current (as built) design conditions shown in the middle graph since some of the facilities have recently received an NPDES permit with more stringent limits (i.e., for an expansion) but have not yet physically upgraded the wastewater treatment plant. Raleigh, Wake Forest, Smithfield, and Goldsboro each have more restrictive permits that are not effective until the planned modifications of their facilities are completed. Comparing the bottom two charts, the effect of the lower loading rates is obvious. The new permits are expected to improve water quality significantly. The second (upper) DO profile in the bottom chart is the predicted DO profile when every direct discharge to the Neuse River is allocated to effluent limitations of 5 mg/l BOD5 and 2 mg/l ammonia. This is the basis of NCDEM's recommended management policy regarding the Neuse. Although the predicted DO is expected to rise at every sag point (especially the lower river), some DO violations are still expected even at those more stringent limits. Where the DO concentrations in the river are expected to be greater than 5 mg/l in this case, it is only by a slight margin, indicating little room for error and very clearly showing the limited assimilative capacity remaining in the Neuse River with existing discharges limited to state-of-the-art levels of treatment.

The water quality model, as well as analysis of instream data, indicate more stringent controls on Neuse River BOD loading are needed. Based on the model and data, the recommended TMDL strategy for direct discharges of oxygen-consuming wastes in the Neuse River mainstem is to require summer advanced tertiary treatment levels (i.e., generally 5 mg/l BOD and 2 mg/l NH_3 or better) for municipalities and an equivalent economically feasible level of treatment for industries. This recommendation would apply to new and expanding facilities at permit issuance and would be a long-term goal for most dischargers on the mainstem. Scheduling for compliance of these limits for existing nonexpanding facilities would be determined on a case-by-case basis depending on the facility's size, current treatment levels, feasibility, plans for expansion, and other factors.

The model shows that tributary loading of BOD can also significantly affect the water quality of the Neuse River. The tributary loads were simulated at 5 mg/l BOD5 and 2 mg/l ammonia (as a point source load) and at standard WLA assumptions of the SOP, which are 2 mg/l CBOD and 1 mg/l NBOD (equal to 0.22 mg/l ammonia). Although the predicted DO profiles are similar, the additional DO deficit is unacceptable given the length of stream with substandard DO, and the magnitude of the predicted DO sag in the estuary. Therefore, it is recommended that all tributaries that flow directly into the Neuse River mainstem (i.e., those that enter the river below Falls Lake Dam) would be allocated for point sources and targeted for nonpoint sources such that increases in BOD loading at the mouth of the tributary are minimized. However, in cases where a discharge is in close proximity to the mouth of a direct tributary to the Neuse, the permittee would not be given limits more stringent than 5 mg/l BOD5 and 2 mg/l Ammonia (NH_3-N) unless it is required to protect water quality standards in the tributary or in the mainstem downstream of the outfall.

Subbasin 01

Streams in this subbasin typically have low summer month flows and limited BOD waste assimilative capacity, especially in the Eno River watershed. Consequently, problems are often encountered with maintaining adequate instream dissolved oxygen concentrations in the permitting of new or expanding discharge facilities. Most can be addressed through applying *standard operating procedures* (SOP) for point source wasteload allocations, along with programs to implement nonpoint source *best management practices* (BMPs). The following streams and lakes, however, have been identified as needing more stringent waste limit requirements due to well-documented water quality problems and the need to maintain water quality standards.

The Flat River basin, including the North and South Flat Rivers and their tributaries, has experienced water quality problems with BOD, solids, and fecal coliforms. Sources of these pollutants are suspected to be both point sources and nonpoint sources including failing septic systems and agricultural runoff. Point source discharges to zero 7Q10 flow streams have been targeted for removal and other point sources may be required to meet more stringent effluent limits. Ending at Lake Michie, the Flat River load of sediments should be reduced through control of erosion and implementation of agricultural best management practices. A more definitive management strategy will be targeted for 1998 pending further investigation of sources and causes.

Lake Michie is protected to some degree by its water supply classification and the associated water supply watershed rules. Direct discharges will not be allowed to the reservoir. Existing discharges to small, unnamed tributaries to the lake are recommended for removal which may be accomplished, in part, by a thorough examination of nondischarge alternatives. It is likely that those discharges that remain will be required to meet advanced tertiary limits upon expansion or renovation in light of the stream's limited waste assimilative capacity.

The Little River Reservoir watershed, including the North and South Fork Little Rivers, is largely unaffected by point source discharges. WLAs, existing and proposed, will be performed as per SOP and adjusted as necessary to alleviate very localized problems. No point source discharges will be allowed into the lake. Nonpoint sources of pollutants should be targeted for control as necessary to protect the reservoir. The Little River and its tributaries (Mountain Creek, Cabin Branch) below Little River Reservoir will be regulated according to SOP.

The Eno River has received considerable attention by NCDEM in the past. Level-C water quality models exist for the headwaters near Hillsborough and a stretch from Durham's Eno River WWTP to Falls Lake. Special protection of the Eno River is necessary because it is a major contributor to Falls Lake and pollutants transported in the Eno exhibit a cumulative effect in the zone of transition to lake waters. A large part of the Eno River is contained in the Eno River State Park and is highly valued for aesthetics and recreation. All major discharges to the Eno River and its tributaries are required to meet limits on oxygen-consuming wastes reflective of advanced tertiary treatment levels in order to protect Falls Lake water quality and the uses stated above. Minor discharges and residences are recommended to pursue nondischarge alternatives or connection to a municipality or other WWTP when possible. Local ordinances and/or incentives may achieve this as well as increased control of urban runoff. Hillsborough has recently improved its effluent quality significantly through the use of activated carbon treatment and the Durham Eno River WWTP is scheduled for removal. Continued monitoring of the Eno River is recommended through this permit cycle to evaluate the effects of reduced pollutant loading from the major discharges, and to ensure that protection of this valuable public resource is maintained.

The TMDL strategies for the Knap of Reeds Creek arm of Falls Lake will be the same as those for the Eno River. Past water quality problems have been directly attributed to the John Umstead Hospital discharge and its loading of BOD and nutrients to the slow-moving lake waters. Advance tertiary limits are now required of the facility and the plant has been upgraded. As a result of the observed sensitivity of these waters to effluent quality and to maintain water quality standards, the recommended standard procedure for this watershed will include the requirement of advanced tertiary limits for all major discharges, and normal wasteload allocation analyses for minor discharges.

Ellerbe Creek and its tributaries are subject to degradation from point and nonpoint sources, and urban runoff. The low flow into shallow, slow-moving lake waters has facilitated development of eutrophic conditions and substandard DO concentrations in the absence of algae. The City of Durham is in the process of eliminating two of its municipal discharges (i.e., Eno River and Little Lick Creek WWTPs) and consolidating the treatment works at its Northside WWTP on Ellerbe Creek. This is a major step in a regional approach to wastewater treatment, where all the wastewater is highly treated and discharged at one location rather than at three separate, less efficient discharges. Also, the additional flow at the Northside plant is expected to decrease the travel time through the Ellerbe Creek arm of Falls Lake, which together with decreased instream nutrient concentrations due to highly advanced treatment should reduce the potential for eutrophic conditions. Due to the small drainage area and low streamflows of Ellerbe Creek and the accessibility to municipal sewage treatment, the Division's goal from now on will be to eliminate all discharges of oxygen-consuming wastes other than the Northside WWTP. The plant will be required to meet at least tertiary levels of treatment and to extensively monitor the stream and its response to the effluent.

Lick Creek TMDL strategies are similar to those of Ellerbe Creek and Eno River. Water quality is expected to improve following the removal of Durham's municipal WWTP. In light of the stream's limited waste assimilative capacity, it is recommended that no new wastewater outfalls be permitted, and that expanding facilities, if permitted, will receive advanced tertiary effluent limits.

Many of the remaining tributaries to Falls Lake are low flow streams impacted by point and nonpoint sources. Direct discharges to or immediately upstream of Falls Lake will not be permitted in order to assure protection of the lake's recreational and water supply uses. Tributary discharges will be carefully evaluated through standard WLA procedures to determine appropriate limits.

Subbasin 02

Neuse subbasin 030402 contains the City of Raleigh and surrounding urban areas and is the subbasin most impacted by urban runoff. Its waterbodies are also impacted by multiple small discharges. The documented water quality problems in streams such as Crabtree Creek will be somewhat diminished with the implementation of stormwater controls, but more comprehensive point source control may also be necessary. Elsewhere in the basin, streams are typically characterized by low flows and agricultural runoff.

Crabtree Creek is being targeted for both point and nonpoint pollution control. New stormwater discharge permits requring improved waste treatment will alleviate some of the observed water quality degradation. It is also recommended that no new NPDES outfalls be permitted to Crabtree Creek above Lassiter Mill Pond except for the Cary-Northside plant. This plant serves an important role as a regional facility. Furthermore, a comprehensive water quality model will be developed to evaluate the effect of the numerous (36) existing point sources and to develop a management strategy by renewal of the Neuse basin plan in 1998. It is strongly suggested that any non-discharge alternatives be implemented and that discharges be removed when possible. While discharge permit limits will be derived according to standard procedure until the model is completed, it is known that there is limited assimilative capacity in Crabtree Creek and wasteload allocations will reflect this.

The lower portion of Swift Creek has no additional assimilative capacity for oxygen-consuming wastes as evidenced by a field calibrated water quality model that was developed and applied for the stream from below Lake Benson to its mouth (NCDEM, 1992b). As a result of the modeling analysis, it is recommended that no new discharges be allowed unless it can be shown that no more environmentally sound alternative is available. The long-range strategy for the creek includes eventual removal of the existing discharges as alternatives become available. Existing discharges are being required to meet advanced tertiary treatment limits in order to protect water quality standards.

A sewer interceptor line is being installed in the Perry Creek watershed. It is expected that the interceptor will provide service for most, if not all, of the existing discharges. Connection to the service will be required where available. Removal of the discharges is expected to significantly improve water quality. A study of Perry Creek has indicated that advanced tertiary treatment will be necessary for discharges of BOD that remain after the Perry Creek interceptor goes on-line.

Austin Creek, Harris Creek, and Poplar Creek were evaluated with a comprehensive model for each stream that accounted for multiple discharges. Each will be managed in accordance with standard operating procedure. The known presence of the federally endangered dwarf wedge mussel in this subbasin could affect the WLA and permit conditions for some facilities.

Subbasin 03

Subbasin 030403 is the drainage area for Middle Creek. A field-calibrated water quality model was developed for Middle Creek from near its source to its confluence with Swift Creek and indicates that the assimilative capacity is depleted (NCDEM 1992c). Efforts will be made to remove the several small package treatment plants by encouraging regionalization of wastewater treatment within this basin. The Division's long-term goal for point sources below Sunset Lake will be to eliminate discharges, where feasible, except for the Cary and Fuquay-Varina municipal wastewater treatment plants, which will be required to meet advanced tertiary treatment requirements. The known presence of the federally endangered dwarf wedge mussel in this subbasin could affect the WLA and permit conditions for some facilities.

Subbasin 04

This subbasin contains the relatively small drainage areas of Black, Hannah, Stone, and Mill Creeks below Smithfield, NC, and only eight permitted discharges. Black, Hannah, and Stone Creeks are currently on the list of impaired streams (Table 6.1). It is recommended that the sources of impairment be investigated and the nonpoint sources of pollutants targeted as necessary. Since there is no interaction between the relatively few discharges, permit limits for oxygen-consuming wastes will be determined in accordance with standard operating procedure, with target protection being to minimize BOD loading to the Neuse River.

Subbasin 05

Subbasin 030405 straddles the Neuse River between Goldsboro and Kinston. Per the Neuse mainstem studies described above, oxygen-consuming TMDLs for this basin will reflect advanced tertiary treatment for discharges to the mainstem and to minimize BOD loading from tributaries.

Subbasin 06

This subbasin contains Buffalo Creek and Little River. The few interacting discharges within this drainage area will be adequately managed through standard wasteload allocation methods. For the section of Buffalo Creek above Lake Wendell, NPDES permits will reflect a minimum of advanced tertiary treatment (i.e., 5 mg/l BOD and 2 mg/l NH_3-N) for new and expanding discharges at permit issuance. Existing facilities in this segment will be handled on a case-by-case basis. In addition, the Town of Wendell is considering relocating its discharge from Buffalo Creek, and may tie onto the Raleigh WWTP. Mill Creek is also listed as impaired, but the Town of Kenly has removed its discharge from the stream and conditions are expected to improve. The Division will continue to monitor the stream. Also, NPDES permitting decisions in the Little River will depend on potential impacts to endangered species inhabiting that stream.

Subbasin 07

The Contentnea Creek drainage area comprises subbasin 030407. Water quality problems are well documented in these surface waters, both from chemical and biological monitoring (Chapter 4). Both point and nonpoint sources are responsible and should be more carefully controlled through the TMDL process; however, further investigation is needed to pinpoint substantial sources. This basin likely will receive NCDEM's highest priority is a priority for cooperative efforts between government agencies to identify and prioritize where nonpoint source controls will be most efficiently implemented.

A calibrated water quality model exists for Contentnea Creek from the City of Wilson to just upstream of the Wayne County line. It is recommended that this model be expanded during this permit cycle to include more of the discharges and develop a comprehensive BOD TMDL for the entire subbasin. It is expected that DO problems in this basin can be partially regulated through point and nonpoint source control, but natural conditions, such as low flow, deep slow-moving water, and swampy conditions are likely to contribute as well. Study plans will be developed and a modeling analysis performed to evaluate this issue. Also, the known presence of the federally endangered dwarf wedge mussel in this subbasin could affect the WLA and permit conditions for some facilities.

Subbasin 08

This is a small subbasin including approximately 25 miles of the Neuse River and its tributaries. There are eight permitted discharges that are adequately handled through standard wasteload procedures protecting to background conditions at the Neuse River. In the Neuse River itself substandard DO concentrations are well documented below the Weyerhaeuser discharge. The existing Weyerhaeuser NPDES permit limits were determined by application of a calibrated one-dimensional water quality model (GAEST), which may have over simplified the complexities of the river-estuary junction. Weyerhaeuser is currently required by its permit to gather additional data to aid NCDEM in the development of a more advanced multi-dimensional model for the estuary. The resulting model will be used in conjunction with NCDEM's QUAL2E model of the mainstem Neuse River to provide a more comprehensive management tool.

Subbasin 09

Swift Creek and its tributaries drain this subbasin (it should be noted that this is a different Swift Creek than that in 030402). Five discharges will be allocated through normal wasteload procedures. The areas on the list of impaired waterbodies will be evaluated to pinpoint the specific sources of impairment. It is expected that the removal of the West Craven High School discharge will improve water quality in Swift Creek. Further actions may include nonpoint source control.

Subbasin 10

Slocum Creek is located in Subbasin 030410, and substandard DO concentrations have been observed below the surface. Part of the DO problem is due to eutrophication and poor tidal flushing, but a portion of it may be attributed to BOD loading from the U.S. Marine Corps (USMC) Cherry Point Air Station and the Town of Havelock discharges. NCDEM has been working with both facilities to remove their discharges. The USMC will be relocating its discharge to the Neuse River mainstem, and the plant will have state of the art BOD removal. The Town of Havelock is looking into tying on to the USMC WWTP or piping to the Neuse River. It is recommended that no new outfalls will be permitted to this creek.

Subbasins 10, 11, 13, and 14

These subbasins drain directly into the estuarine part of the Neuse River, from approximately New Bern to the Pamlico Sound. Discharges include large industrial and small domestic discharges, with a majority of the very lower basin discharges being washdowns from fish packing and processing facilities. WLA analyses in estuarine areas are more complex than those to river systems due to the tidal and wind effects on the hydrology and the three-dimensional circulation patterns. Due to the time and resource constraints, a comprehensive estuary model was not developed for inclusion in this plan. However, monitoring regimes are being developed and a calibrated multidimensional water quality model is planned to be available by the next permit cycle to serve as a link between the river loadings and the estuarine response. The estuary modeling will be a cooperative effort between Weyerhaeuser, the U.S. Geological Survey (USGS), and NCDEM. Standard WLA procedures will apply to these subbasins until the modeling effort and subsequent management plans are completed. New and expanding discharges in the estuary area will likely receive NPDES limits reflecting advanced wastewater treatment.

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 Neuse River basin has limited assimilative capacity for nutrients. Due to its physical and geographical characteristics, the Neuse River and estuary are especially susceptible to degradation from excessive nutrient loadings. Summertime eutrophic conditions are well documented throughout the basin (See data summaries, Chapter 4).

6.4.2 Control Strategies

NCDEM first recommended nutrient management in the Falls Lake watershed in 1983. The implementation plan was revisited in 1987 by NCDEM, and existing discharges greater than 50,000 gallons per day were given until January 1990 to achieve compliance with limits of 2.0 mg/l TP. In 1988, however, NCDEM recognized the need for basinwide nutrient management in the Neuse River and developed a Nutrient Sensitive Water (NSW) strategy for the remainder of the basin. A basinwide nutrient budget was developed and target reductions of 50% of the total phosphorus and 30 to 40% of the total nitrogen were established. The target reductions of the NSW management plan were developed from a comprehensive nutrient budget for the Neuse River between Falls Dam and New Bern. Effluent TP limits of 2.0 mg/l were applied to all new or expanding discharges below Falls Lake greater than 500,000 gallons per day. Facilities were given until May 1993 to come into compliance with the TP limit. Currently a majority of the facilities have already done so.

In 1992, Research Triangle Institute (RTI) updated the nutrient budget in a study performed for the Albemarle-Pamlico Estuarine Study program (See Chapter 3, Section 3.2.2). RTI's analysis provides estimates, with uncertainty parameters, of total nutrient loadings by Neuse subbasin and by land use type. This information is summarized in Section 3.2 and is useful for evaluating the effectiveness of existing nutrient controls as well as targeting the largest sources of nutrients.

Since 1983, phosphorus loading has decreased substantially. A 1988 statewide ban of phosphate detergents contributed significantly to the decrease of anthropogenic phosphorus introduced to the state waters. NCDEM estimated that the phosphate ban alone resulted in a 41% reduction of TP loads from wastewater treatment plants statewide. The reduction in instream phosphorus concentrations in the Neuse River below Falls Lake is clearly illustrated in Figure 4.6 in Chapter 4. The encouraging decrease in nutrient concentrations appears to be primarily attributable to the phosphate ban and to regulation of point sources through the NSW strategy cited above. However, further point source limitations (except in certain local circumstances) are expected to be less effective in total reduction than controlling nonpoint sources, particularly from agricultural land. The point source contribution is expected to decrease further as the remaining affected facilities achieve compliance with the NSW limitations. The relative contributions of point and nonpoint nutrient loading suggest that there is much to gain from actively targeting nonpoint sources of nutrients for implementation of best management practices. This will be a major component in the Division's nutrient control strategy.

In addition to the NSW strategy, more stringent TP limits, as well as possible establishment of TN limits, will be necessary in localized areas. While the NSW designation was designed to protect the basin as a whole on an annual basis, some localized areas are much more impacted by a constant discharge. Through modeling analyses and detailed monitoring, it is evident that eutrophication problems (i.e., algae blooms, nuisance conditions, etc.) are common in areas where a discharge dominates a low flow stream, especially above lakes or other impoundments. Evidence is mounting that directly relates the instream TP concentration to these conditions and supports an instream target for TP and perhaps TN. Currently, however, Division procedure is to assign more stringent nutrient limits where it can be shown that during summer low flow periods the discharge is directly impairing the water quality of the receiving water.

Subbasin 01

This subbasin comprises the entire Falls Lake drainage area. Additional nutrient controls are required to protect Falls Lake in the summer when inflow is low. Major discharges to Falls Lake tributaries can expect to receive TP limits more stringent than those required by the basinwide nutrient sensitive waters strategy. For instance, the City of Durham is under a Consent Order to eliminate its Eno and Little Lick Creek WWTPs, and the consolidated plant at Northside (Ellerbe Creek) will have state-of-the-art nutrient removal that will lower both the instream concentrations in these tributaries, as well as loading to the lake arms.

Lake Rogers is located on Ledge Creek in this subbasin and does not support its uses due to nutrient problems. The lake is hypereutrophic and also is infested with Hydrilla. The source of the nutrients is unknown, but a study to determine the sources of pollution is a Division priority.

All the other subbasins contribute to the Neuse River below Falls Lake. Routine NSW strategy limitations will apply throughout these Basins, with exceptions where more localized problems have been documented. Nonpoint contributions of nutrients have been estimated by RTI and offer quite a bit of insight as to where nonpoint source targeting will have the most significant results.

Subbasin 02

Big Lake is located on Sycamore Creek and is classified as not supporting its uses. The major cause of the problems is drawdown for aquatic weed control. This lake is scheduled to be restored in 1993 with a Federal Clean Lakes Grant. Also, small impoundments in the Swift Creek watershed (Austin Pond and the impoundment below the Town of Clayton WWTP) are under surveillance by NCDEM regarding nutrient enrichment, and local management strategies more stringent than the existing basin NSW plan may be forthcoming.

Lake Benson is a partially supporting reservoir located on Swift Creek. The main problem with this lake is Hydrilla, and the Division of Water Resources will continue to monitor the lake through its aquatic weed program.

Subbasin 03

Preliminary monitoring results in Sunset Lake, an impoundment in the upper Middle Creek basin, indicated that local eutrophication is occurring due to both point and nonpoint sources. This lake will be targeted by NCDEM to develop a management strategy for the 1998 basin plan update

Subbasin 06

Lake Wendell is located on Buffalo Creek below the Town of Wendell's WWTP and is not supporting its uses due to nutrient problems. The Town of Wendell is investigating relocating its discharge or tying onto the Raleigh WWTP under the conditions of its Special Order by Consent. If Wendell's discharge is not eliminated, their NPDES permit will require the wastewater treatment to meet a TP limit of 0.5 mg/l. The Division should monitor any improvements after the Wendell discharge is removed and investigate nonpoint sources of nutrients.

Subbasin 07

The primary site in the Neuse River Basin that has continually been documented as being a problem is subbasin 07, the Contentnea Creek drainage basin. Agricultural land in this basin is estimated to contribute over 20% of the nutrient loading to the entire Neuse River mainstem between Falls Lake and New Bern (Table 3.4). Therefore, NCDEM intends to work closely with the appropriate agencies to identify and prioritize where nonpoint BMPs would most effectively be implemented within this area to reduce impacts on the entire lower basin. Several impoundments, most notably Taylors Millpond, Buckhorn Reservoir and Wiggins Mill Reservoir are located in this subbasin. The nutrient problems observed in these lakes will also be addressed through this effort.

Subbasin 10

Slocum Creek (South River area) has exhibited severe eutrophication problems. At present, the Town of Havelock and the U.S. Marine Corps (USMC) have NPDES discharges to this creek. This creek has no freshwater inflow during low baseflow periods, and the mouth of the creek narrows significantly before entering the Neuse River so flushing due to tides is extremely limited. Therefore, point and nonpoint nutrient sources may have a large impact on the stream. In order to help alleviate the situation, NCDEM advised the Town and USMC to look into removing their discharges from the creek. The USMC will be relocating its discharge to the Neuse River, and Havelock will continue to be directed to relocate its discharge or tie onto the USMC facility.

Neuse Mainstem

The chlorophyll-a data plotted in Figures 4.6 and 4.7 indicate that the zone of greatest nutrient impact in the Neuse River mainstem is located in the lower reaches between New Bern and Oriental. In addition, Section 4.5.2 indicates that eutrophication, as indicated by high chlorophyll a concentrations, is the most widespread cause of water quality impairment in estuarine waters. The Division will continue to monitor the water quality in these areas to determine how effective the NSW strategy is and to investigate sources of point and nonpoint source nutrient loading in targeted watersheds.

Discharges in these basins may receive more stringent TP limits in the future due to their dominating contributions of nutrients during low-flow summer months, and nonpoint sources will be targeted for control BMPs.

6.5 TOXIC SUBSTANCES

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

6.5.1 Assimilative Capacity

The assimilative capacity, the amount of wastewater the stream can assimilate under designated flow conditions (7Q10 for aquatic life based standards, average flow for carcinogens), available for toxics in the Neuse Basin varies from stream to stream. In larger streams where there is more dilution flow, there is more assimilative capacity for toxic dischargers. In areas with little dilution, facilities will receive chemical specific nutrient standards which are close to the standard. Toxics from nonpoint sources typically enter a waterbody during storm events. The waters need to be protected from immediate acute effects and residual chronic effects. A review of the ambient station data in the Neuse River Basin indicates that there are only four streams which have toxics problems. These streams are: Knap of Reeds Creek, Ellerbe Creek, Crabtree Creek, and Pigeon House Creek.

6.5.2 Control Strategies

Point source dischargers 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. In addition, all major dischargers are required to perform annual pollutant scans for all priority pollutants. These data are used at permit renewal to determine if any other toxic parameters need to be limited in the NPDES permit. Whole effluent toxicity limits are also assigned to all major dischargers 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. And Raleigh and Durham will be implementing stormwater programs that will include identifying and removing illicit discharges to storm drain systems. Additional strategies for streams not meeting instream standards or action levels are discussed by subbasin below:

Subbasin 01

Knap of Reeds Creek has had several exceedances of North Carolina's action level for copper. Umstead Hospital has recently gone through plant upgrades, and biological improvements may not yet have occurred. The stream should continue to be monitored for improvement. Ellerbe Creek has also had exceedances of North Carolina's action level for copper. This stream is affected by Durham's Northside WWTP and urban runoff. The City of Durham is upgrading the Northside WWTP, and Durham will be required to implement stormwater management strategies. NCDEM should continue to monitor the stream for improvement as these controls are implemented.

Subbasin 02

Ambient data indicate that Crabtree Creek has had violations of the lead standard and the zinc and copper action levels. This Creek runs through heavily urbanized areas of Wake County (Cities of

Cary and Raleigh). Raleigh will be implementing stormwater management strategies in the near future, and the stream should continue to be monitored to see if improvements occur.

Pigeon House Creek also runs through Raleigh, and has had exceedances of the copper and zinc action levels. Again, stormwater management strategies will apply to this watershed, and the stream should be monitored to see if improvements occur.

Subbasin 08

Weyerhaeuser was listed on the State's 304(l) "short" list because of the accumulation of dioxin within fish sampled in the lower Neuse basin. Since the creation of that list, the Division implemented an individual control strategy for Weyerhaeuser in the form of an NPDES limit for dioxin. Followup monitoring is being conducted to determine the level of effectiveness.

REFERENCES CITED - CHAPTER 6

North Carolina Division of Environmental Management, 1992a, A QUAL2E-UNCAS Application to the Neuse River from Falls Dam to Streets Ferry in North Carolina, NCDEM Water Quality Section, Raleigh, NC.

NCDEM, 1992b, A Water Quality Analysis of the Proposed Town of Garner Wastewater Treatment Plant and Its Impact on Swift Creek, NCDEM Water Quality Section, Raleigh, NC.

NCDEM, 1992c, A Water Quality Analysis of the Proposed and Existing Discharges to Middle Creek below Sunset Lake, NCDEM Water Quality Section, Raleigh, NC.

CHAPTER 7

BASINWIDE PLAN SUMMARY AND FUTURE INITIATIVES

7.1 OVERVIEW OF NEUSE BASINWIDE GOALS AND OBJECTIVES

Near-term objectives, or those achievable at least in part during the next five years, include implementing TMDLs or other management strategies, as appropriate, to significantly reduce point and nonpoint source loadings of BOD, nutrients and other pollutants in order to make measurable improvements towards addressing the priority issues described in Chapter 6. These include progress towards restoring impaired waters and protecting high resource value and biologically sensitive waters.

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 growth and development.

Attainability 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, NCDEM believes that these goals are attainable through the basinwide water quality management approach.

Below are some additional highlights of the plan and a presentation of future water quality management initiatives.

7.2 NEUSE NPDES PERMITTING AND TMDL STRATEGIES

7.2.1 BOD and Ammonia

The water quality model from Falls Lake to Street's Ferry discussed in Chapter 6, as well as analysis of instream data, indicate more stringent controls are needed on direct discharges of BOD to the Neuse River in order to maintain the dissolved oxygen standard throughout the mainstem, particularly in the area from Kinston to the upper estuary. The model also shows that tributary loading of BOD can significantly affect the water quality of the Neuse River. Accordingly, it is recommended that all tributaries that directly affect input to the Neuse River mainstem (i.e., those entering the Neuse below Falls Lake) should be treated as point sources. Discharges on tributaries will be given wasteload allocations designed to minimize BOD loading to the river. Below are recommended point source control strategies for BOD and NH3 that are discussed more fully in Chapter 6.

- Neuse Mainstem from Falls Dam to Streets Ferry: Advanced tertiary treatment levels (i.e., 5 mg/l BOD and 2 mg/l NH3 in summer and 10 mg/l BOD and 4 mg/l in winter) for municipalities and equivalent economically feasible level of treatment for industries are recommended for discharges on the mainstem to protect the instream dissolved oxygen standard of 5 mg/l. This recommendation would apply to new and expanding facilities at permit issuance and would be a long term goal for all dischargers on the mainstem. Wasteloads for existing nonexpanding dischargers will be handled on a case-by-case basis.

- Neuse Tributaries below Falls Lake (not including those tributaries listed below): NPDES allocations will be recommended so as to minimize BOD loading to the mainstem. Where a discharge is close to the mouth of the tributary, the permittee will not be given limits more stringent than for mainstem dischargers unless required to protect water quality standards in the tributary.

- Eno River, Knap of Reeds Creek, Ellerbe Creek, Lick Creek, Crabtree Creek (above Lassiter Mill Pond), Swift Creek (below Lake Benson), Middle Creek, and Slocum Creek: Studies indicate that no [1]new discharges should be permitted. Existing discharges should be removed, where feasible. Advanced tertiary treatment will be phased in for those that cannot be removed (and has already been accomplished for several major dischargers in Durham, Cary and Fuquay-Varina).

- Neuse River Estuary below Streets Ferry, Contentnea Creek Subbasin, Flat River and Crabtree Creek below Lassiter Mill: Permit strategies are being developed. Water quality problems have been identified but are not fully understood. Wasteloads will be done on a case-by-case basis. A computer model is being developed for the estuary. Tertiary limits are anticipated to be recommended for new and expanding facilities.

- Falls Lake, Lake Michie, Orange Reservoir, Wiggins Mill Reservoir, Buckhorn Reservoir and Unnamed Tributaries to the above: Studies indicate that no additional discharges should be permitted in order to protect water quality standards.

Most recently permitted wastewater treatment plants have already received waste limits consistent with the above recommendations. Scheduling for compliance of these limits for existing nonexpanding discharges will be determined on a case-by-case basis taking into account the type and age of the plant, size of its discharge, current treatment levels, cost feasibility, and significance of water quality impacts.

7.2.2 Nutrients

The Falls Lake portion of the Neuse basin was declared nutrient sensitive in 1983 and the remainder of the basin was declared nutrient sensitive in 1988. Since 1988, effluent phosphorus limits of 2.0 mg/l (or lower depending on the circumstances) have been applied to all new or expanding discharges greater than 50,000 gallons per day and all existing discharges greater than 500,000. All discharge facilities greater than 500,000 gallons per day were given until May 1993 to come into compliance with the phosphorus limit. Currently a majority of the facilities have already done so.

Nonpoint source nutrient loadings and updating the NSW strategy for the Neuse Basin are discussed further in Section 7.3.

7.2.3 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;
- 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.

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[1] The term "new" can include previously permitted discharge facilities where no "significant construction" has occurred during the "term of the permit" (15A NCAC 2H .0100)

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.

7.2.4 Toxic Substances

Point source dischargers will be allocated chemical specific toxics limits (metals, chlorine and organics) and monitoring requirements based on a mass balance technique discussed in Appendix III of this report. In addition, all major dischargers are required to perform annual pollutant scans for all priority pollutants. These data are used at the time of permit renewal to determine if any other toxic parameters need to be limited in the NPDES permit. Whole effluent toxicity limits are assigned to all major dischargers and any discharger of complex wastewater. New and expanding wastewater treatment plants will be required to dechlorinate their chlorinated effluent or to use alternate disinfection methods.

7.3 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, accounts for the majority of impaired freshwater stream miles, 89 percent of the acreage of impaired salt waters and over 75 percent of the impaired lakes in the Neuse basin. Sediment is the most widespread cause of nonpoint source impairment in freshwater streams while excessive nutrient loading constitutes the most widespread problem in lakes and salt waters.

Nonpoint source efforts will be aimed at better controls on urban runoff (through the new urban stormwater regulations) and continuing efforts will be made to work with the agricultural, forestry and development communities to reduce nutrient and sediment runoff through expanded and improved BMP coverage. Agricultural BMPs are particularly needed in the Contentnea Creek subbasin in order to reduce its contribution of nutrients to the estuary and identified impaired impoundments in the subbasin. In addition, emphasis will be placed on efforts to understand and minimize fecal coliform contamination of shellfish waters and reduction of runoff from concentrated animal operations.

Reducing nonpoint source nutrient loading to the basin's sounds and lakes will be a high priority over the next five years. Considerable progress has been seen in reducing point source loadings to the basin; however, little is known at present on the location and effectiveness of agricultural BMPs that have been implemented in the Neuse Basin in recent years. Also, the dynamics of nutrient assimilation and cycling in the Neuse estuary are not fully understood. There are no conclusive studies available on what would constitute an allowable nutrient loading to the estuarine system. It is known, however, that the system is being overloaded, as evidenced by excessive algal growth, and that further nutrient reductions are necessary.

NCDEM will be evaluating the present NSW nutrient reduction strategies prior to updating the Neuse Plan in 1998 with the objective of developing revised point and nonpoint source nutrient reduction goals. This objective will include identification of nutrient reduction technologies and associated costs of implementation for both point and nonpoint source pollution. This effort will require continuing close coordination with researchers, baseline water quality monitoring data and obtaining solid information on the location, type, number and effectiveness of agriculture BMPs. NCDEM is currently working with the US Soil Conservation Service to develop hydrologic maps for maintaining agriculture BMP data that will be compatible with the subbasin map units used by NCDEM. This should prove extremely helpful in gathering the data needed on agricultural BMPs. In addition, a nutrient loading model is being developed for the Tar-Pamlico basin and that may have application in the Neuse basin.

7.4 FUTURE MODELING PRIORITIES

As indicated in Chapter 6, wasteload allocation analyses in estuarine areas, which are some of the most fragile waters in the state, are more complex than those for river systems due to the tidal and wind effects on the hydrology and the three-dimensional circulation patterns. Due to the time and resource constraints, a comprehensive estuary model was not developed for inclusion in this plan. However, monitoring regimes are being developed and a calibrated multidimensional water quality model is planned to be available by the next permit cycle to serve as a link between the river loadings and the estuarine response. The estuary modeling is expected to be a cooperative effort between Weyerhaeuser, the U.S. Geological Survey (USGS), and NCDEM. Standard WLA procedures will apply to these subbasins until the modeling effort and subsequent management plans are completed. Consideration will be given not only to addressing impacts from BOD but also to nutrients and other parameters that may be of concern on a case-by-case basis.

In addition to the estuarine model, calibrated BOD/DO models will be developed for Contentnea Creek (Subbasin 030407) and remaining unmodeled portions of Crabtree Creek. Further refinement of the model of the Neuse mainstem between Fort Barnwell and Streets Ferry will also be examined.

7.5 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 collected from (1) ambient water chemistry, (2) sediment chemistry, (3) biological communities, (4) contaminant concentrations in fish and other biota, and (5) ambient toxicity. The specific parameters measured will relate directly to the long-term water quality goals and objectives defined within the basinwide management strategy.

7.6 FUTURE PROGRAMMATIC INITIATIVES

7.6.1 Use of Discharger Self-Monitoring Data

NCDEM will explore the pros and cons of utilizing discharger self-monitoring data 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 system for later analysis. However, there is a potential wealth of information when considering the number of dischargers, their distribution, the frequency of sampling and the fact that sampling is already being required.

7.6.2 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 NCDEM's Construction Grants and Loan Program. This possibility will be investigated further.

7.6.3 Improved Data Management and Expanded Use of Geographic Information System (GIS) Computer Capabilities

NCDEM 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.

APPENDIX 1

Summary of North Carolina's Water Quality Classifications and Standards

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 freshwaters, 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 64% in the critical area and 30% built upon area outside of the critical area allowed with engineered stormwater controls for the 1" storm'	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
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; ½-acre lots or 24% built-upon outside of critical area; up to 30% in critical area and 50% built-upon area outside critical area with engineered stormwater controls for the 1" storm'	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

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STANDARDS (continued)

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
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): ½-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 ½ mile and draining to water supplies from normal pool elevation of reservoirs, or ½ 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".

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
Saltwater:				
Class SC	Saltwaters protected for secondary recreation, aquatic life propagation and survival and other uses as described for Class C	See attached Table 2.; WATER QUALITY STANDARDS FOR SALTWATER CLASSES; standards listed under "Standards For All Tidal Saltwaters" column (aquatic life and human health sections) apply to Class SC waters, unless preempted by more protective standard.	Stormwater Disposal Rules (15A NCAC 2H .1000) apply to all waters in the 20 coastal counties; low density option: 30% built-upon area or 1/3 acre lots, or structural stormwater controls with higher density, as specified	
Class SB	Saltwaters protected for primary recreation and all Class SC uses (similar to Class B)	Same as Class SC except no floating solids, settleable solids or sludge deposits attributable to sewage, industrial or other wastes	Same as Class SC	Reliability requirements same as for Class B
Class SA	Shellfishing and all Class SC and SB uses	Same as for Class SC, except fecal coliform = 14 colonies per 100 ml of water; all other waters = 200/100 ml	Same as for Class SC, except low density option = 25% built-upon area	No domestic discharges and only nonprocess industrial discharges, such as seafood packing house or cooling

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STADARDS (continued)

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/1; NH_3-N= 2 mg/1; DO=6 mg/1	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/1 allowed if due to natural conditions		

TABLE 1. WATER QUALITY STANDARDS FOR FRESHWATER CLASSES

Parameters	Standards For All Freshwater: Aquatic Life	Standards For All Freshwater: Human Health	More Stringent Standards To Support Additional Uses: WS Classes	More Stringent Standards To Support Additional Uses: Trout
Arsenic (ug/l)	50			
Barium (mg/l)			1.0	
Benzene (ug/l)		71.4	1.19	
Beryllium (ng/l)		117	6.8	
Cadmium (ug/l)	2.0			0.4
Carbon tetrachloride (ug/l)		4.42	0.254	
Chloride (mg/l)	230 (AL)		250	
Chlorinated benzenes (ug/l)			488	
Chlorine, total residual (ug/l)	17 (AL)			17
Chlorophyll a, corrected (ug/l)	40 (N)			15 (N)
Chromium, total (ug/l)	50			
Coliform, total (MFTCC/100ml)			50 (N)(2)	
Coliform, fecal (MFTCC/100ml)		200 (N)		
Copper (ug/l)	7 (AL)			
Cyanide (ug/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 (ug/l)		49.7	0.445	
Iron (mg/l)	1.0 (AL)			
Lead (ug/l)	25 (N)			
Manganese (ug/l)			200	
MBAS (ug/l) (Methylene-Blue-Active Substances)	500			
Mercury (ug/l)	0.012			
Nickel (ug/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 (ug/l)			100	
2,4,5-TP (Silvex) (ug/l)			10	
pH (units)	6.0-9.0 (Sw)			
Phenolic compounds (ug/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 (ug/l)	5			
Silver (ug/l)	0.06 (AL)			
Solids, total dissolved (mg/l)			500	
Solids, suspended	(N)			
Sulfates (mg/l)			250	
Temperature	(N)			
Tetrachloroethane (1,1,2,2) (ug/l)		10.8	0.172	
Tetrachloroethylene (ug/l)			0.8	
Toluene (ug/l)	11			0.36
Toxic Substances	(N)			
Trialkyltin (ug/l)	0.008			
Trichloroethylene (ug/l)		92.4	3.08	
Turbidity (NTU)	50; 25 (N)			10 (N)
Vinyl chloride (ug/l)		525	2	
Zinc (ug/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 ug/l but the daily average must be 5.0 ug/l or more.
- (2) Applies only to unfiltered water supplies.

TABLE 2. WATER QUALITY STANDARD FOR SALTWATER CLASSES

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 (ug/l)	50		
Benzene (ug/l)		71.4	
Beryllium (ng/l)		117	
Cadmium (ug/l)	5.0		
Carbon tetrachloride (ug/l)		4.42	
Chlorophyll a (ug/l)	40 (N)		
Chromium, total (ug/l)	20		
Coliform, fecal (MFFCC/100ml)		200 (N)	14 (N)
Copper (ug/l)	3 (AL)		
Cyanide (ug/l)	1.0		
Dioxin (ng/l)		0.000014	
Dissolved gases	(N)		
Dissolved oxygen (mg/l)	5.0 (1)		
Hexachlorobutadiene (ug/l)		49.7	
Lead (ug/l)	25 (N)		
Mercury (ug/l)	0.025		
Nickel (ug/l)	8.3		
Phenolic compounds		(N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079	
Polynuclear aromatic hydrocarbons (ng/l)		31.1	
Pesticides (ng/l)			
Aldrin	3.0	0.136	
Chlordane	4.0	0.588	
DDT	1.0	0.591	
Demeton	100		
Dieldrin	2.0	0.144	
Endosulfan	9.0		
Endrin	2.0		
Guthion	10		
Heptachlor	4.0	0.214	
Lindane	4.0		
Methoxychlor	30		
Mirex	1.0		
Parathion	178		
Toxaphene	0.2		
pH (units)	6.8-8.5 (1)		
Radioactive substances		(N)	
Salinity	(N)		
Selenium (ug/l)	71		
Silver (ug/l)	0.1 (AL)		
Solids, suspended	(N)		
Temperature	(N)		
Tetrachloroethane (1,1,2,2) (ug/l)		10.8	
Toxic substances	(N)		
Trialkyltin (ug/l)	0.002		
~~Trichloroethylene (ug/l)~~		~~92.4~~	
Turbidity (NTU)	25 (N)		
Vinyl chloride (ug/l)		525	
Zinc (ug/l)	86 (AL)		

Note:
(N) See 2B .0212 (b), (c), or (d) 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.

APPENDIX II

Sources and Types of Water Quality and Biological Data Collected by NCDEM

APPENDIX II

SOURCES AND TYPES OF WATER QUALITY AND BIOLOGICAL DATA COLLECTED BY NCDEM

Biomonitoring

Benthic macroinvertebrates, or benthos, are organisms, mostly aquatic insect larvae, that live in and on the bottom substrates of rivers and streams. 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 species 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 (EPTs). Likewise, ratings can be assigned with a "biotic index". This index summarizes tolerance data for all species 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 poorly assessed by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) 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 = 0-5)

	Mountains	Piedmont/Coastal
Excellent	<2.18	<2.61
Good	2.19-2.58	2.61-2.93
Good-Fair	2.59-2.99	2.94-3.24
Fair	3.00-3.46	3.25-3.69
Poor	>3.46	>3.69

*These criteria apply to flowing water systems only. Biotic index criteria are only used for full-scale (10-sample) qualitatative samples

Phytoplankton Sampling

Phytoplankton or algae are microscopic plants found in the water column of lakes, rivers, streams, and estuaries. Through photosynthesis, these tiny plants provide the base for the aquatic food web and, as such, can be a determining factor in overall aquatic production. Phytoplankton populations are dependent upon nutrient availability and other ecological factors such as light, temperature, pH, salinity, organic matter, grazing by higher trophic levels and water velocity. Phytoplankton are especially useful as indicators of eutrophication.

Prolific growths of phytoplankton, often due to abundant nutrients, sometimes result in surface "blooms" in which one or more species of algae may actually form a visible mat on top of the water. Surface 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 actual biovolume and density estimates. Usually, an algal sample with a biovolume larger than 5,000 mm^3/m^3, density greater than 10,000 units/ml, or chlorophyll a concentration approaching 40 ug/l (the North Carolina state standard) constitutes a bloom. Other components of the phytoplankton program include ambient monitoring, lake monitoring, and special studies.

Fisheries

To the public, the condition of the fishery is one of the most meaningful indicators of water quality. 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.

Fish Community Assessment

The amount of sedimentation, nutrients, and toxicants a stream receives, in conjunction with available habitat and basic water quality characteristics, will dictate the type of fish community that a stream can support. Therefore, by determining the structure of the fish community at a certain location, assumptions about fish community and water quality can be surmised. Fish have the following advantages in regard to their use in evaluating water quality and biotic integrity :

(1) Fish are integrators of community response to aquatic environmental quality conditions; they are the end product of most aquatic food webs, thus the total biomass of fishes is highly dependent on the gross primary and secondary productivity of lower organisms.
(2) They constitute a conspicuous part of the aquatic biota and are recognized by the public for their sport, commercial and endangered status, and represent the end product of protection for most water pollution abatement programs.
(3) They reproduce once per year and complete their entire life cycle in the aquatic environment which they inhabit.
(4) They have relatively high sensitivity to many substances and physical conditions.
(5) There is an abundance of information concerning their life history, ecology, environmental requirements and distribution.

Criteria have been developed to assign fish biological integrity classes, ranging from poor to excellent, to each fish community sample. The method of assigning classifications is an Index of Biotic Integrity (IBI) that has been modified from Karr's Index of Biotic Integrity [1]for North Carolina. The North Carolina IBI is based on a number of component observations. The principal components of fish community evaluations include information about species richness and composition, trophic composition, and fish abundance and condition. The actual assessment of biological integrity using IBI is

[1]Karr, J.R. K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running water: a metrhod and its rationale. illinois History Survey Special Publication No. 5, Urbana.

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 area, 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 with a maximum value of 60. Integrity classes and their respective score ranges are listed below.

Excellent	58-60	Poor-Fair	35-39
Good-Excellent	53-57	Poor	28-34
Good	48-52	Very Poor -Poor	23-27
Fair-Good	45-47	Very Poor	12-22
Fair	40-44	No Fish	<12

Fish Tissue

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 have been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation through aquatic food webs and may accumulate in fish and shellfish tissues. Thus fish tissue monitoring can serve as an important early warning indicator of contaminated 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. A list of fish tissue parameters accompanied by their FDA criteria are presented below. 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 samples are also evaluated by comparing results to a number of least water quality impacted locations(reference sites).

Metals

	FDA		FDA
Cadmium	None	Chromium	None
Nickel	None	Lead	None
Copper	None	Arsenic	None
Mercury	1.0ppm	Selenium	None

Synthetic Organics

	FDA		FDA
Aldrin	0.3ppm	o,p DDD	5.0ppm
Dieldrin	0.3ppm	p,p DDD	5.0ppm
Endrin	0.3ppm	o,p DDE	5.0ppm
Methoxychlor	None	p,p DDE	5.0ppm
Alpha BHC	None	o.p DDT	5.0ppm
Gamma BHC	None	p,p DDT	5.0ppm
PCB-1254	2.0ppm	cis-chlordane	3.0ppm
Endosulfan I	None	trans-chlordane	3.0ppm
Endosulfan II	None	Hexachlorobenzene	None

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 each lake's trophic status-a relative measure of nutrient enrichment and productivity, and whether the lake's uses have been threatened or impaired by pollution.

Tables presented in each subbasin summarize data used to determine the trophic status 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 status of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NRCD 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 judgement is used to assign an appropriate classification. NCTSI scores are also skewed by the highly colored water typical of dystrophic lakes. These acidic, "black-water" lakes are scattered throughout the coastal plain, often located in swampy areas or overlying peat deposits.

The summary tables list lakewide averages of total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), and chlorophyll a (CHLA in µg/l). The surface water classification follows. The final column indicates whether the designated uses of the lake are supported by current water quality: "Full" indicates all uses are supported; "Threatened" indicates all uses are currently supported, but one or more uses is threatened (i.e. could be impaired in the future unless pollution control actions are taken); "Partial" indicates one or more uses is partially supported and remaining uses are fully supported; "Not" indicates one or more uses is not supported. Causes of use impairment or threat are explained below each table.

All lakes in the Neuse basin are classified "Nutrient Sensitive Waters". By definition, nutrient controls are needed to protect such waters from excessive growths of vegetation.

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 usually reported as a series of field data tables and summaries of laboratory analysis reports. Occasionally, for large surveys, complete reports with survey narratives and summaries are written. For the purposes of this report intensive surveys and SOD studies that have been performed within each subbasin will be listed in table format accompanied by a brief summary of surveys that have been performed within the last five years.

Ambient Monitoring System
The Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine water quality monitoring stations (about 350 statewide) strategically located for the collection of physical and chemical water quality data. Sampling stations are sited under one or more of the following monitoring designations:

Fixed Monitoring Stations	Rotating Monitoring Stations
Point source	Basinwide Information
Nonpoint source	HQ & OR Waters
Baseline	Water Supply

The type of water quality analyses, or parameters, that are performed is determined by the freshwater or saltwater waterbody classification and corresponding water quality standards. Under this arrangement, basic *core* parameters are based on Class C waters with additional parameters added when justified. Parametric coverage is organized by freshwater or saltwater designation as shown in Tables 4.1 and 4.2.

Water quality data collected at all AMS stations are evaluated for the period 1987-1991 since basinwide permitting is done in five year cycles. These data were downloaded from STORET to a desktop computer for analysis. Because the methodology for determining parametric coverage within the AMS program has recently been revised, some stations have little or no data for several parameters. However, for the purpose of standardization it was felt that data summaries for each station should include all parameters that will be sampled in the future. In addition, monthly sampling regimes are being initiated as each basin comes up for assessment.

TABLE I.1. Ambient Monitoring System Freshwater Designations.

C WATERS (minimum monthly coverage for all stream stations)

Field Parameters
dissolved oxygen, pH, conductivity, temperature, chlorine,
Nutrients
total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite
Physical Measurements
total suspended solids, turbidity, hardness
Bacterial
fecal coliforms (Millipore Filter method)
Elements
aluminum (No present water quality standard), arsenic, cadmium, chromium, copper*, iron*, lead, mercury, nickel, silver*, zinc*

TROUT WATERS - No changes or additions
SWAMP WATERS - No changes or additions
WATER SUPPLY
Chlorides, total coliforms, manganese, total dissolved solids
NUTRIENT-SENSITIVE WATERS
Chlorophyll a (where appropriate)

PLUS any additional parameters of concern for individual station locations
*Action level instead of water quality standard.

TABLE I.2 Ambient Monitoring System Saltwater Designations.

SC WATERS (minimum monthly coverage for all stations)

Field Parameters
dissolved oxygen, pH, conductivity, temperature, chlorine, salinity, secchi disk (where appropriate)
Nutrients
total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite
Physical Measurements
total suspended solids, turbidity, hardness, chlorides
Bacterial
fecal coliforms(Millipore Filter method)
Elements
aluminum(No present water quality standard), arsenic, cadmium, chromium, copper*, iron*, lead, mercury, nickel, silver*, zinc*

SA WATERS
Fecal coliforms (tube method where appropriate)
SWAMP WATERS - No changes or additions
NUTRIENT-SENSITIVE WATERS
Chlorophyll a (where appropriate)

PLUS any additional parameters of concern for individual station locations
*Action level instead of water quality standard.

APPENDIX III

Modeling Information

and

List of Modeled Stream Segments

APPENDIX III.A

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, GAEST, and QUAL2E. WASP is also supported by EPA, and a user manual may be obtained from them. You should note that both GAEST and QUAL2E are one dimensional and are 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. 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. This approach was used to develop the Neuse River Nutrient Sensitive Waters (NSW) strategy. 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. The nutrient budgets developed by the Division were updated by Research Triangle Institute (RTI) through the Albemarle Pamlico Estuarine Study.

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 (unknown 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.

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APPENDIX III.B

CALIBRATED MODELS IN THE NEUSE BASIN

STREAMS

QUAL2E models have been calibrated for the following streams. QUAL2E is a one dimensional model supported by EPA which simulates BOD, the nitrogen series, and dissolved oxygen. The model can be run to simulate other parameters, but DEM does not routinely run these options.

Neuse River - The entire mainstem from Falls Dam to Streets Ferry has been modeled using QUAL2E (NCDEM, 1992)

Eno River - A QUAL2E model was calibrated for the lowest 10.5 miles of the River. The model runs from the Durham WWTP (below Highway 15-501) to Falls Lake (United States Environmental Protection Agency, 1989).

Ellerbe Creek - A QUAL2E model was calibrated for the lowest 6.6 miles of stream from the Durham Northside WWTP (below SR 1709) to Falls Lake (United State Environmental Protection Agency, 1989).

Crabtree Creek - A private consultant calibrated a QUAL2E model (with DEM's review) from the Cary Northside WWTP to below Lassiter Mill Dam (HDR, 1991).

Swift Creek - The lowest 28 miles of stream were modeled using QUAL2E. The model extends from Lake Benson to the confluence of Swift Creek and the Neuse River (NCDEM, 1992).

Middle Creek - A QUAL2E model was calibrated for Middle Creek from Sunset Lake to its mouth (confluence with Swift Creek) (NCDEM, 1992).

Contentnea Creek - A 13 mile section of stream was modeled using QUAL2E. The model ran from the Wilson WWTP to the NC 222 Bridge at Statonsburg (Research Triangle Institute, 1987).

ESTUARIES

Neuse River - A Georgia Estuary (GAEST) model was developed from Streets Ferry to New Bern to examine the effects of the Weyerhaeuser discharge. GAEST is a one dimensional estuary model developed by the Georgia Environmental Protection Division to simulate instream dissolved oxygen concentrations. Weyerhaeuser is developing a study plan to collect data to update the model to a 2 dimensional model. (NCDEM, 1989)

LAKES

Nutrient budget analyses have been developed for the Falls Lake watershed, Lake Wendell watershed, Buckhorn Reservoir watershed, and Wiggins Mill Reservoir watershed. These budgets are used to determine if nutrient controls more stringent than those required through the Neuse River NSW strategy are needed.

REFERENCES CITED - APPENDIX III.B

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NCDEM, 1992, A Water Quality Analysis of the Proposed Town of Garner Wastewater Treatment Plant and Its Impact on Swift Creek, NCDEM Water Quality Section , Raleigh, NC

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Research Triangle Institute and Olsen Associates, 1987, A Water Quality Model for Contentnea Creek near Wilson, North Carolina, RTI, Research Triangle Park, NC

United States Environmental Protection Agency, 1989, Technical Appendix to the Environmental Impact Statement: Durham-Eno River Wastewater Treatment Plant and Service Area, EPA Report No. 904/9-89-001b

APPENDIX IV

Major Nonpoint Source Management Programs

In North Carolina

APPENDIX IV

MAJOR NONPOINT SOURCE MANAGEMENT PROGRAMS IN NORTH CAROLINA

I. Agricultural Nonpoint Source Control Programs

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-Soil Conservation Service also provides technical assistance.

The current annual statewide budget to share BMP costs (75:25) 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 Neuse River Basin districts, approximately $ 6.5 million in BMP cost share dollars have been spent. There is also federal assistance through ASCS for BMP implementation. Approximately $ 1 million has been spent through ASCS in the Neuse Basin.

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 N.C., 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 (application of pesticides through irrigation systems) 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 lbs of hazardous waste and less than 2 lbs 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.

Education and Research

Crop and animal production programs are administered under the research and education activities of the N.C. Agricultural Research Service and the N.C. Cooperative Extension Service. 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 area and many other projects undertaken by Research and Extension. The local contact that county Cooperative Extension 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.

Animal Waste Management Regulations

North Carolina has adopted the federal water quality protection regulation that applies to animal feeding operations (15A NCAC 2H.0122-.0123 and General Statute 143-215(e)). Under the regulation, concentrated animal feeding operations which discharge to waters of the State are considered a point source and are regulated by the Division of Environmental Management under the National Pollution Discharge Elimination System. The Director of DEM may designate any animal feeding operation as concentrated on the basis of size or on a case-by-case basis (regardless of size) if it is determined to be discharging to surface waters. Currently, DEM inspects animal waste facilities only in response to citizen complaints or detected water quality problems. If a farmer is not in compliance and needs to modify his operation, appropriate agricultural agencies are notified as a source of technical assistance. In effect, the regulation prohibits the discharge of animal waste without a permit from DEM. Any farmer who directly discharges waste from a lagoon (through a pipe or overflow) or fails to control stormwater runoff from a storm event less intense than the 25-year, 24-hour storm is in violation of the regulation and subject to enforcement action. Enforcement action could also be initiated if a water quality standard is contravened.

The current policy statement in the regulations for waste not discharged to surface waters deems animal waste management systems to be permitted without any minimum standards or conditions. This means a farmer does not have to make a formal permit application to DEM since the permit is automatically issued to all treatment works and disposal systems for animal waste by virtue of the policy statement. However, a proposal to amend the existing nondischarge regulation for animal operations is currently under consideration. The proposed amendments would require animal waste management plans to be developed for new, expanded and existing animal operations > 100 animal units in order to be deemed permitted. The standards and specifications of the USDA-Soil Conservation Service would be the minimum criteria used for plan approval by the local soil and water conservation districts.

Depending on the nature of a violation caused by an animal operation, there may or may not be a grace period given to a farmer to come into compliance before a penalty is assessed. For example, a grace period of 60 days is currently provided by regulation for first offenders to permanently remove a discharge before being required to apply for a permit. However, with the passage of Senate Bill 386, animal operations where manmade pipes, ditches, or other conveyances have been constructed for the purpose of willfully discharging pollutants may be fined without a mandated grace period for the first offense effective January 1, 1992. A fine can also be assessed immediately for water quality standard violations.

Civil and/or criminal penalties of up to $10,000 per day and/or imprisonment may be assessed for violations of water quality standards and illegal discharges. Fines for the willful discharge of pollutants shall not exceed $5,000 for the first offense unless water quality standards are violated.

Soil, Plant Tissue, and Animal Waste Testing Program

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. These services provide farmers with information necessary to improve crop production efficiency, to manage the soil properly and to protect environmental quality.

Soil Survey Program

The Soil Survey Program in North Carolina is a cooperative effort between federal, state, and local governments. According to the SCS, in the Neuse River Basin there are now 11 counties with published modern soil surveys, three counties with modern surveys awaiting publication, one county with a modern survey in progress. Two counties which have been mapped are outdated and need to be re-mapped.

Resource Conservation and Development Program

State and local governments with the authority to plan and implement activities in multi-jurisdictional areas are assisted by the USDA-Soil Conservation Service through the Resource Conservation and Development Program (RC&D). Areas of assistance include flood prevention, sedimentation and erosion control, public water-based recreation, fish and wildlife development, agricultural water management, and the abatement of agricultural related pollution.

In North Carolina, there are seven RC&D areas including: North Central Piedmont, New River Highlands, Southwestern North Carolina, Mountain Valleys, Mid-East, Albemarle, and Region H. Forty of the 100 counties in North Carolina are in RC&D areas.

River Basin Surveys and Investigations Program

The River Basin Surveys and Investigation Program is administered by the USDA-Soil Conservation Service to provide technical assistance in solving problems which involve erosion and sedimentation, flooding, floodplain management, and agricultural water management. Other priorities include protecting wetlands and floodplains and improving water quality. Erosion inventories have been completed in the Tar, Neuse, Haw, and Deep River Basins. In North Carolina, River Basin studies have formed the basis for strategies that support the Flood Prevention and Erosion Control Programs.

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-Soil Conservation Service in cooperation with the N.C. 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 Neuse River Basin, there are a number of land treatment projects underway with more in the planning stages.

Food Security Act of 1985 and the Food, Agriculture, Conservation, and Trade Act of 1990

See Section 5.4.1 in Chapter 5.

II. Urban Nonpoint Source Pollution

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. 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.

The purpose of the Water Supply Protection Program is to provide an opportunity for 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 the amount and types of permitted point source discharges, as well as a requirement to control nonpoint sources of pollution. By classifying a watershed as a water supply watershed, a local government and adjacent jurisdictions 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.

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

Coastal Stormwater Management Regulations

In November 1986, the EMC adopted rules which required new development in a limited zone (575 feet) around Class SA (shellfish) waters to control stormwater either by limiting density or completely controlling a 4.5 inch, 24-hour storm with the use of a stormwater treatment system. The regulations applied to development activities which required either a CAMA major permit or a Sediment/Erosion Control Plan (generally development disturbing more than one acre). The design storm, low density limits, and areal coverage were all quite controversial and the adopted rules represented a compromise by all parties. A sunset provision was added to the rules to force the staff and Commission to reconsider the rules after a year. These rules expired December 31, 1987, but new stormwater regulations were adopted having an effective date of January 1, 1988. These regulations are administered by the Water Quality Section in DEM. Approximately five man-years are allocated to implementing this program. Planning Branch staff are responsible for providing guidance and interpretation to promote consistent implementation of the rules. DEM regional staff review and approve plans and enforce the requirements of the regulations.

Perhaps the most important measure accomplished with the regulations has been the applicability of stormwater controls to development activities within the 20 CAMA coastal counties. Certainly the near-water impact of stormwater as addressed in the original rules is important, but the staff believed the cumulative impact of stormwater runoff throughout the coastal zone also needed to be addressed. Therefore, the expanded area of coverage helps provide better protection of both shellfish waters and coastal water quality in general.

Other major items specified in the rules address the sizing of stormwater treatment systems. For developments adjacent to SA waters, infiltration systems must be able to retain 1.5 inches of rainfall, whereas development in other areas must control one inch of rainfall. Wet detention ponds are not allowed for stormwater control near SA waters and must be sized for 85 percent TSS removal in other areas. In addition, porous pavement is considered an innovative infiltration system (only five are allowed until they are proven to work) as evidence has not been provided regarding its effectiveness in coastal areas. A low density option of the new regulations applies a built-upon limit of 25 percent for SA areas and 30 percent for other coastal areas rather than a limit on effective impervious cover. Development exceeding these levels is required to have a engineered stormwater system as indicated.

In summary, the regulations which have an expanded areal coverage increases the annual number of projects affected from approximately 50 (original rules) to 500. This increase is coincident with a reduction in design storm that is comparable to requirements in other states. In addition, the low density option, retained from the original regulations, is encouraged as operation and maintenance concerns associated with stormwater controls are not applicable.

ORW and HQW Stream Classifications

All Outstanding Resource Waters (ORWs) and High Quality Waters (HQWs) have a management strategy that includes provisions for urban stormwater runoff. Controls for urban stormwater, either through development density limitations or stormwater treatment systems, are required by DEM. Other NPS management agencies are expected to place priority on protecting these valuable resources as well.

Federal Stormwater Program (North Carolina National Pollutant Discharge Elimination System 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. These regulations became effective in December 1990. Authority to administer these regulations has been delegated to the North Carolina Division of Environmental Management. 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 apply for a stormwater discharge permit.

The municipal permit application requirements are designed to lead to the formation of site-specific stormwater management programs for Charlotte, Durham, Greensboro, Raleigh, Winston-Salem, and Cumberland County. Therefore, the permits issued to municipalities for their municipal separate storm sewer systems will be explicitly written for each individual municipality. The municipalities will develop application reports which will formulate 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. As with all point source discharges regulated by the Clean Water Act, stormwater discharges are subject to applicable water quality-based standards. Industrial facilities discharging through a municipal separate storm sewer system also will be required to submit a permit application to the state and receive a permit.

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.

In North Carolina, the stormwater regulations affect more than 16,000 industrial facilities. Of the 16,000, it is projected that six to ten thousand will require permitting.

The goal of the stormwater discharge permitting program being developed 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.

III. Construction

Sedimentation and Erosion Control 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 N.C. 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 which are used. The intent is to offer permanent downstream protection for stream banks and channels from damages caused by increased runoff velocities. If voluntary compliance to 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.

There are a number of local municipal and county erosion and sedimentation control programs in the Neuse River Basin. These 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 is required to incorporate more stringent sedimentation controls as specified in the High Quality Water rules. The N.C. 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 DEM, 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.

Sedimentation control rules remain in effect for High Quality Waters (HQW). These rules require more stringent erosion control measures for projects draining to HQWs.

IV. On-Site Wastewater Disposal

Sanitary Sewage Systems 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.

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 sanitarians 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.

V. Solid Waste Disposal

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 (NCDEHNR) 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 municipal 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.

VI. Forestry

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. The 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 DEM.

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 DEM for appropriate enforcement action.

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.

VII. Mining 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.

VIII. Hydrologic Modification

Hydrologic modification is defined as channelization, dredging, dam construction, flow regulation/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. The U.S. Army Corps of Engineers (Corps) is the agency most involved in issuing permits for land-disturbing activities in wetlands. The Corps administers a national regulatory program (Section 404 of the Clean Water Act) aimed at controlling the discharge of dredged or fill material into waters of the United States. Waters of the United States refers to navigable waters, their tributaries, and adjacent wetlands. Activities covered under Section 404 must involve the discharge of dredge and fill material and may include dams, dikes, marinas, bulkheads, utility and power transmission lines, and bank stabilization.

In addition to Section 404 of the Clean Water Act, the Corps has regulatory powers under the Rivers and Harbors Act of 1899. 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 application was changed to include factors other than navigation. These additional factors were fish and wildlife, conservation, pollution, aesthetics, ecology, and general public interest. Activities which may be covered under the Rivers and Harbors Act of 1899 include piers, dams, dikes, marinas, bulkheads, utility and power transmission lines, bank stabilization, and the discharge of dredged or fill material.

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 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 are established in permits where appropriate.

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.

IX. Wetlands

Regulatory Programs

The Division of Coastal Management administers two state laws that provide coastal wetland protection. These laws are:

1) *North Carolina Dredge and Fill Act (1969)* 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).

2) *North Carolina CAMA (1974)* attempts to control development pressures through coordinated management in order to preserve North Carolina's coastal features that make it economically, aesthetically, and ecologically rich. The Coastal Resources Commission (CRC), a 15-member board appointed by the governor, oversees CAMA implementation.

Part of the CRC's responsibility is the identification of Areas of Environmental Concern (AEC). These areas are regarded as sensitive and productive coastal lands and waters where uncontrolled development might cause irreversible loss of property, public health, and the natural environment. Four categories of AEC are defined:

1) the estuarine system
2) the ocean system
3) public fresh water supplies
4) natural and cultural resource areas

AEC covers practically all coastal waters and three percent of the land in coastal counties.

A permit program was established to protect AEC based on standards that guide development. CAMA permits require an obligation to meet the CRC's development guidelines. Permits are revoked if these guidelines are not followed and fines can be levied if the development has harmed the state's coastal resources.

Any proposed project requiring federal permits or authorization in the 20 coastal counties are reviewed by the Division of Coastal Management for consistency with the Coastal Management Program (as mandated by the U.S. Coastal Zone Management Act of 1972). Generally, major federal permits reviewed for consistency are Section 10 of the Rivers and Harbors Act, Section 404 of the Clean Water Act, and U.S. Coast Guard permits for bridge and causeway construction and modification over navigable waters. A joint permitting process allows a CAMA-permitted project to simultaneously receive a Section 404 permit.

The Division of Environmental Management is responsible for the issuance of 401 Water Quality Certifications (as mandated under Section 401 of the Clean Water Act). A 401 certification is required for the discharge of pollutants into surface waters for projects that require a federal permit. The 401 certification indicates that the discharged pollutant will not violate state water quality standards. A federal permit cannot be issued if a 401 certification is denied. The 401 certification process is coordinated with the 404 and CAMA processes in the 20 counties of CAMA jurisdiction. There is a joint application form, joint public notice, and a single place to apply for the required permits. Regulations, wetland standards and use classifications, permitting guidance, and operating procedures are currently being developed to enhance water quality and wetland protection.

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.

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, but DEHNR is in the process of drafting wetland protection rules.

X. Groundwater Protection Program

It is estimated that over 50 percent of the North Carolina residents rely on groundwater for their drinking water. North Carolina has three fundamental strategies for managing these groundwater resources. First, the state establishes and enforces construction, monitoring, and reporting guidelines for facilities that generate or treat waste which can pollute groundwater. Second, where groundwater has been contaminated or is threatened, action is required to control the pollution and restore the groundwater to the extent feasible. Third, the resource must be prudently managed to assure adequate groundwater quality and availability to support present and future growth and development. These fundamental strategies form the foundation for the state groundwater program.

To prevent groundwater pollution, the state has classified groundwaters, established groundwater quality standards, and has implemented a permit system. State permits are conditioned to meet the required standards, and compliance with permit conditions is monitored by the state. All relevant state environmental permit applications are reviewed by the Groundwater Section of the Division of Environmental Management to assure compliance with groundwater standards.

The Groundwater Section's management program for responding to groundwater pollution incidents is an outgrowth of North Carolina's interagency emergency response program. Interagency response procedures have been established for emergencies where public health or welfare is threatened. Procedures for remedial-type actions and contamination incidents have also been implemented. The groundwater incident management program provides the mechanism for standardized pollution response procedures and a consolidated inventory of contaminated sites.

Legislation was passed in the 1988 North Carolina General Assembly which appropriated money for a state Leaking Underground Storage Tank Cleanup Fund. This fund will help to defray the state's cost in cleaning up and correcting damages caused by leaking underground petroleum and chemical tanks. Two types of funds were established by this legislation: a commercial fund and a non-commercial fund. The commercial fund will operate from fees collected from commercial tank operators effective January 1, 1989. The fund can contain from $5 to $15 million and award payments up to $1 million per occurrence. In contrast, the non-commercial fund is a nonreverting revolving fund and can be supplemented in later years by appropriations from the General Assembly or available grants.

The nondischarge permit program, regulating waste disposal activities not discharging to surface waters, is a state program administered by the DEM Water Quality Section under authority of NCGS 143-215.1. This is in essence a groundwater permit, regulating activities such as sewer line extensions, sludge disposal and other land applications systems, and waste lagoons not discharging to surface waters.

The DEM Groundwater Section has also implemented a program for Underground Injection Control (UIC). A UIC permit is required for wells which are to be used for injection, recharge, or disposal purposes. Injection wells for waste disposal purposes, other than Class V wells, are currently prohibited by state statute. The Section is currently developing rules for the regulation of underground storage tanks (UST).

Landfills in North Carolina are regulated by the Division of Solid Waste Management. Hazardous waste facilities requiring permits are reviewed to assure compliance with state groundwater regulations. The NCDEHNR also has responsibility for monitoring solid and hazardous waste disposal sites to prevent contamination of groundwater supplies.

Mining in North Carolina is regulated under the Mining Act of 1971, NCGS 74-50, which requires a permit for any mining activity. This permit program is administered by the Land Quality Section of the Department of Environment, Health and Natural Resources, Division of Land Resources, and those permit applications where groundwater may be impacted are reviewed by the DEM Groundwater Section.

Under the North Carolina Coastal Area Management Act of 1974, permits are required (under NCGS 113A-118) for any development in coastal "areas of environmental concern" (AEC) designated by the state. Any projects requiring a permit which may impact groundwater are reviewed by the DEM Groundwater Section. Significant and/or unique coastal resource areas such as public water supply aquifers or well fields may be nominated for AEC designation consideration to the N.C. Coastal Resources Commission.

APPENDIX V

LIST OF NPDES DISCHARGERS IN THE NEUSE BASIN

Appendix V. NPDES Dischargers in the Neuse Basin

Facilities in Subbasin 030401

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0003336	001	AMERIMARK BUILDING PRODUCTS	N/A	0.0490	Non-Contact Cooling Water
NC0037869	001	ARBOR HILLS MHP	0.0060	0.0022	Mobile Home Park
NC0036846	004	ATHOL MANUFACTURING COMPANY	N/A	0.0000	Textile
NC0036846	003	ATHOL MANUFACTURING COMPANY	N/A	0.0000	Textile
NC0036846	002	ATHOL MANUFACTURING COMPANY	N/A	0.0000	Textile
NC0036846	001	ATHOL MANUFACTURING COMPANY	N/A	0.0000	Textile
NC0076309	001	AUTRY RESIDENCE(BOBBY)	0.0002		Single Family
NC0081078	001	BEATON RESIDENCE (KATHLEEN)	0.0003		Single Family
NC0081442	001	BERGMAN RESIDENCE (LEE RAY)	0.0003		Single Family
NC0058785	001	BIBLE BAPTIST CHURCH	0.0030	0.0000	Institution (College, Rest Home, etc)
NC0081116	001	BRIGGS RESIDENCE(JANE & KENNON	0.0003		Single Family
NC0080462	001	BROWN RESIDENCE (DUANE W.)	0.0003		Single Family
NC0081043	001	BURGIN RESIDENCE (DONALD E.)	0.0003		Single Family
NC0030007	001	CAISON RESIDENCE (CHARLES C.)	0.0010		Single Family
NC0080403	001	CARLSON RESIDENCE (ROY & SUSAN	0.0003		Single Family
NC0061549	001	CAROLINA SUNROCK CORPORATION	0.0500	0.0000	Mine Dewatering
NC0077941	001	CARVER (RESIDENCE), RICKY	0.0003		Single Family
NC0080047	001	CENTURA BANK	0.0004		Single Family
NC0031968	001	COLEY MOBILE HOME PARK	0.0250		Mobile Home Park
NC0051403	001	COLONIAL BLDG CO - L BARTON #2	0.5000		Subdivision
NC0080411	001	COMBS RESIDENCE (BOYD D.)	0.0003		Single Family
NC0044997	001	COOLEY RESIDENCE (JOYCE)	0.0010		Single Family
NC0075183	001	COURTYARD	0.0012	0.0001	Restaurant
NC0007625	001	CREEDMOOR WTP, TOWN OF	0.0180	0.0179	Municipal
NC0024520	001	DALEY INVESTMENTS-DBA DAYS INN	0.0250	0.0067	Hotel, Motel, Inn, Campground
NC0080241	001	DAVENPORT FAMILY TRUST	0.0003		Single Family
NC0079359	001	DESPOT RESIDENCE (TERRENCE)	0.0003		Single Family
NC0058416	001	DHR-JOHN UMSTEAD HOSPITAL WTP	0.1000	0.0360	Water Plant (Surface Water)
✔ NC0026824	001	DHR-JOHN UMSTEAD HOSPITAL WWTP	3.5000	1.3533	Municipal
NC0042242	001	DIXIE TRAILER PARK	0.0100	0.0031	Mobile Home Park
NC0081388	001	DOWNEY RESIDENCE (GARY R.)	0.0003		Single Family
✔ NC0026336	001	DURHAM (ENO WWTP)	2.5000	1.6013	Municipal
✔ NC0026310	001	DURHAM (LITTLE LICK CRK WWTP)	1.5000	0.5069	Municipal
✔ NC0023841	001	DURHAM (NORTHSIDE WWTP)	10.0000	5.8452	Municipal
NC0042951	001	DURHAM CO SCH-GLENN ELEM	0.0052	0.0042	School
NC0022853	001	DURHAM PRODUCTS	0.0150	0.0052	Industrial/Commercial
NC0003379	001	EATON CORP.-AIR CONTROLS DIV.	N/A	0.2263	Metal Forming
NC0044628	001	ECONOMY MOTEL	0.0050	0.0015	Hotel, Motel, Inn, Campground
NC0079600	001	ELLIS RESIDENCE (J. E.)	0.0002		Single Family
~~NC0058556~~	~~001~~	~~FINCH RESIDENCE (MIKE)~~	~~0.0004~~		~~Single Family~~
NC0077224	001	FRANK ERNEST (RESIDENCE)	0.0004		Single Family
NC0051764	001	FRANKS RESIDENCE (WARREN)	0.0003		Single Family
NC0078042	001	GADOWAY RESIDENCE (RICK)	0.0004		Single Family
NC0077445	001	GENERAL INDUSTRIES	0.0072	0.0007	Aquifer Restoration
NC0043389	001	GORMAN BAPTIST CHURCH	0.0040	0.0008	Institution (College, Rest Home, etc)
NC0049522	001	GRIFFIN PROPERTY (RUDY)	0.0010		Single Family
NC0046841	001	HARTWELL RESIDENCE (JOHN)	0.0010		Single Family
NC0049662	001	HEATER UTILITIES, INC.	0.2500	0.0319	Condominium
NC0063614	001	HEATER UTILITIES-WILDWOOD	0.0800	0.0217	Subdivision
✔ NC0026433	001	HILLSBOROUGH WWTP, TOWN OF	3.0000	1.2563	Municipal
NC0081141	001	HORNE RESIDENCE (GREG S.)	0.0003		Single Family
NC0077411	001	HOWARD D. PATRICIA DELANO	0.0004		Single Family

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Appendix V. NPDES Dischargers in the Neuse Basin

NC0081213	001	HOWARD RESIDENCE (LUCY)	0.0003		Single Family
NC0079278	001	HUTCHINS RESIDENCE (CHARLIE)	0.0003		Single Family
NC0079804	001	KING RESIDENCE (PAIGE O.)	0.0004		Single Family
NC0059099	001	LAKE RIDGE AERO PARK	0.0160	0.0021	Subdivision
NC0076651	001	LATTA RESIDENCE (MARIE D.)	0.0002		Single Family
NC0075426	001	LITTLE HUFF,INC.	0.0140	0.0095	Aquifer Restoration
NC0080845	001	M.M. FOWLER, INC./HURLEYS GUL	0.0017		Aquifer Restoration
NC0072044	001	MARTIN MARIETTA-PERSON QUARRY	N/A	0.0000	Mine Dewatering
NC0079073	001	MARTIN RESIDENCE (WYATT)	0.0003		Single Family
NC0043001	001	MT. SYLVAN UNITED METH. CH.	0.0020	0.0000	Institution (College, Rest Home, etc)
NC0066044	001	NELLO TEER-DURHAM	N/A	0.8666	Mine Dewatering
NC0075868	001	NOBLE(BETTY)	0.0003		Single Family
NC0077925	001	NORBERT A BLEAU	0.0003		Single Family
NC0058220	001	NORRIS RESIDENCE (CHRISTOPHER)	0.0004		Single Family
NC0077780	001	PAYNE, RICHARD C & BERNICE	0.0003		Single Family
NC0076597	001	PEARSON RESIDENCE(J.L)	0.0003		Single Family
NC0058165	001	PERRY RESIDENCE (JAMES A.)	0.0003		Single Family
NC0036471	002	PERSON CO SCH - HELENA ELEM.	0.0030	0.0028	School
NC0036471	001	PERSON CO SCH - HELENA ELEM.	0.0030	0.0028	School
NC0078930	001	PETERSON RESIDENCE(WILLIAM J.)	0.0002		Single Family
NC0003859	001	PIEDMONT MINERALS CO INC	N/A	0.3000	Mining and Minerial Processing
NC0051071	001	REDWOOD ACADEMY	0.0020	0.0000	School
NC0076091	001	RIGGSBEE(MR.&MRS.ANDREW J.)	0.0003		Single Family
NC0078883	001	SCARBOROUGH RESIDENCE (JANE)	0.0003		Single Family
NC0056731	001	SEDGEFIELD DEV.CORP-GRANDE OAK	0.0068	0.0022	Subdivision
NC0079367	001	SHEARL RESIDENCE(ERNEST M.)	0.0003		Single Family
NC0079111	001	SMITH RESIDENCE(HERSEL SR.)	0.0003		Single Family
NC0081086	001	STEPHENSON RESIDENCE(TIMOTHY L	0.0003		Single Family
NC0081345	001	STEWART RESIDENCE (HELEN G.)	0.0003		Single Family
NC0049808	001	STONEGATE MHP	0.0342		Mobile Home Park
NC0078981	001	STRICKLAND RESIDENCE(EDWIN R.)	0.0003		Single Family
NC0075591	001	SWINDELL(JAMES W.)	0.0003		Single Family
NC0078514	001	TEASLEY RESIDENCE (ARTHUR R)	0.0003		Single Family
NC0075094	001	THE FOOD MART	0.0100	0.0023	Oil Separator
NC0059722	001	THEE C. DIXON (SAID SERV STA)	0.0005		Industrial/Commercial
NC0026981	001	UNITY OIL COMPANY	N/A	0.0000	Oil Separator
NC0046990	001	WIERSMAN RESIDENCE (RICHARD L.	0.0004		Single Family
NC0081124	001	WOODS RESIDENCE (JOHN T.)	0.0003		Single Family
NC0080357	001	WOODS RESIDENCE (W. T.)	0.0004		Single Family
		Totals for Subbasin 030401	21.7155	12.1599	

Facilities in Subbasin 030402

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0048186	001	ABLE MACHINING & ELECTRONIC CO	0.0050		Industrial/Commercial
NC0076589	001	AMERADA HESS/SELMA BULK TERM.	N/A	0.0254	Oil Separator
NC0056987	001	AMMONS PITTMAN REALTOR	0.0006		Single Family
NC0078905	001	ANDERSON PROPERTY (DORIS W.)	0.0050		Single Family
NC0060470	001	APEX WTP, TOWN OF	N/A		Water Plant (Surface Water)
NC0073440	001	AUSTIN LAKE CLUB	0.1000		Subdivision
NC0055972	001	BARCLAY AMERICAN MORTGAGE CORP	0.2000	0.0340	Subdivision
NC0027570	001	BOBBY L. MURRAY/PLANTATION INN	0.0250	0.0109	Hotel, Motel, Inn, Campground
NC0036145	002	BP OIL - SELMA	N/A	0.0775	Oil Terminal
NC0036145	001	BP OIL - SELMA	N/A	0.0775	Oil Terminal
NC0001431	004	BURLINGTON IND., SMITHFIELD	N/A	0.0089	Boiler Blowdown

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	NC0001431	003	BURLINGTON IND., SMITHFIELD	N/A	0.0089	Boiler Blowdown
	NC0001431	002	BURLINGTON IND., SMITHFIELD	N/A	0.0089	Boiler Blowdown
	NC0001431	001	BURLINGTON IND., SMITHFIELD	N/A	0.0089	Boiler Blowdown
✔	NC0001376	001	BURLINGTON IND., WAKE PLANT	5.0000	2.7724	Textile
	NC0059609	001	BUTTS, DAVID A & TRACY B.RESI	0.0003		Single Family
	NC0051322	001	CARO.WAT.SERV,INC/ASHLEY HILL	0.2500	0.0181	Subdivision
	NC0064378	001	CAROLINA WTR SERV-WILLOW BROOK	0.0600	0.0047	Subdivision
	NC0060330	002	CAROLINA WTR SERV.-GUY ROAD	N/A	0.0095	Swmming Pool Backwash
	NC0060330	001	CAROLINA WTR SERV.-GUY ROAD	N/A	0.0095	Swmming Pool Backwash
	NC0062219	001	CAROLINA WTR SERV.-MAIL PLANTN	0.2100	0.0116	Subdivision
	NC0075990	002	CARY OIL CO./TRIANG.MINI MART	0.0095	0.0016	Aquifer Restoration
	NC0075990	001	CARY OIL CO./TRIANG.MINI MART	0.0095	0.0016	Aquifer Restoration
✔	NC0048879	001	CARY-NORTH WWTP, TOWN OF	4.0000	1.9297	Municipal
✔	NC0030716	001	CENTRAL JOHNSTON COUNTY WWTP	4.5000	2.3990	Municipal
	NC0021954	002	CITGO PETROLEUM - SELMA	N/A	0.0179	Oil Separator
	NC0021954	001	CITGO PETROLEUM - SELMA	N/A	0.0179	Oil Separator
	NC0025453	001	CLAYTON WWTP, TOWN OF	0.6000	0.7889	Municipal
	NC0031011	001	COLONIAL PIPELINE - SELMA	N/A	0.0000	Oil Terminal
	NC0063541	001	COMPASS DEVELOPMENT CORP.	0.0260	0.0097	Subdivision
	NC0063533	001	COMPASS DEVELOPMENT CORP.	0.0500	0.0051	Subdivision
	NC0052311	001	CONOCO INC-SELMA	N/A	0.0000	Oil Separator
	NC0065706	001	COTTONWOOD HOMEOWNERS ASSO	0.0260	0.0073	Subdivision
	NC0057134	001	CROSBY WATER & SEWER	0.3200	0.0361	Industrial/Commercial
	NC0056391	001	CROSS CREEK MOBILE ESTATES	0.0700	0.0270	Mobile Home Park
	NC0026999	001	DUMAS OIL COMPANY	N/A	0.0002	Oil Terminal
	NC0001023	001	EDWARD VALVES, INC.	N/A		Non-Contact Cooling Water
	NC0027006	001	EXXON COMPANY USA-SELMA	N/A	0.0100	Oil Terminal
	NC0027227	001	FINA OIL AND CHEMICAL COMPANY	N/A	0.0000	Oil Terminal
	NC0058831	001	FINKNER PROPERTY (ALVA)	0.0004		Single Family
	NC0049883	001	FOXHALL VILLAGE MHP	0.0800	0.0009	Mobile Home Park
	NC0067270	001	GOFORTH DEVELOPMENT-RIVERFALLS	0.0940		Subdivision
	NC0070572	001	GREEN SPRING VALLEY MOBILE EST	N/A		Mobile Home Park
	NC0068462	001	GSCCC, INC.-CAMP HARDEE	0.0250		Hotel, Motel, Inn, Campground
	NC0080519	001	GUY C. LEE LUMBER CO.	N/A		Wood Products
	NC0055701	001	HEATER UTILITIES, INC.	N/A		Industrial/Commercial
	NC0040606	001	HEATER UTILITIES, INC.	0.0350	0.0163	Subdivision
	NC0060577	001	HEATER UTILITIES-BEACHWOOD	0.1000	0.0068	Subdivision
	NC0058505	001	HEATER UTILITIES-MALLARD XING.	0.1000	0.0105	Subdivision
	NC0032786	001	HIDDEN COVE, INC (MHP)	0.0350	0.0138	Mobile Home Park
	NC0057002	001	HOBBS PROPERTY	0.0004		Single Family
	NC0046272	002	HOMESTEAD VILLAGE MHP	0.0450	0.0339	Mobile Home Park
	NC0046272	001	HOMESTEAD VILLAGE MHP	0.0450	0.0339	Mobile Home Park
	NC0060771	001	INDIAN CREEK OVERLOOK DEV.	0.1120	0.0068	Subdivision
	NC0063746	001	IRA D LEE ASSOC., INC. DEERCH	0.0500	0.0097	Subdivision
	NC0073318	001	IRA D. LEE & ASSOCIATES	0.2000	0.0000	Subdivision
	NC0046710	001	J.H.POOLE,SR-CREEKSIDE MOBILE	0.0200	0.0120	Mobile Home Park
	NC0064149	001	JONES DAIRY FARM CORPORATION	0.0650	0.0250	Subdivision
	NC0040266	001	KNIGHTDALE ESTATES	0.0250	0.0087	Mobile Home Park
	NC0048135	001	LAWRENCE TRANSFER AND STORAGE	0.0023	0.0001	Industrial/Commercial
	NC0056995	001	LAWTON RESIDENCE (CRAIG M.)	0.0003		Single Family
	NC0002780	001	MARTIN MARIETTA-GARNER	N/A	0.2714	Mining and Mineral Processing
	NC0049875	001	MARTIN MARIETTA-RALEIGH/DURHAM	N/A	0.0100	Mining and Mineral Processing
	NC0056499	001	MILL RUN ASSC./UNIPROP	0.0450	0.0070	Mobile Home Park
	NC0061905	001	MOODY RESIDENCE (SCOTT)	0.0004		Single Family
	NC0050041	001	MORRISVILLE WWTP, TOWN OF	0.2000	0.0933	Municipal

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Appendix V. NPDES Dischargers in the Neuse Basin

NC0050938	001	MORRISVILLE(PERIMETER PK),TOW	0.2000	0.0593	Municipal
NC0056901	001	MOSELEY RESIDENCE (M.N.)	0.0004		Single Family
NC0049034	001	MT. AUBURN SHERRIFF'S TRAINING	0.0024	0.0004	Institution (College, Rest Home, etc)
NC0058840	001	NADEAU RESIDENCE (PATRICK)	0.0006		Single Family
NC0080551	001	NATVAR COMPANY	N/A		Non-Contact Cooling Water
NC0003590	001	NELLO TEER-CRABTREE	N/A	0.0000	Mine Dewatering
NC0064408	001	NEUSE CROSSING UTILITIES CORP.	0.3000	0.0012	Subdivision
NC0072281	001	NOLIA HILLS DEV CORP/RBA GROUP	0.0250		Subdivision
NC0045101	002	NORTHERN TELECOM-RALEIGH	0.0100		Industrial/Commercial
NC0045101	001	NORTHERN TELECOM-RALEIGH	0.0100		Industrial/Commercial
NC0064246	001	PACE MOBILE HOME PARK	0.0150	0.0054	Hospital
NC0076457	001	PHIBRO ENERGY, INC., (SELMA)	N/A	0.0216	Oil Terminal
NC0081230	001	PHILLIPS 66 COMPANY	0.0072		Aquifer Restoration
NC0032875	002	PHILLIPS PIPE LINE COMPANY-SEL	N/A	0.0000	Oil Separator
NC0032875	001	PHILLIPS PIPE LINE COMPANY-SEL	N/A	0.0000	Oil Separator
NC0060526	001	POPE INDUST.PARK, II LTD.	0.0075	0.0040	Industrial/Commercial
NC0069876	001	PROVAN RESIDENCE (DONALD & KAY	0.0004		Single Family
NC0075876	001	R.L.BRADSHER CONTRACTING&FARM.	N/A		Sand Dredging
✔ NC0029033	001	RALEIGH NEUSE RIVER WWTP	40.0000	28.1440	Municipal
NC0068993	001	RDU AIRPORT AUTH--BULK FUEL	N/A	0.0000	Oil Separator
NC0076058	001	RDU AIRPORT AUTHORITY	N/A	0.0000	Oil Separator
NC0075604	002	RDU AIRPORT/AMER. AIRLINES	N/A		Stormwater
NC0075604	001	RDU AIRPORT/AMER. AIRLINES	N/A		Stormwater
NC0071293	001	RICHARDSON RESIDENCE (PAUL)	N/A		Single Family
NC0075256	001	RIVER DELL UTILITIES,INC.	N/A		Water Plant and Water Conditioning
NC0056278	001	RIVER MILL HOMEOWN. ASSOC.,IN	0.0200	0.0028	Subdivision
NC0039292	001	RIVER WALK M.H.P.	0.0510	0.0308	Mobile Home Park
NC0038784	001	RIVERVIEW MOBILE HOME PARK	0.0350	0.0408	Mobile Home Park
NC0058980	001	S. E. DOUGLASS WAREHOUSE	0.0010	0.0008	Drug Manufacture
NC0072311	001	S.S.B. (A PARTNERSHIP)	0.1000		Subdivision
NC0081477	001	SAS INSTITUTE INC.	N/A		Non-Contact Cooling Water
NC0003549	001	SHELL OIL COMPANY - SELMA	N/A	0.0666	Oil Terminal
NC0079081	001	SIRCHIE FINGER PRINT LAB. INC.	N/A		Non-Contact Cooling Water
NC0070688	001	SOUTHMARK CORP. OF NC	0.2000		Subdivision
NC0072095	001	STALLINGS RESIDENCE (LESTER)	0.0004		Single Family
NC0062367	001	STRAWNS CROSSING	0.0500	0.0205	Subdivision
NC0067580	001	SWIFT CREEK PLANTATION ASSOC.	0.1350		Subdivision
NC0060801	001	THE DURANT GROUP	0.0500		Subdivision
NC0046230	001	THE FALLS UTILITY COMPANY	0.0060	0.0143	Subdivision
NC0061328	001	TILTON RESIDENCE (WILLIAM S.)	0.0004		Single Family
NC0069477	001	TOMLINSON RESIDENCE (CLIFTON E	0.0003		Single Family
NC0065714	001	TRADEWINDS HOMEOWNERS ASSO.INC	0.0500	0.0063	Subdivision
NC0049204	001	TRIAD TERMINAL CO. OF SELMA	N/A	0.0020	Oil Terminal
NC0059111	001	TULLOSS PROPERTY-LOT 07	0.0004		Single Family
NC0059129	001	TULLOSS PROPERTY-LOT 12	0.0004		Single Family
NC0028983	001	U.S. FLOOR SYSTEMS, INC.	N/A	0.0000	Apartment
NC0067717	001	UMSTEAD FARMS	0.0900		Subdivision
NC0028771	001	USEPA - ENV. SCI. RES. LAB	N/A		Saltwater Corrosion Research
NC0049051	001	WAKE CO. SCH.-ROLESVILLE ELEM.	0.0075	0.0024	School
NC0007528	001	WAKE FOREST WTP, TOWN OF	N/A	0.1196	Water Plant (Surface Water)
✔ NC0030759	001	WAKE FOREST-SMITH CREEK WWTP	1.2000	0.4980	Municipal
NC0058246	001	WAKE HIGH MEADOWS HOMEOWNERS	0.0350	0.0134	Subdivision
NC0003646	001	WAKE STONE CORP-KNIGHTDALE	N/A	0.0000	Mine Dewatering
NC0050601	001	WAKE STONE CORP-TRIANGLE QUAR.	0.5000	0.0000	Mine Dewatering
NC0063398	001	WAKE-DURHAM LIMITED PART	0.6000		Subdivision

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✔ NC0045896	001	WAKEFIELD FARMS	1.0000		Subdivision
NC0049832	001	WALL'S ANTIQUES	0.0030	0.0001	Industrial/Commercial
✔ NC0045608	001	WARD TRANSFORMER COMPANY	0.0500	0.0128	Stormwater
NC0057967	001	WASHBURN RESIDENCE (W.B.,JR.)	0.0004		Single Family
NC0059412	001	WHITLEY, (MR&MRS FREDERICK)	0.0004		Single Family
		Totals for Subbasin 030402	61.5114	37.9690	

Facilities in Subbasin 030403

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
✔ NC0064050	001	APEX, TOWN OF (MIDDLE CRK.)	3.6000	0.6996	Municipal
✔ NC0065102	001	CARY-SOUTH WWTP, TOWN OF	6.4000	3.3316	Municipal
NC0031003	001	COLONIAL PIPELINE - APEX	N/A	0.0000	Oil Separator
NC0030724	002	COUNTRYSIDE MOBILE ESTATES	0.0125	0.0078	Mobile Home Park
NC0030724	001	COUNTRYSIDE MOBILE ESTATES	0.0125	0.0078	Mobile Home Park
NC0066150	001	FMRK, INC.-BRIGHTON FOREST	0.1170		Subdivision
✔ NC0066516	001	FUQUAY-VARINA WWTP (PROPOSED)	6.0000		Municipal
NC0062740	001	HEATER UTIL.-BRIARWOOD FARM MH	0.0400	0.0144	Mobile Home Park
NC0073679	001	HEATER UTILITIES,INC	N/A		Water Plant and Water Conditioning
NC0066893	001	HOLDING PROPERTY-MIDDLE CREEK	0.4000		Mobile Home Park
NC0061638	001	NERO UTILITY, INC.	0.0200	0.0033	Subdivision
NC0065633	001	NICOLE ESTATES	0.0750		Subdivision
NC0079553	001	R & T JONES OIL COMPANY	0.0072	0.0000	Aquifer Restoration
NC0022217	001	STAR ENTERPRISE - APEX	N/A	0.0000	Oil Separator
NC0035181	001	THE FORTY NINERS CLUB, INC.	0.0065	0.0053	Institution (College, Rest Home, etc)
NC0066915	001	THE LEVINSON STEEL COMPANY	0.0250		Subdivision
NC0049093	001	WAKE CO. SCH.-WILLOW SPRINGS E	0.0034	0.0016	School
NC0062715	001	WYNDRIDGE DEVELOPERS, INC.	0.1500		Subdivision
		Totals for Subbasin 030403	16.8691	4.0718	

Facilities in Subbasin 030404

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
✔ NC0020389	001	BENSON WWTP, TOWN OF	1.5000	1.0221	Municipal
NC0065196	001	DUPREE'S MOBILE HOME COURT	N/A		Mobile Home Park
NC0078255	001	JAG INC.-W. JOHNSON MOBILE AC.	N/A		Water Plant and Water Conditioning
NC0038954	001	JOHNSTON CO SCH-S. JOHNSTON HS	0.0200	0.0070	School
NC0072419	001	JOHNSTON CO. SATELLITE JAIL	0.0053		Institution (College, Rest Home, etc)
NC0058033	001	MARTIN MARIETTA-BENSON	N/A	0.1062	Mine Dewatering
		Totals for Subbasin 030404	1.5253	1.1353	

Facilities in Subbasin 030405

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0062162	001	BASS LAKE MOBILE HOME PARK	N/A		Water Plant and Water Conditioning
NC0076724	001	COASTAL LUMBER CO./KINSTON	N/A		Wood Treatment
✔ NC0003760	003	E. I. DUPONT, KINSTON	N/A	0.0145	Organic Chemical Manufacture
✔ NC0003760	002	E. I. DUPONT, KINSTON	N/A	0.0145	Organic Chemical Manufacture
✔ NC0003760	001	E. I. DUPONT, KINSTON	3.6000	0.0145	Organic Chemical Manufacture
NC0038741	001	HOWELL'S CHILD CARE CENTER INC	0.0187	0.0080	Institution (College, Rest Home, etc)
✔ NC0020541	001	KINSTON, CITY-PEACHTREE PLANT	6.7500	4.1109	Municipal
✔ NC0024236	001	KINSTON-NORTHSIDE WWTP	4.5000	0.7334	Municipal
NC0021644	001	LA GRANGE WWTP, TOWN OF	0.7500	0.5289	Municipal
NC0032581	001	LENOIR CO SCH - CONTENTNEA ELE	0.0100	0.0185	School
NC0032522	001	LENOIR CO SCH - SAVANNAH MIDDL	0.0075	0.0095	School
NC0032531	001	LENOIR CO SCH - SOUTHWOOD ELEM	0.0090	0.0072	School

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NC0032573	001	LENOIR CO SCH-MOSS HILL ELEM.	0.0110	0.0055	School
NC0032557	001	LENOIR CO SCH-S. LENOIR HIGH	0.0120	0.0121	School
NC0063177	002	SEYMOUR JOHNSON AIR FORCE BASE	N/A	2.3584	Oil Separator
NC0063177	001	SEYMOUR JOHNSON AIR FORCE BASE	N/A	2.3584	Oil Separator
NC0069647	001	TEXASGULF CHEMICALS	N/A	0.0269	Boiler Blowdown
NC0039233	001	WALNUT CREEK, VILLAGE OF	0.0250	0.0241	Municipal
NC0038075	001	WAYNE CO SCH-EASTERN WAYNE HS	0.0180		School
NC0044865	001	WAYNE CO SCH-SPRING CRK	0.0030		School
		Totals for Subbasin 030405	15.7142	10.2462	

Facilities in Subbasin 030406

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0076406	001	CONESTOGA WOOD SPECIALIT. INC.	N/A	0.0430	Boiler Blowdown
NC0048194	001	GLAXO INC.	N/A	0.0000	Cooling Tower Blowdown
NC0072745	001	GLAXO, INC.	N/A		Water Plant (Surface Water)
NC0038938	001	JOHNSTON CO SCH-CORINTH HOLDER	0.0090	0.0055	School
NC0064891	001	KENLY NEW WWTP, TOWN OF	0.5200	0.3057	Municipal
NC0075493	001	NELLO TEER-PRINCETON QUARRY	N/A	0.9833	Mining and Minerial Processing
NC0026662	001	PRINCETON, TOWN OF WWTP	0.2750	0.1536	Municipal
NC0049042	001	RILEY HILL SCHOOL	0.0012	0.0005	School
NC0069027	001	RIVER DELL FARMS (FINCH PROP.)	0.1500		Mobile Home Park
NC0068942	001	TRUCKLAND, INC.	0.0060	0.0000	Oil Separator
NC0031763	001	WAKE CO. SCH.-E. WAKE HIGH SCH	0.0375		School
NC0062901	001	WATER OAKS DEVELOPMENT	0.1100		Subdivision
NC0025020	001	WENDELL WWTP, TOWN OF	0.7000	0.2665	Municipal
NC0000809	001	ZEBULON WTP, TOWN OF	N/A	0.0243	Water Plant (Surface Water)
		Totals for Subbasin 030406	1.8087	1.7827	

Facilities in Subbasin 030407

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0043958	001	A.C.MONK & COMPANY, INC.	N/A	0.0000	Non-Contact Cooling Water
✔ NC0032077	001	CONTENTNEA SEWAGE DIST. WWTP	2.0000	1.5284	Municipal
NC0029718	001	DOC - EAST'N CORR. CTR.-GREENE	0.1000	0.0750	Institution (College, Rest Home, etc)
NC0048062	001	EUREKA WWTP, TOWN OF	0.0400	0.0393	Municipal
✔ NC0029572	001	FARMVILLE WWTP, TOWN OF	3.5000	1.4737	Municipal
NC0002160	001	GSH CORPORATION	N/A		Non-Contact Cooling Water
NC0025712	001	HOOKERTON WWTP, TOWN OF	0.0600	0.0204	Municipal
NC0032565	001	LENOIR CO SCH-N. LENOIR HIGH	0.0180	0.0121	School
NC0061492	001	MAURY SANITARY LAND DISTRICT	0.0650	0.0120	Municipal
NC0021563	001	MIDDLESEX WWTP, TOWN OF	0.0800	0.0673	Municipal
NC0037915	001	NASH CO SCH-SOUTHERN NASH HS	0.0150	0.0095	School
NC0049948	001	SARATOGA WTP, TOWN OF	N/A		Water Plant (Surface Water)
NC0020842	001	SNOW HILL WWTP, TOWN OF	0.2500	0.1551	Municipal
NC0023388	004	STANDARD COMMERCIAL TOBACCO,C	N/A	0.0000	Non-Contact Cooling Water
NC0023388	003	STANDARD COMMERCIAL TOBACCO,C	N/A	0.0000	Non-Contact Cooling Water
NC0023388	002	STANDARD COMMERCIAL TOBACCO,C	N/A	0.0000	Non-Contact Cooling Water
NC0023388	001	STANDARD COMMERCIAL TOBACCO,C	N/A	0.0000	Non-Contact Cooling Water
NC0007536	001	STANTONSBURG WTP, TOWN OF	N/A		Water Plant (Surface Water)
NC0057606	001	STANTONSBURG WWTP, TOWN OF	0.3750	0.4217	Municipal
NC0080004	001	TURNER OIL COMPANY OF WILSON	0.0140		Aquifer Restoration
NC0020362	001	WALSTONBURG WWTP, TOWN OF	0.1380	0.0168	Municipal
NC0034819	001	WAYNE CO SCH-C. B. AYCOCK H.S.	0.0100	0.0025	School
NC0034801	001	WAYNE CO SCH-NORWAYNE JR HIGH	0.0120	0.0021	School

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NC0056537	002	WEST WILSON WATER SYSTEM	N/A		Water Plant and Water Conditioning
NC0056537	001	WEST WILSON WATER SYSTEM	N/A		Water Plant and Water Conditioning
NC0057321	001	WILSON CO. SCH.-GARDNERS	0.0038	0.0022	School
NC0042889	001	WILSON CO. SCH.-ROCK RIDGE SCH	0.0110	0.0010	School
NC0042854	001	WILSON CO. SCH.SPRINGFD.MIDDLE	0.0094	0.0009	School
NC0076252	001	WILSON PETROLEUM CO./GRD.WATER	0.0050	0.0030	Aquifer Restoration
✔ NC0023906	001	WILSON WWTP, TOWN OF	12.0000	7.8365	Municipal
✔ NC0079316	001	ZEBULON TOWN OF-LITTLE CREEK	1.8500		Municipal
NC0024368	001	ZEBULON WWTP, TOWN OF	0.5280	0.4775	Municipal
		Totals for Subbasin 030407	21.0842	12.1579	

Facilities in Subbasin 030408

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0075281	002	CRA. CO. WOOD ENERGY LIM. PAR.	N/A	0.0156	Cooling Tower Blowdown
NC0075281	001	CRA. CO. WOOD ENERGY LIM. PAR.	0.5040	0.0156	Cooling Tower Blowdown
NC0033006	001	CRAVEN CO SCH - FT BARNWELL	0.0100		School
NC0029904	001	CRAVEN CO SCH - W. CRAVEN MIDD	0.0170	0.0024	School
NC0042765	001	CRAVEN EVAL/TRAIN CTR	0.0030	0.0020	School
NC0061191	001	MARTIN MARIETTA-CLARKS QUARRY	12.0000	10.8299	Mine Dewatering
NC0077852	001	MOSES S. HARRIS-PROPERTY	0.0600		Apartment
NC0076554	001	TEXFI INDUSTRIES, INC	0.1152		Aquifer Restoration
✔ NC0003191	001	WEYERHAEUSER, NEW BERN	27.0000	22.8132	Industrial/Commercial
		Totals for Subbasin 030408	39.7092	33.6789	

Facilities in Subbasin 030409

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0079979	001	MALLARD OIL COMPANY	0.0144		Aquifer Restoration
NC0034169	001	PITT CO SCH-D H CONLEY HS	0.0160		School
NC0031828	001	VANCEBORO WWTP, TOWN OF	0.1000	0.1557	Municipal
NC0080071	001	VANCEBORO, TOWN OF	N/A		Water Plant and Water Conditioning
NC0047724	001	WEYERHAEUSER CAR WASH	0.1000	0.0002	Car Wash
NC0073229	001	WEYERHAEUSER, AYDEN	N/A	0.2279	Wood Products
		Totals for Subbasin 030409	0.2304	0.3838	

Facilities in Subbasin 030410

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0007285	001	BARBOUR BOAT WORKS INC.	0.0005		Non-Contact Cooling Water
NC0074837	001	BRIDGETON TOWN WWTP	0.0750		Municipal
NC0007609	003	C.M.MUSE SEAFOOD INC	N/A		Seafood or Fish Packing
NC0007609	002	C.M.MUSE SEAFOOD INC	N/A		Seafood or Fish Packing
~~NC0007609~~	~~001~~	~~C.M.MUSE SEAFOOD INC~~	~~N/A~~		~~Seafood or Fish Packing~~
NC0056618	001	CAROLINA PINES UTILITY CO.	0.5000	0.0105	Subdivision
NC0033111	002	CAROLINA WATER SERVICE, INC.	1.0000	0.0899	Subdivision
NC0033111	001	CAROLINA WATER SERVICE, INC.	1.0000	0.0899	Subdivision
NC0032981	001	CRAVEN CO SCH - BRIDGETON ELEM	0.0070		School
NC0047104	001	D. B. ARANT, INC.	N/A		Wood Products
NC0078701	001	E. J. POPE & SON, INC.	0.0144		Aquifer Restoration
NC0061450	001	EASTERN SHORE TOWNHOUSES OA	0.0250		Apartment
NC0073873	001	ENCEE CHEMICAL SALES, INC	N/A	0.0000	Non-Contact Cooling Water
NC0060321	001	FIRST CRAVEN SANITARY DISTRICT	N/A	18.1763	Water Plant and Water Conditioning
NC0078727	001	FISHER OIL COMPANY	0.0144		Aquifer Restoration
NC0003174	003	FULCHER'S POINT PRIDE SEAFOOD	0.0006		Seafood or Fish Processing
NC0003174	002	FULCHER'S POINT PRIDE SEAFOOD	0.0006		Seafood or Fish Processing

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NC0003174	001	FULCHER'S POINT PRIDE SEAFOOD	0.0006		Seafood or Fish Processing
NC0001813	001	GEORGIA PACIFIC-BRIDGETON	N/A	0.0550	Non-Contact Cooling Water
NC0072290	001	GLENBURNIE MINE	N/A		Mine Dewatering
✔ NC0021253	001	HAVELOCK WWTP, CITY OF	1.5000	1.0981	Municipal
NC0078131	001	HAVELOCK, CITY	N/A		Water Plant and Water Conditioning
NC0075230	001	HOLLAND SEAFOODS	N/A		Seafood or Fish Packing
NC0000931	001	MARTIN MARIETTA-NEW BERN	N/A	14.8475	Mine Dewatering
✔ NC0025348	001	NEW BERN WWTP, CITY OF	4.7000	2.9703	Municipal
NC0057011	001	ORIENTAL WWTP	0.1000	0.0860	Municipal
NC0040789	001	PAMILCO COUNTY	N/A		Water Plant and Water Conditioning
✔ NC0001881	001	PHILLIPS PLATING COMPANY	0.1000	0.0212	Metal Plating
NC0051888	001	RENNY'S CREEK MINE	N/A	0.0230	Mine Dewatering
NC0056545	001	SHIPYARD PROPERTY	0.0750	0.0155	Hotel, Motel, Inn, Campground
NC0002364	002	SOUND PACKING COMPANY	N/A		Seafood or Fish Packing
NC0002364	001	SOUND PACKING COMPANY	N/A		Seafood or Fish Packing
NC0070084	001	STATLEY PINE UTILITIES	0.1000		Subdivision
NC0002518	002	TOM THUMB SEAFOOD	N/A		Seafood or Fish Processing
NC0002518	001	TOM THUMB SEAFOOD	N/A		Seafood or Fish Processing
NC0003816	139	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	137	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	136	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	135	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	128	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	122	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	121	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	120	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	119	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	118	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	117	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	116	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	115	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	114	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	113	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	111	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	110	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	109	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	106	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	105	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	103	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
NC0003816	102	USMC MCAS CHERRY POINT	N/A	0.0000	Metal Plating
✔ NC0003816	001	USMC MCAS CHERRY POINT	3.5000	0.0000	Industrial/Commercial/DOMESTIC
NC0066613	001	ZACHARY TAYLOR - HWY 55 SITE	0.2500		Subdivision
NC0066621	001	ZACHARY TAYLOR - SANDY POINT	0.2500		Subdivision
		Totals for Subbasin 030410	13.2131	37.4835	

STORMWATER (oil/WATER SEPARATORS)

Facilities in Subbasin 030411

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0077917	001	C W CAREY OIL COMPANY	0.0100		Aquifer Restoration
NC0030406	001	CAROLINA WTR SERV.-RIVER BEND	0.1700	0.0602	Subdivision
NC0032549	001	LENOIR CO SCH - WOODINGTON MID	0.0120	0.0100	School
NC0080438	001	MARTIN MARIETTE-POLLOCKSVILLE	N/A	0.0000	Mine Dewatering
NC0020001	001	PINK HILL WWTP, TOWN OF	0.1000	0.0701	Municipal
NC0021342	001	TRENTON WWTP, TOWN OF	0.0700	0.0330	Municipal
		Totals for Subbasin 030411	0.3620	0.1735	

Major Facilities are checked by the permit number. Design (MGD) column is the permitted design flow for that facility in millions of gallons per day (MGD). Aver. (MGD) is the average facility-reported flow for calendar year 1991 in millions of gallons per day. A blank in the Aver. (MGD) column indicates the facility is not required to report flow. N/A in the Design column indicates the facility does not have a design flow but may report wasteflow. The Discharge Type column is the primary type of wastewater discharged from the facility.

Appendix V. NPDES Dischargers in the Neuse Basin

Facilities in Subbasin 030412

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0007081	001	BURLINGTON IND., MT. OLIVE	N/A	0.0300	Non-Contact Cooling Water
NC0050695	001	CELOTEX CORP	N/A	0.0000	Contact Cooling Water
✔ NC0003417	005	CP&L LEE S.E. (PWR PLT)	N/A	0.0000	Ash Pond and Coal Pile
✔ NC0003417	002	CP&L LEE S.E. (PWR PLT)	N/A	0.0000	Ash Pond and Coal Pile
✔ NC0003417	001	CP&L LEE S.E. (PWR PLT)	1.4000	0.0000	Ash Pond and Coal Pile
✔ NC0023949	001	GOLDSBORO WWTP, CITY OF	6.3750	6.0816	Municipal
NC0075108	001	SO. BELL TEL.& TELEGRAPH CO.	0.0860	0.0014	Aquifer Restoration
NC0030392	001	WAYNE COUNTY (GENOA IND. WWTP)	0.4000	0.0882	Municipal
NC0072583	001	WEBBER'S HATCHERY	N/A		Non-Contact Cooling Water
NC0074667	001	WORSLEY COMPANIES-SCOTCHMAN#76	0.0060	0.0004	Aquifer Restoration
		Totals for Subbasin 030412	8.2670	6.2017	

Facilities in Subbasin 030413

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0066109	001	BAY RIVER METRO SEWERAGE DIST.	0.2000	0.0747	Municipal
NC0038911	001	MCCOTTER SEAFOOD CO.	N/A		Seafood or Fish Packing
NC0002071	004	PAMLICO PACKING COMPANY	0.0010	0.0002	Seafood or Fish Packing
NC0002071	003	PAMLICO PACKING COMPANY	0.0010	0.0002	Seafood or Fish Packing
NC0002071	002	PAMLICO PACKING COMPANY	0.0010	0.0002	Seafood or Fish Packing
NC0002071	001	PAMLICO PACKING COMPANY	0.0010	0.0002	Seafood or Fish Packing
NC0050547	002	POTTER SEAFOOD CO.	N/A		Seafood or Fish Processing
NC0050547	001	POTTER SEAFOOD CO.	N/A		Seafood or Fish Processing
NC0002569	004	R.E. MAYO & COMPANY, INC.	N/A		Seafood or Fish Processing
NC0002569	003	R.E. MAYO & COMPANY, INC.	N/A		Seafood or Fish Processing
NC0002569	002	R.E. MAYO & COMPANY, INC.	N/A		Seafood or Fish Processing
NC0002569	001	R.E. MAYO & COMPANY, INC.	N/A		Seafood or Fish Processing
		Totals for Subbasin 030413	0.2040	0.0755	

Facilities in Subbasin 030414

Permit No.	Pipe	Facility Name	Design (MGD)	Aver. (MGD)	Discharge Type
NC0007170	003	GASKILL SEAFOOD, INC	0.0500		Seafood or Fish Processing
NC0007170	002	GASKILL SEAFOOD, INC	0.0500		Seafood or Fish Processing
NC0007170	001	GASKILL SEAFOOD, INC.	0.0500		Seafood or Fish Packing
NC0007781	001	REBEKAH GOODWIN SEAFOOD	N/A		Seafood or Fish Packing
		Totals for Subbasin 030414	0.1500	0.0000	

Major Facilities are checked by the permit number. Design (MGD) column is the permitted design flow for that facility in millions of gallons per day (MGD). Aver. (MGD) is the average facility-reported flow for calendar year 1991 in millions of gallons per day. A blank in the Aver. (MGD) column indicates the facility is not required to report flow. N/A in the Design column indicates the facility does not have a design flow but may report wasteflow. The Discharge Type column is the primary type of wastewater discharged from the facility.