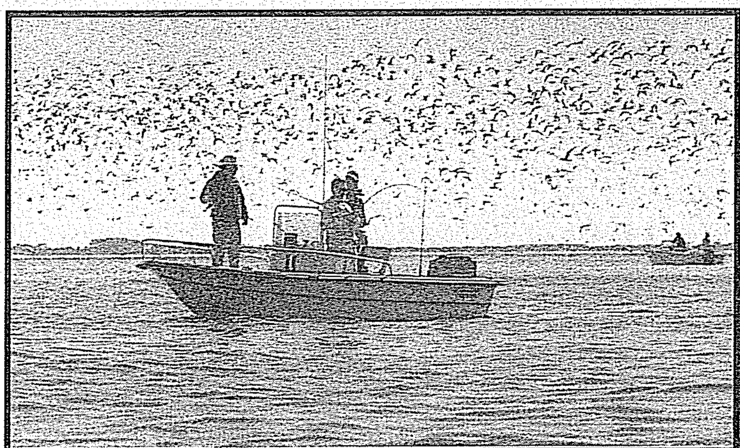
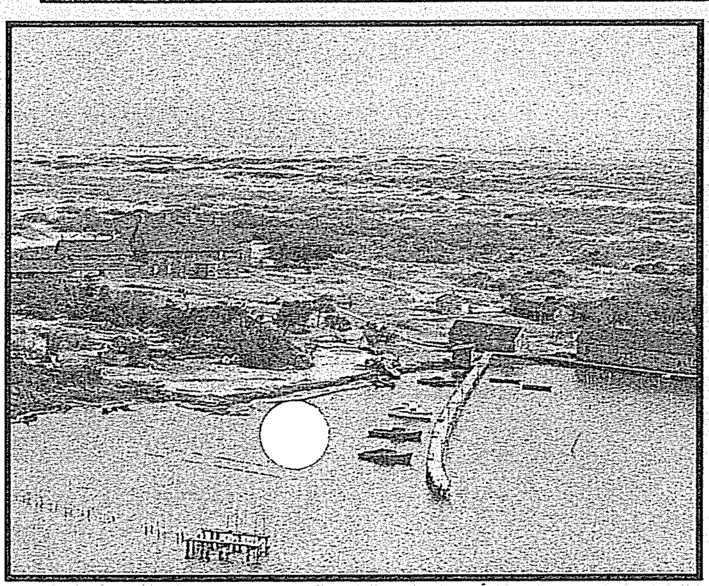
PASQUOTANK RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN





North Carolina Department of Environment, Health, and Natural Resources
Division of Water Quality • Water Quality Section • September, 1997

Michael F. Easley, Governor
William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director
Division of Water Quality

April 22, 2003

Thank you for your interest in North Carolina's water quality issues. Enclosed is the basinwide water quality plan that you recently requested from the Division of Water Quality (DWQ).

The basinwide planning program aims to identify and restore full use to impaired waters, identify and protect highly valued resource waters, and protect the quality and intended uses of North Carolina's surface waters while allowing for sound economic planning and reasonable growth. North Carolina relies on the input and experience of its public to ensure that the water quality plans are effective. DWQ coordinates plan development; however, plan implementation and effectiveness entails the coordinated efforts and endorsement of many agencies, groups, local governments, and the general public. Your participation is essential for us to achieve our goals.

Our website (http://h2o.enr.state.nc.us/wqs/) provides detailed information on our program, other basin plans, current events, publications, and rules and regulations. Please visit us at this site.

DWQ appreciates your interest in water quality issues, and we hope to continue working with you into the future. Please contact me if you have any further questions or ideas on specific basins at (919) 733-5083, ext. 354.

Sincerely,

Darlene Kucken

Darlene Kucken
Basinwide Planning Program Coordinator

Enclosure

N. C. Division of Water Quality 1617 Mail Service Center Raleigh, NC 27699-1617 (919) 733-7015

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ADDENDUM: Use Support Changes for the Pasquotank River Basin

March 2000

The fully supporting but threatened (support-threatened, ST) category is no longer used as a use support rating. In the past, ST was used to identify a water that was fully supporting but had some notable water quality problems. ST could represent constant, degrading, or improving conditions. North Carolina's use of ST was very different from that of the US Environmental Protection Agency (EPA), which uses it to identify waters that are characterized by declining water quality. In addition, the US EPA requires the inclusion of ST waters on the 303(d) list in its proposed revision (August, 1999) to the 303(d) list rules (Appendix VIII). Due to the difference between US EPA's and North Carolina's definitions of ST, North Carolina no longer uses this term. Because North Carolina has used fully supporting but threatened as a subset of fully supporting (FS) waters, those waters formerly called ST are now rated FS. This change is reflected in the 305(b) report for 2000. Based on this change, use support ratings for all basins have been altered.

The use support rating of Burnt Mill Creek (subbasin 52) has been revised based on new biological information. This stream was formerly rated NS but is now not rated (NR). This revised rating is reflected in the 2000 303(d) list and 305(b) report.

Revised use support ratings for the Pasquotank River basin are presented below.

Streams and Rivers

Table 4.8 - Use Support Status for Freshwater Streams (Miles) (1991-1995) for Pasquotank River Basin (*Found on p. 4-45 of this plan.*)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Evaluated	Total Miles
03-01-50	131.9	0	0	0	131.9
03-01-51	89.8	0	0	1.4	91.2
03-01-52	43.8	11.8	3.2	9.2	68.0
03-01-53	41.5	33.4	0	59.3	134.2
03-01-54	53.7	0	0	0	53.7
Total	360.7	45.2	3.2	69.9	479.0
Percent	75	9	1	14	

Table 4-9 Use Support Status for Estuarine Waters in the Pasquotank River Basin
(Found on p. 4-48 of this plan.)

Area Name	DEH Area	Total acres	Overall Use Support (acres) FS	PS	NS	Major Causes (acres) Fecal	DO	Chla	Metals	Major Sources Point	Nonpoint	Source Description
Roanoke Sound	H1	20,500	18,550	1,950	0	1,950				500	1,450	WWTP, urban runoff, septic tanks, marinas
Croatan Sound	H2	42,500	41,609	891	0	891					891	Urban runoff, septic tanks, marinas
Stumpy Sound	H3	5,500	5,235	265	0	265					265	Septic tanks
Hatteras	H4	5,800	5,175	625	0	625					625	Urban runoff, septic tanks, marinas
Outer Banks	H5	66,800	66,469	331	0	331					331	Urban runoff, septic tanks, marinas
Open	H6	246,800	246,800	0	0							
North River	I1	25,000	25,000	0	0							
Eastern Albemarle Sound	I2	55,000	54,200	800	0	800					800	Septic tanks, urban runoff
Scuppernong River	I3	28,500	28,500	0	0							
Alligator River	I4	36,000	36,000	0	0							
Pasquotank River	I5	21,000	21,000	0	0							
Little River	I6	7,500	6,375	1,125	0		1,125				1,125	Ag, swamp
Perquimans River	I7	12,000	12,000	0	0							
Yeopim River	I8	6,500	6,500	0	0							
Sandy Point	I9	8,400	8,400	0	0							
Leonard's Point	I10	17,000	17,000	0	0							
Plymouth	I12	16,000	16,000	0	0							
Western Albemarle Sound	I14	44,000	44,000	0	0							
Middle Albemarle Sound	I15	114,000	114,000	0	0							
Currituck Sound	I16	90,000	90,000	0	0	**						
Total Acres		868,800	862,813	5,987	0	4,862	1,125	0	0	500	5,487	
Percent			99.3	0.7	0.0	81.21	18.79	0.00	0.00	8.4	91.6	
Pasquotank River Total		868,800	862,813	5,987	0	4,862	1,125	0	0	500	5,487	
Percent		100	99.3	0.7	0.0	81.2	18.8	0.00	0.00	8	92	

PASQUOTANK RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN

September, 1997

Prepared by:

North Carolina
Division of Water Quality
Water Quality Section
P.O. Box 29535
Raleigh, NC 27626-0535

(919) 733-5083

This document was approved and endorsed by the NC Environmental Management Commission on September 11, 1997 to be used as a guide by the NC Division of Water Quality in carrying out its Water Quality Program duties and responsibilities in the Pasquotank River Basin.

<u>Cover Photo Credits</u>
All photographs were taken by the NC Wildlife Resources Commission
Top left: Fishing on the coast
Bottom left: Hunt Club on Currituck Sound
Right: Cape Hatteras Lighthouse

250 copies of this public document were printed at a cost of $2,399.00 or $9.60 per copy.

FOREWORD

The Pasquotank River Basin has seen a significant increase in population over the past twenty years, most of it concentrated immediately along the coast and sounds. Pressure for continued growth is expected to be strong during the coming decades. As coastal areas grow, more development takes place causing the generation of more stormwater runoff, the addition of new septic tanks, the need for more wastewater treatment capacity, a need for new and expanded water supply sources and the location of new marinas. Yet options for wastewater disposal and water supply are extremely limited. And the region's economically important wetland, fisheries and brackish estuarine resources are sensitive to the effects of increased development.

Protecting surface waters in the Pasquotank River Basin represents a major challenge. Although it is labeled the 'Pasquotank Basin', the basin contains the Albemarle Sound and several of its major tributaries (the Perquimans, Little, Pasquotank, Scuppernong and Alligator rivers), as well as Currituck, Croatan and Roanoke sounds, and the northeast portion of the Pamlico Sound along the outer banks.

The majority of the surface waters in the basin are saltwaters (many of low salinity), but there are some freshwaters in the upper parts of the rivers feeding the Albemarle Sound. Of the 479 miles of freshwater streams and rivers in the Pasquotank Basin, use support ratings were determined for 85% or 413 miles. Nine percent (9%) are considered partially supporting, and 1% not supporting adding up to 10% of the waters being considered impaired. Impairment of freshwaters is thought to be attributable to agricultural activities, including animal operations.

Use support determinations were made for all of the 868,800 acres of saltwater in the Pasquotank Basin. Less than 1% were rated as partially supporting or impaired. The cause of impairment was unacceptably high concentrations of fecal coliform bacteria in waters classified for shellfishing. Nonpoint source pollution (stormwater runoff) is estimated to be the primary pollution source in the saltwater areas. Waters are thought to be impacted primarily by multiple nonpoint sources including urban runoff, septic tanks and marinas.

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

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

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EXECUTIVE SUMMARY

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

Basinwide management is a watershed-based approach to water quality protection. The plan is being prepared by the North Carolina Division of Water Quality (DWQ), however implementation of the plan and protection of water quality involved the efforts of all stakeholders in the basin. The *Pasquotank Basinwide Water Quality Management Plan* (Pasquotank Plan) is the fifteenth in a series of basinwide water quality management plans that will be prepared by DWQ for all seventeen of the state's major river basins by the year 1998. The plan will be used as a guide by DWQ in carrying out its water quality program duties and responsibilities in the Pasquotank River Basin.

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

The Pasquotank Plan is due for completion in September of 1997 and will be updated in the year 2002. Basinwide NPDES permitting is scheduled to commence in February of 1998.

BASINWIDE GOALS

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

PUBLIC WORKSHOPS

Two public workshops were conducted in the Pasquotank River basin on the afternoon of July 25, and the morning of July 26, 1996. They were attended by over 50 participants. These workshops were held in Elizabeth City and Manteo, respectively, and were co-sponsored by the North Carolina Cooperative Extension Service (CES), the North Carolina League of Municipalities and DWQ. A summary of the comments received at these workshops is provided in Chapter 6 of the plan. DWQ examined the comments received at the workshop and grouped them into seven broad categories. These categories are as follows:

- resource issues (such as fisheries, spawning and nursery areas, submerged rooted vegetation),
- cooperation and coordination between States, state agencies, and local governments,
- nonpoint source pollution,
- growth/development issues,
- regulatory issues, and
- education.

Further information on the comments received at the workshops is presented in Chapter 6 of the plan.

PASQUOTANK BASIN OVERVIEW

The Pasquotank River basin encompasses 3,697 square miles of low-lying lands and vast open waters, including Albemarle Sound, in the state's northeast outer coastal plain. It includes all or portions of Camden, Currituck, Dare, Gates, Hyde, Pasquotank, Perquimans, Tyrrell and Washington counties. It contains numerous small watersheds that drain into Albemarle, Currituck, Croatan, Roanoke and Pamlico sounds. One of these watersheds is the Pasquotank River for which the basin is named. A small portion of the basin extends up into Virginia. Figure 1 provides a map of that portion of the basin that is within North Carolina.

The Albemarle Sound is a large fresh to brackish estuarine waterbody in northeastern North Carolina. Major tributaries inlcude the Chowan, Roanoke, North, Pasquotank, Little and Perquimans Rivers on the north side, and the Scuppernong, and Alligator Rivers on the south. Salinities in the Albemarle Sound are low due to dilution from the large inflow of freshwater relative to the sound's volume. Likewise, the large inputs of freshwater from the Chowan and Roanoke rivers into the sound result in a relatively short retention time.

Major tributaries on the northwestern side of Albemarle Sound are the Pasquotank, Little and Perquimans rivers. The Pasquotank River flows along the border of Pasquotank and Camden counties and is the only water-supply watershed in the basin. The river is fresh above Elizabeth City and brackish and tidally influenced below. The Little River is a slow-flowing coastal stream that flows along the border of Perquimans and Pasquotank counties. The Perquimans River originates in the Great Dismal Swamp and flows south before emptying into Albemarle Sound. The largest town in its watershed is Hertford. Land use in the area is mainly agriculture with widespread use of drainage canals.

On the southeastern side of Albemarle Sound are the Alligator and Scuppernong rivers. The Alligator River is a large blackwater river, with a surface area of 64,000 acres that has been designated as Outstanding Resource Waters. It is remote from any urban areas and is bordered by wooded swamps and pocosins. The Alligator River National Wildlife Refuge extends along the entire eastern shore of the river. The river's outstanding resource is its function as a major spawning area for anadromous fish, principally river herring (alewife and blueback herring), and the national wildlife refuge. The Scuppernong River watershed is mainly forested wetlands and agriculture with widespread use of canals which drain wetlands.

Currituck Sound is a shallow, fresh to brackish estuarine waterbody in the northeastern portion of the basin whose circulation is influenced largely by wind movement. In the past, Currituck Sound supported a viable waterfowl hunting industry and largemouth bass fishery, both of which have declined due to habitat changes. A vast marsh area bordering a large portion of the Currituck Sound serves as a critical part of the Atlantic Flyway for migratory waterfowl. Thousands of wintering ducks, geese and swans contribute to the sound's reputation for waterfowl hunting. The Northwest River is a major tributary of Currituck Sound. It receives drainage from a number of

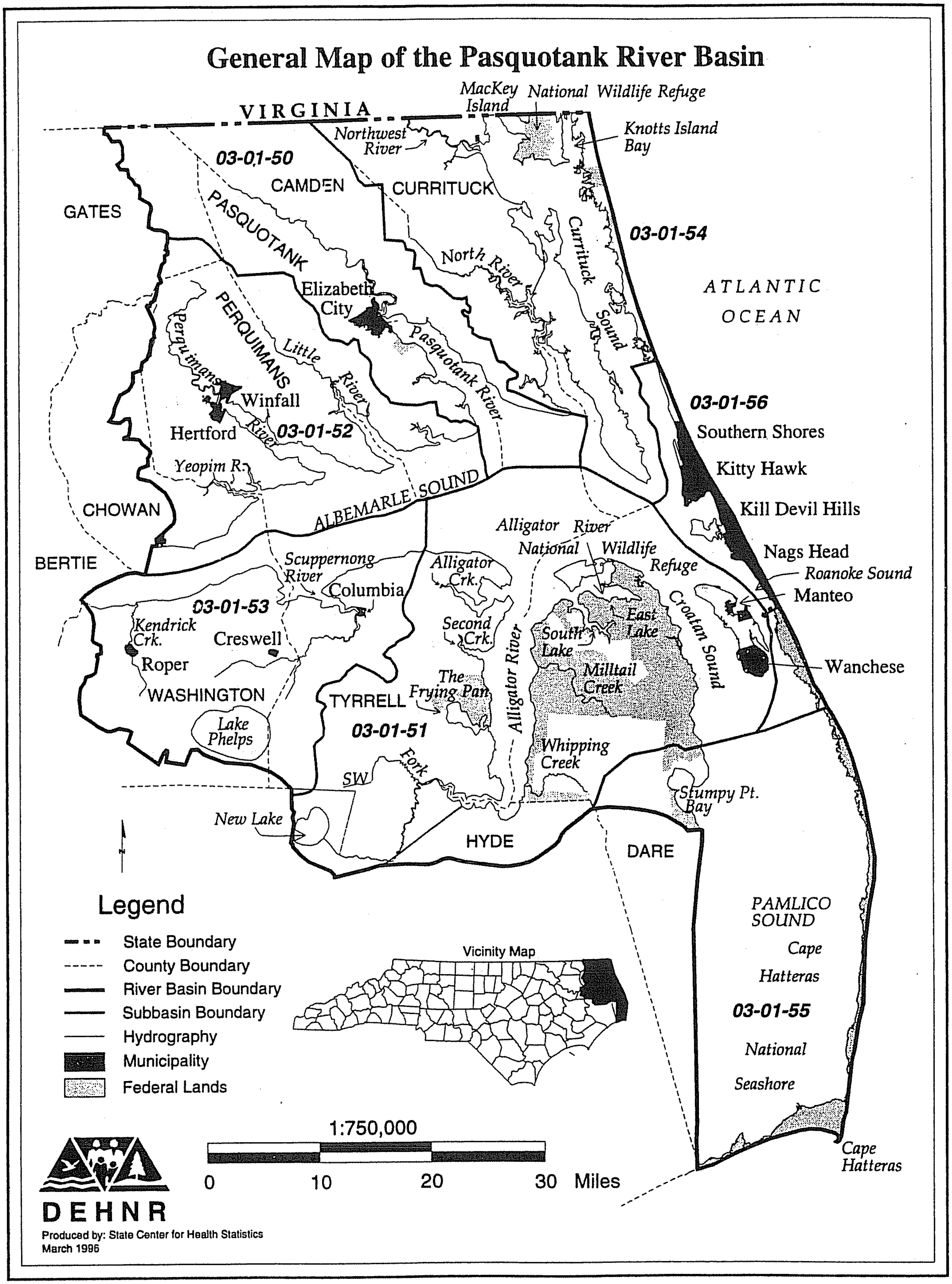

Figure 1. General Map of the Pasquotank River Basin in North Carolina

canals leading out of the Great Dismal Swamp. Most of the waters in this subbasin are brackish estuarine, including Currituck Sound and the North River.

The Pasquotank River basin also includes waters along the Outer Banks south of Currituck Sound, including Roanoke Sound, Croatan Sound and Pamlico Sound from Oregon Inlet to Hatteras Inlet. Roanoke Island, with the cities of Manteo and Wanchese, and the Outer Banks from Nags Head to Southern Shores are the most developed areas. Land use in these areas is primarily residential and commercial. All waters in this subbasin are estuarine, with the exception of a few small lakes in the maritime forest of the outer banks. Much of the area is adjacent to the Cape Hatteras National Seashore and Pea Island National Wildlife Refuge.

The Pasquotank River basin is part of the Albemarle-Pamlico Estuarine system, the second largest estuarine system in the United States. In 1987 this estuarine system became part of the Environmental Protection Agency National Estuary Program and was the subject of a major study known as the Albemarle-Pamlico Estuarine Study (APES). The results of research conducted as part of APES culminated in the Comprehensive Conservation and Management Plan (CCMP) which is currently being implemented. It is discussed further in Chapters 5 and 6. Basinwide management is part of this implementation.

Land cover data generated under APES revealed that 42% of the basin was open water. This was followed by agriculture (21%), wetlands (18%) and forest (17%).

Based on data from the US Department of Agriculture Natural Resources Conservation Service (NRCS), land cover changes from 1982 and 1992 showed a 58% increase in the amount of urban/built-up land, and a 67% increase in pastureland.

The Pasquotank River basin has an estimated population of 97,215 people based on 1990 census data. Population density for the basin is 46 persons/square mile. However, in Elizabeth City and the Kill Devil Hills/Nags Head area of the outer banks it is 305 persons/square mile. The coastal areas, particularly around Nags Head, Kitty Hawk and Kill Devil Hills, have experienced tremendous growth in the twenty years between 1970 and 1990. According to figures from the NC Department of Administration, the counties of Currituck and Dare (which encompass the coastal area) are anticipated to experience 56% and 128% levels of population growth respectively from 1990 into the year 2020.

Water use in the basin comes from both surface and ground water sources, but the vast majority (94%) comes from ground water sources. From 1992 to the year 2020, water use is expected to rise significantly, growing by 89%.

ASSESSMENT OF WATER QUALITY IN THE PASQUOTANK RIVER BASIN

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

Summary of Biological Indicators

Benthic Macroinvertebrates - In freshwaters, benthic macroinvertebrates (or benthos) are primarily bottom-dwelling aquatic insect larvae such as species of stoneflies, mayflies and caddisflies. In estuarine waters, which are predominant in the Pasquotank Basin, they are made up of shellfish, worms and crabs. Measurements of the number, types and diversity of these organisms at strategic sampling sites is an important means of assessing water quality. Benthic macroinvertebrate sampling has been conducted at 27 sites throughout the Pasquotank basin with results ranging from Poor to Good-Fair. However, 22 (or 81%) of these sites have not received a biological rating because they are estuarine waters or swamp waters (the vast majority are estuarine). The data can however be used to provide general water quality characterization when ratings cannot be assigned. Results of estuarine sampling are generally indicative of good water quality.

Fish Community Evaluations - Fish community structure (IBI) analyses were performed on data from 2 sites in the Pasquotank River Basin collected by DWQ. Neither site received a rating because of the swampy nature of the waters sampled.

Fish Tissue Analyses - Fish tissue samples were collected at 22 sites from 1983 to 1995 within the Pasquotank River Basin consisting of 447 observations. Samples were collected as part of the DWQ's ambient fish tissue monitoring program or as part of special mercury studies.

Mercury contamination was most prevalent in Pasquotank subbasins 50, 53 and 54 with a significant portion of samples in these drainages containing mercury above the EPA and/or FDA action levels. Elevated mercury levels were most often associated with long-lived piscivores (bass and bowfin) collected from low productivity, low pH systems. This trend has also been observed throughout other eastern river basins in the state. The source of the contamination is not yet known. Significant mercury contamination was identified at Phelps Lake with over 50% of fish samples containing levels above human health standards. In June of 1996 the State Health Director issued a fish consumption advisory for bass and bowfin in Phelps Lake due to elevated mercury. The advisory recommends that the general population consume no more than 2 meals of the fish per month, and child-bearing women and children consume no fish.

The Albemarle Sound west of a line from Bull Bay (at the mouth of the Scuppernong River) to Harvey Point (near the mouth the Perquimans River) is under a fish consumption advisory because of dioxin contamination. Two major river systems that feed the head of the sound, the Roanoke and Chowan rivers, are contaminated with dioxin from upstream paper mills. These facilities have upgraded their facilities and eliminated dioxin from their effluent, but the pollutant has not yet worked its way out of the system. The current advisory recommends that the general population consume no more than two meals per person per month and that children and pregnant or nursing women consume no fish until further notice. Herring, shellfish and shad (including roe) are not included in the advisory.

Lakes Studies - In the Pasquotank River basin, there are three lakes: Alligator Lake (New Lake) (subbasin 51), Swan Creek Lake (subbasin 51) and Phelps Lake (subbasin 53). NTSI scores for the three lakes indicate that Alligator Lake and Swan Creek Lake are dystrophic and Phelps Lake is oligotrophic. Phelps Lake is a Carolina Bay lake and is a part of Pettigrew State Park. It has naturally low pH levels (in other words it is acidic). All of the lakes are considered to be fully supporting their designated uses.

Use-Support Ratings

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

Freshwater Streams and Rivers - Of the 479 miles of freshwater streams and rivers in the Pasquotank basin, use support ratings were determined for 85% or 413 miles. The relative percentage for the different ratings are presented below.

SUPPORTING 75%
Fully supporting (41%)
Support-threatened (34%)
IMPAIRED 10%
Partially supporting (9%)
Not supporting (1%)
NOT EVALUATED: 14%

These use support values are different from the values in the 1992-1993 305(b) Report. The total waters supporting their uses appear to have increased, while those that are impaired appear to have decreased. While the water quality may have improved since the 1992-1993 305(b) report, the changes in values are primarily due to changes in the way use support ratings are derived (discussed in section 4.4.6 of Chapter 4).

Salt (Estuarine) Waters - Use support determinations were made for all of the 868,800 acres of saltwater in the Pasquotank Basin. The vast majority of saltwaters in the basin are considered to be supporting their uses. The relative breakdown of the ratings is as follows:

SUPPORTING 99.3%
Fully supporting (91.6%)
Support-threatened (7.7%)
IMPAIRED 0.7%
Partially supporting (0.7%)
Not supporting (0%)
NOT EVALUATED: 0%

Fecal coliform bacteria was the major cause of impairment for those waters that are impaired. Elevated levels of fecal coliform bacteria are an indicator of water quality degradation that requires the closure of shellfishing areas.

Lakes - The three lakes in the Pasquotank River Basin, Alligator Lake, Swan Lake and Phelps Lake, are all considered to be supporting their designated uses.

It should be noted that Phelps Lake is under a fish consumption advisory for mercury. As described in section 4.6.6 of Chapter 4, this advisory does not influence the use support designation.

MAJOR WATER QUALITY ISSUES AND RECOMMENDATIONS

Several water quality issues emerge as being of particular importance in light of factors such as the degree of water quality degradation, the value of the resources being impacted and the number of users potentially affected. Those issues considered most significant on a basinwide scale are presented below. Chapter 6 of the Pasquotank Plan provides recommendations for many other issues including growth management and managing inputs of fecal coliform bacteria, sediment and oxygen consuming wastes. Those presented here are of most concern to the Pasquotank basin.

A. COASTAL GROWTH MANAGEMENT

The Need for Coastal Growth Management

The coastal zone is a popular place, attracting visitors and permanent residents, alike. Over 50% of today's US population lives along the coast, and most of future growth is predicted to occur in coastal areas (NOAA, 1993). The situation in North Carolina and in the Pasquotank River Basin is no different. Over the last decade, the coastal growth rate has been nearly twice that of the state (NC CFC, 1994). North Carolina's coastal population grew by nearly 200,000 and growth rates for most coastal counties will exceed 20% by the turn of the century (Culliton et al., 1990, NC CFC). Growth on Roanoke Island and the Dare County portion of the Outer Banks has far-outpaced the remainder of the basin as discussed in Chapter 2.

Unfortunately, continued growth exerts a variety of environmental impacts on coastal ecosystems. Examples include wastewater disposal, stormwater runoff, habitat disruption, and demands on natural resources such as water supply needs, marina construction and fishery resources (Center for Watershed Protection, 1995).

The economies of many coastal North Carolina communities are strongly dependent upon a high quality environment. Visitors and residents alike expect to be able to catch and consume local seafood, swim and boat without threats to health and safety and enjoy scenic surroundings. If such expectations are not met, tourism industries will decline and coastal economies may suffer. Commercial fisherman and others upon whose livelihoods depend on a clean environment can be harmed as well. Unfortunately, evidence, such as the closure of shellfish waters due to fecal coliform bacteria contamination, is showing that such effects are beginning (Center for Watershed Protection, 1995).

Coastal residents sometimes find it easier to blame water quality problems on upland sources. Contrary to this belief, the greatest pollution control per unit effort can be achieved by concentrating on coastal sources (Phillips, 1991).

Growth Management Needed at the Local Level

Growth management--defined here as local planning and development review requirements designed to maintain or improve water quality (Center for Watershed Protection, 1995)--has often been unpopular among local governments for a variety of reasons. While it is important to acknowledge this, we must also acknowledge that further improvements in state programs, while necessary, are by themselves unlikely to prevent further deterioration of coastal water quality. Increasingly, local governments in areas such as the Chesapeake Bay and Puget Sound watersheds have recognized that a more proactive approach is essential to protect their coastal resources. Seventy percent of the local governments in the 12 county Puget Sound region, for example, have adopted some form of a stormwater management plan (Dohrmann, 1995).

The Comprehensive Conservation and Management Plan (CCMP), which was prepared by the NC Department of Environment, Health and Natural Resources (NC EHNR) as part of the Albemarle-Pamlico Estuarine Study (NC EHNR, 1994) echoes the need for local government planning in addressing coastal growth. In discussing the growth issue, it acknowledges that several types of planning are already required at the local level. Coastal counties are required to prepare land use plans under requirements of the federal Coastal Zone Management Act and amendments. At the state level, this program is administered by the NC Division of Coastal Management (DCM). Local governments that provide public water service must prepare water supply plans through a program administered by the NC Division of Water Resources. However, the CCMP goes on to state that "While these requirements result in environmental planning for many parts of the region, many local communities -- as well as local natural resources -- would benefit from expanded comprehensive planning aimed at meeting both environmental and economic goals." (NC EHNR, 1994). The document goes on to recommend that the state provide resources to local governments to assist in proactive, voluntary planning initiatives - especially in the area of geographic information systems (GIS). Some state GIS efforts are discussed below.

Some Recommendations/Resources for Addressing Coastal Growth

Over the past several years DWQ, DCM and other agencies have been involved in a number of projects to encourage and assist local governments in carrying out wastewater planning and growth management activities. One of these projects was the development of the *Blueprint to Protect Coastal Water Quality: A Guide to Successful Growth Management in the Coastal Region of North Carolina* (Center For Watershed Protection, 1995). This was developed as part of a federal grant project sponsored by the Division of Water Quality and carried out by the Neuse River Council of Governments. Local governments should consider the application of growth management techniques outlined in the "Blueprint" document. It provides practical concepts and tools that can be implemented at the local level to protect coastal water quality. Copies are available free of charge from the DWQ's central office in Raleigh.

In addition to the Blueprint document, the Division of Water Quality, in cooperation with the Center of Geographic Information and Analysis (CGIA) recently held a series of three one-day workshops for local governments on GIS. The workshops were funded through a federal CCMP implementation grant from the EPA. One of the workshops was held in the Pasquotank Basin in Plymouth.

The NC Division of Coastal Management has also been providing extensive GIS information to local governments to aid in development of local land use plans. These plans must be consistent with state guidelines and address a wide range of issues, including resource protection and conservation, hazards mitigation, economic development and public participation. 1995 revisions to the land use planning guidelines strengthened the connection between land use planning and surface water quality. Future land use plan updates must consider water quality use classifications, watershed planning and problems identified in basinwide plans.

B. WORKING WITH THE NPS TEAM TO CONTROL NPS POLLUTION

Pollution from nonpoint sources is identified as the major contributor to water quality impairment in the river systems of the Pasquotank River Basin. It will be important during this basinwide planning cycle to actively work with the NPS team to better identify nonpoint source pollution contributions and to improve conditions where feasible. It is recognized that in some cases the information that DWQ has on the probable contributions from land uses such as agriculture are dated and sketchy. Accomplishments in managing runoff from agriculture and animal operations that have occurred during the last five years or so (such as Conservation Management Plans in compliance with the Farm Bill, or improved management of waste from animal operations in compliance with new regulations) are not reflected in this information. It is important for the progress that has been made in BMP implementation to be identified and acknowledged. Team members can assist in consolidating this information. However, agriculture and animal operations remain prominent in the landscape of the river basin and it will be important to work toward further gains in this area in order to protect water quality.

Addressing nonpoint source pollution is best accomplished by a knowledgeable team of local professionals and stakeholders - the NPS team. Therefore, the primary recommendation for impaired waters in the Pasquotank basin is to work with this team to prioritize areas for restoration and target available resources toward them. The NPS team is further discussed in sections 6.2.2 and 6.2.4 and in Chapter 7.

C. IDENTIFICATION AND RECLASSIFICATION OF BIOLOGICALLY SENSITIVE OR HIGH VALUE RESOURCE WATERS

There are several areas in the basin that have been designated as inland primary nursery areas (PNA's) by the NC Wildlife Resources Commission. This designation makes these areas eligible for consideration for designation as HQW. These reclassifications are currently pending internal review. In addition, Phelps Lake is being considered for ORW designation based on a request received from the Division of Parks and Recreation. All of these potential reclassifications are listed below:

Waterbody	County	From Class	To Class
Broad Creek	Camden	SC	SC HQW
Deep Creek	Currituck	SC	SC HQW
East Lake	Dare	SC Sw	SC Sw HQW
Jean Guite Creek	Dare	SC	SC HQW
Little Alligator River	Tyrrell	SC Sw	SC Sw HQW
Lutz Creek	Currituck	SC	SC HQW
Phelps Lake	Washington	C Sw	C Sw ORW
Tull Creek and Bay	Currituck	B Sw, C Sw	B Sw HQW, C Sw HQW

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

FUTURE INITIATIVES IN THE PASQUOTANK RIVER BASIN

USE RESTORATION WATERS

The North Carolina Division of Water Quality is currently developing the Use Restoration Waters (URW) program to restore surface waters to their designated uses. If adopted, this program will allow the state to work with local governments, businesses, and residents to develop management strategies appropriate for the area. In order to be effective, the URW program will include a mix of voluntary and mandatory programs. The voluntary and mandatory programs will be coordinated on a watershed-specific basis by DWQ and a group of stakeholders who have an interest in the impaired water body and associated watershed. In addition, the URW program will attempt to develop cooperative relationships among these agencies so that overlapping efforts can be consolidated and targeted to restore designated water body uses.

WETLANDS RESTORATION

The NC General Assembly has established a wetland restoration program in this state. North Carolina is beginning a concentrated effort to inventory and digitally map wetlands throughout the state. As the program progresses, a restoration plan will be developed for each river basin and incorporated into the basinwide planning process. Through this, the water quality protection function of wetlands can be used more effectively in areas prioritized during basinwide planning.

NONPOINT SOURCE TEAMS

DWQ has begun setting up nonpoint source teams in each of the state's 17 major river basins. One has been set up for the Pasquotank Basin and will be reconvened in the near future. These teams will have representatives from agriculture, urban stormwater, construction, mining, on-site wastewater disposal, forestry, solid waste, wetlands, groundwater, local governments and other interested organizations. These teams will provide descriptions of NPS activities within a basin, conduct assessments of NPS controls in targeted watersheds, identify future monitoring sites, develop five-year action plans for priority NPS issues and NPS watersheds, and develop Section 319 project proposals for priority watersheds.

REGIONAL COUNCILS

The Comprehensive Conservation and Management Plan (CCMP) for the Albemarle/Pamlico (A/P) Sounds region recommended that regional councils be formed in each of the A/P region's five river basins. An Executive Order was signed by Governor Hunt in April 1995 calling for the establishment of the five regional councils. The Neuse Basin Regional Council was the first formed (November 1995). The other four, including one for the Pasquotank, are currently being established.

Each council will include local government representation (one municipal and one county rep from each county in the basin) as well as representation from non-governmental stakeholder groups in each basin. The groups would have the potential to help target and address the water quality and resources issues of greatest concern to stakeholders in the basin and to forge the link between the APES program, the CCMP and basinwide planning.

IMPROVED MONITORING AND INTERAGENCY COORDINATION

DWQ has been discussing with other environmental agencies the potential for coordination of field resources. If individuals from another environmental agency are visiting certain streams or rivers or lakes to investigate fish populations or wetland areas, they could also collect water quality data from that area.

FURTHER EVALUATION OF SWAMP SYSTEMS

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

GENERAL NPDES PROGRAM INITIATIVES

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

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

Longer-term objectives will include refining overall management strategies after obtaining feedback on current management efforts during the next round of water quality monitoring.

Long-term point source control efforts will stress reduction of wastes entering wastewater treatment plants, seeking more efficient and creative ways of recycling byproducts of the treatment process (including nonpotable reuse of treated wastewater), and keeping abreast of and recommending the most advanced wastewater treatment technologies.

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

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

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

This Plan presents strategies for management of both point and nonpoint sources of pollution. The Division of Water Quality (previously Division of Environmental Managment) is preparing a basinwide water quality management plan for each of the state's 17 major river basins, as shown in Figure 1.1.

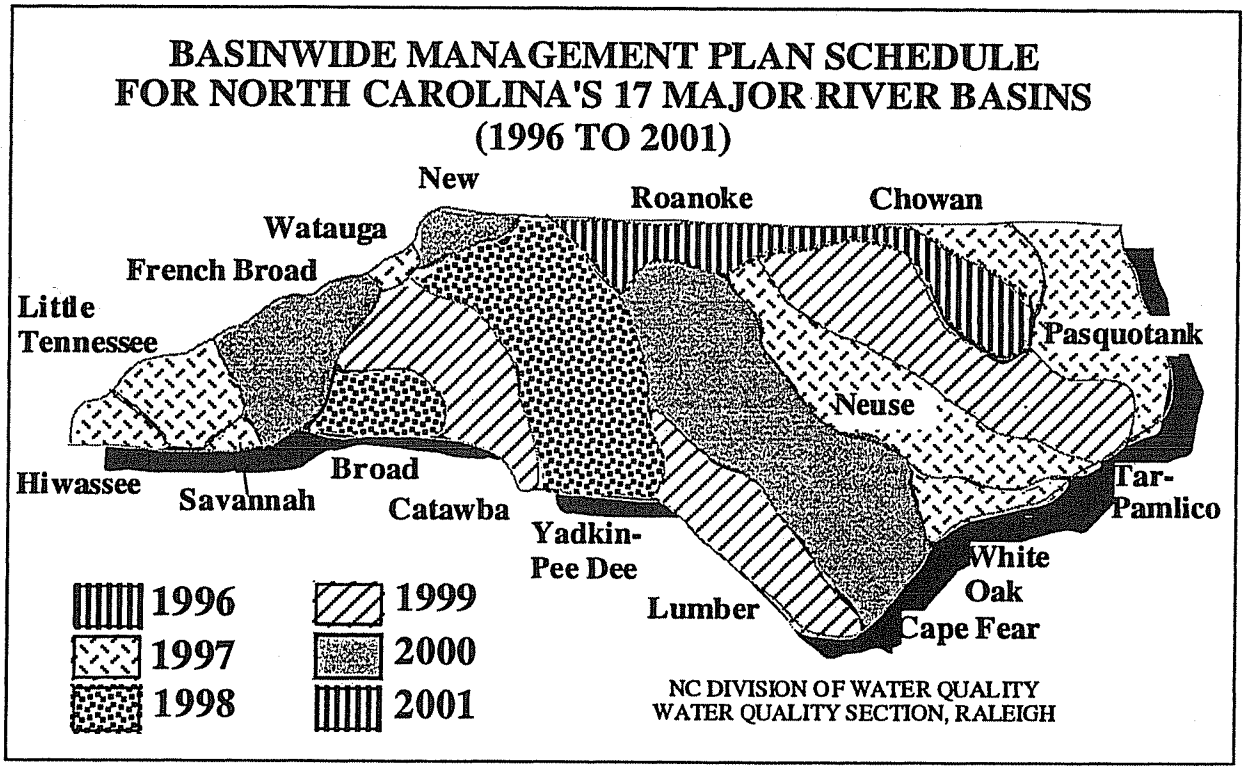

Figure 1.1 Basinwide Management Plan Schedule (1996 to 2001)

1.2 GUIDE TO USE OF THIS DOCUMENT

CHAPTER 1: Introduction - This chapter provides a non-technical description of the purpose of this plan, the basinwide water quality management approach and how this approach will be administered. The description of the basinwide management approach is based primarily on a 54-page framework 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- Some of the specific topics covered in this chapter include:

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

CHAPTER 3: Causes and Sources of Water Pollution - This chapter describes both point and nonpoint sources of pollution. It also describes a number of important causes of water quality impacts including sediment, biochemical oxygen demand (BOD), toxic substances, nutrients, color, fecal coliform bacteria and others. Pollutant loading in the basin and general water quality problem areas are discussed.

CHAPTER 4: Water Quality and Use Support Ratings - This chapter describes the various types of water quality monitoring conducted by DWQ, summarizes water quality in each of the subbasins in the basin and presents a summary of use support ratings for those surface waters that have been monitored or evaluated.

CHAPTER 5: Existing Water Quality Programs and Program Initiatives in the Basin - Chapter 5 summarizes the existing point and nonpoint source control programs available to address water quality problems. These programs are management tools available for addressing the priority water quality concerns and issues that are identified in Chapter 6. Chapter 5 also describes the concept of Total Maximum Daily Loads (TMDLs). TMDLs represent management strategies aimed at controlling point and nonpoint source pollutants. This chapter also describes various program initiatives being implemented in the basin to address water quality problems.

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

CHAPTER 7: Future Initiatives - This chapter presents future initiatives for protecting or improving water quality in the basin. These may include both programatic initiatives such as improving permit compliance, or basin-specific initiatives such as developing strategies for restoring impaired waters.

1.3 NORTH CAROLINA'S BASINWIDE MANAGEMENT APPROACH

Introduction - Basinwide water quality management is a watershed-based management approach being implemented by DWQ which features basinwide permitting, integrating existing point and nonpoint source control programs, and preparing basinwide management plans. DWQ is applying this approach to each of the seventeen major river basins in the state as a means of better identifying water quality problems, developing appropriate management strategies, maintaining and protecting water quality and aquatic habitat, and assuring equitable distribution of waste assimilative capacity for dischargers.

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

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

Water Quality Program Benefits - Several benefits of basinwide planning and management to North Carolina's Water quality program include:

- ***Improved program efficiency.*** By reducing the area of the state covered each year, monitoring, modeling, and permitting efforts can be focused. As a result, *efficiency increases* can be achieved for a given level of funding and resource allocation.
- ***Increased effectiveness.*** The basinwide approach is in consonance with basic ecological watershed management principles, leading to *more effective* water quality assessment and management. Linkages between aquatic and terrestrial systems are addressed (e.g., contributions from nonpoint sources). All inputs to aquatic systems and potential interactive, synergistic and cumulative effects are considered.
- **Better *consistency and equitability*.** By clearly defining the program's long-term goals and approaches, basinwide plans will encourage *consistent* decision-making on permits and water quality improvement strategies. Consistency and greater attention to long-range planning will promote a *more equitable* distribution of assimilative capacity, explicitly addressing the trade-offs among pollutant sources and allowances for economic growth.
- ***Increased public awareness of the state's water quality protection programs.*** The basinwide plans are an educational tool for increasing public awareness of water quality issues within the basin.
- **Basinwide management promotes *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 water quality standards.

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

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

Basin	Begin NPDES Permit Issuance	*Final Plan Receives EMC Approval	Public Mtgs. and Draft out For Review	EMC/WQC Approval For Public Meetings	Inhouse Draft due for Staff Review	DEM Biological Data Collection
Neuse	4/1993	**2/1993**	11/1992	9/1992	7/1992	Summer 91
Lumber	11/1994	**6/1994**	2/1994	11/1993	7/1993	Summer 91
Tar-Pamlico	1/1995	**12/1994**	9/1994	7/1994	5/1994	Summer 92
Catawba	4/1995	**2/1995**	11/1994	9/1994	7/1994	Summer 92
Fr. Broad	8/1995	**5/1995**	2/1995	12/1994	10/1994	Summer 92
New	11/1995	**7/1995**	6/1995	4/1995	3/1994	Summer 93
Cape Fear	1/1996	**9/1995**	6/1995	5/1995	4/1995	Summer 93
Roanoke	1/1997	**9/1996**	4/1996	2/1996	9/1995	Summer 94
White Oak	6/1997	**2/1997**	9/1996	7/1996	4/1996	Summer 94
Savannah	8/1997	**5/1997**	2/1997	12/1996	6/1996	Summer 94
Watauga	9/1997	**4/1997**	12/1997	10/1996	6/1996	Summer 94
Little Tenn.	10/1997	**5/1997**	2/1997	12/1996	7/1996	Summer 94
Hiwassee	12/1997	**5/1997**	2/1997	12/1996	7/1996	Summer 94
Chowan	1/1998	**9/1997**	6/1997	3/1997	11/1996	Summer 95
Pasquotank	2/1998	**9/1997**	6/1997	3/1997	11/1996	Summer 95
Neuse	4/1998	12/1997	7/1997	5/1997	2/1997	Summer 95
Yadkin	7/1998	2/1998	10/1997	5/1997	2/1997	Summer 96
Broad	11/1998	5/1998	2/1998	12/1997	7/1997	Summer 95
Lumber	11/1999	5/1999	2/1999	12/1998	8/1998	Summer 96
Tar-Pamlico	1/2000	5/1999	2/1999	12/1998	5/1998	Summer 97
Catawba	4/2000	10/1999	6/1999	4/1999	12/1998	Summer 97
Fr. Broad	8/2000	2/2000	10/1999	7/1999	3/1999	Summer 97
New	11/2000	5/2000	2/2000	12/1999	8/1999	Summer 98
Cape Fear	1/2001	7/2000	2/2000	12/1999	8/1999	Summer 98
Roanoke	1/2002	7/2001	2/2001	12/2000	8/2000	Summer 99

* Dates in bold print denote plan approval by the EMC

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

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

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

Year	**Activity**
Year 1 to 3	Water Quality Data Collection/Identification of Goals and Issues: Year 1 entails identifying sampling needs and canvassing for information. It also entails coordinating with other agencies, the academic community and local interest groups to begin establishing goals and objectives and identifying and prioritizing problems and issues. Biomonitoring, fish community and tissue analyses, special studies and other water quality sampling activities are conducted in Years 2 and 3 by DWQ's Environmental Sciences Branch (ESB). These studies provide information for assessing water quality status and trends throughout the basin and provide data for computer modeling.
Year 3 to 4	Data Assessment and Model Preparation: Modeling priorities are identified early in this phase and are refined through assessment of water quality data from the ESB. Data from special studies are then used by DWQ's Technical Support Branch (TSB) to prepare models for estimating potential impacts of waste loading from point and nonpoint sources using the TMDL approach. Preliminary water quality control strategies are developed based on modeling, with input from local governments, the regulated community and citizen groups during this period.
Year 4	Preparation of Draft Basinwide Plan: The draft plan, which is prepared by DWQ's Planning Branch, is due for completion by the end of year 4. It is based on support documents prepared by DWQ's Environmental Sciences Branch (water quality data) and the Technical Support Branch (modeling data and recommended pollution control strategies). Preliminary findings are presented at informal meetings through the year with local governments and interested groups, and comments are incorporated into the draft.
Year 5	Public Review and Approval of Plan: At the beginning of year 5, the draft plan, after approval of the Environmental Management Commission (EMC), is circulated for review and public meetings are held. Revisions are made to the document, based on public comments, and the final document is submitted to the EMC for approval midway through year 5. Basinwide permitting begins at the end of year 5.

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

Nonpoint source management proposals will be implemented by several different avenues. The Water Quality Section is setting up nonpoint source (NPS) teams for each basin. These teams are made up of representatives of nonpoint source agencies, resource agencies, and special interest groups. The NPS teams are responsible for prioritizing specific watersheds for follow-up investigations, educational efforts, and best management practice (BMP) implementation. Funding for BMP implementation will be sought from sources such as existing cost-share monies or from federal Section 319 grants. In addition to projects in specific watersheds, the NPS team will develop programmatic action plans for each category of nonpoint source pollution. The action plans detail voluntary actions that agencies and groups have committed to complete to protect and improve water quality in the basin. Many of the action plan items involve increased educational efforts or enforcement of existing programs.

1.4 BASINWIDE RESPONSIBILITIES WITHIN THE DWQ WATER QUALITY SECTION

The Division of Water Quality is the lead state agency for the regulation and protection of the state's surface waters. The Division is comprised of four sections: Water Quality, Groundwater, Construction Grants and Loans, and the Water Quality Laboratory.

The primary responsibilities of the Division of Water Quality are to maintain or restore an aquatic environment to 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 Division receives both state and federal allocations as well as funding through permit fee collections. Policy guidance is provided by the Environmental Management Commission. The major areas of responsibility are water quality monitoring, permitting, planning, modeling (wasteload allocations) and compliance oversight.

The Central office is divided into five branches, each branch is subdivided into units (Figure 1.2). The Planning Branch is responsible for developing surface water quality standards and classifications, nonpoint source program planning, administering the basinwide management program, modeling nonpoint pollution sources, developing use support ratings and supporting related GIS capabilities. It also coordinates the development of TMDLs and wasteload allocations for dischargers, provides primary computer modeling support, and coordinates EPA water quality planning grants and the implementation of the Comprehensive Conservation and Management Plan (CCMP) that resulted from the Albemarle-Pamlico Estuarine Study (APES).

The Regional Program Management Coordination Branch is responsible for providing increased communication and coordination of the water quality program. The responsibilities include the water supply watershed protection program, State Environmental Policy Act coordination for the Section, the operator training and certification program, emergency response, the development and administration of the enterprise wide database management system, and coordination and program management activities between the central and seven regional offices. The Environmental Technologies Unit is responsible for providing better access to data managed by the Water Quality Section so as to facilitate information exchange and analysis with the public as well as internal users. The Technical Assistance and Certification Unit rates the complexity of operation of wastewater treatment plants, provides training and operator certification commensurate with the plant operating needs, and provides technical assistance as requested by wastewater treatment systems. The Local Government Assistance Unit assists local governments in meeting the requirements of the water supply watershed protection program, managing the collection system permitting program, coordinating water quality state environmental policy act responsibilities and managing the EPA 205(j) grants program. The Branch also has the responsibility of ensuring program coordination through the seven Regional Offices.

The Environmental Sciences Branch is responsible for all biological and chemical water quality monitoring, discharger coalition water quality monitoring, and evaluations including benthic macroinvertebrate monitoring (biomonitoring), fish tissue, and fish community studies. The Branch is also responsible for effluent toxicity testing and evaluations, biological laboratory certification, algal and aquatic macrophyte analyses, long term biochemical and sediment oxygen demand, and lakes assessments. The Branch interacts heavily in 305(b) use-support assessments and in water quality standards review and development. The Neuse River Rapid Response Team is coordinated through the Environmental Sciences Branch. The Branch is in the process of developing simplified public access to water quality information via the World Wide Web.

The Point Source Branch is responsible for permitting, compliance and enforcement of wastewater discharges into our state's surface waters. Permitting and enforcement programs include the municipal industrial pretreatment program, state and federal stormwater programs, and the National

Pollutant Discharge Elimination System (NPDES) program. Modeling is conducted to determine the receiving stream's ability to assimilate the discharge and protect the streams uses and surface water standards.

The Non-discharge Branch is responsible for permitting, compliance and enforcement of wastewater discharges that are **not** directly into our state's surface waters. Examples of these include spray irrigation systems, sludge applications, reuse systems and groundwater remediation projects. This branch also handles the section's activities related to wetlands including 401 certifications, wetland policy and mitigation, and DOT and dredging project reviews.

The seven Regional Offices carry out activities such as wetland reviews, compliance evaluations, permit reviews and facility inspections for both discharging and nondischarging systems, ambient water quality monitoring, state environmental policy act reviews, stream reclassification reviews, pretreatment program support and operator training and certification assistance. In addition, they respond to water quality emergencies such as oil spills and fish kills, investigate complaints and provide information to the public. Figure 1.3 shows the location of the regional offices and the counties that they serve.

REFERENCES CITED: CHAPTER 1

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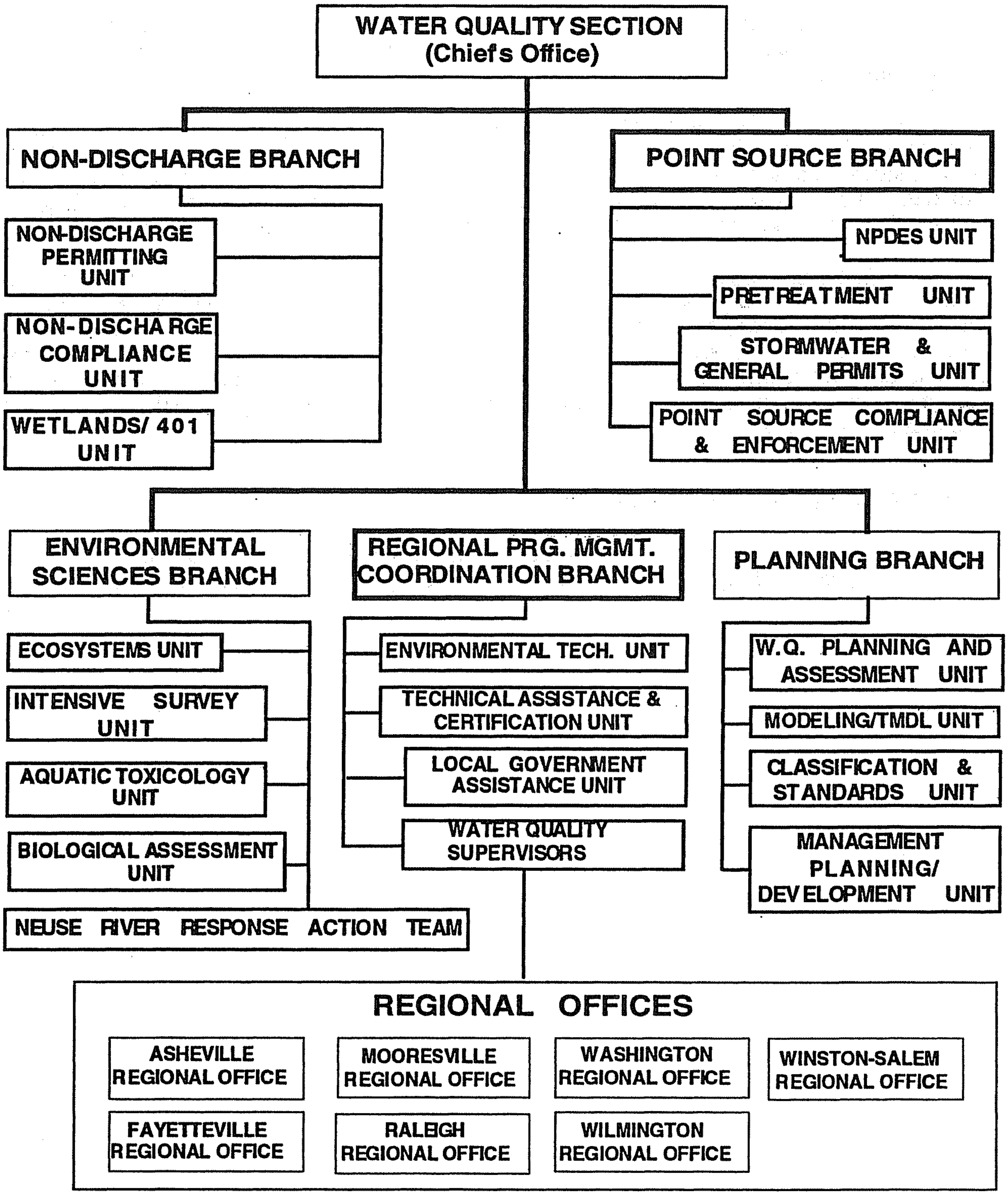
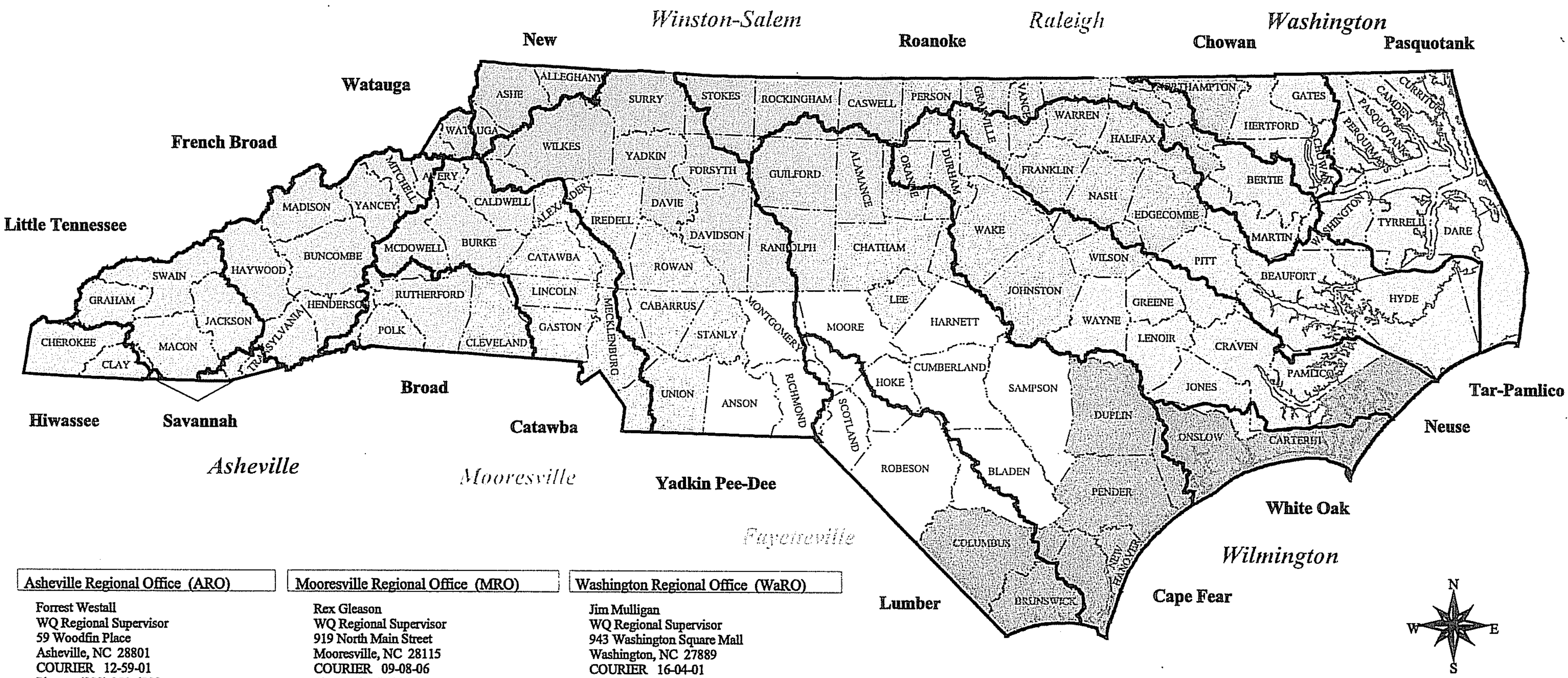


Figure 1.2 Organizational Structure of the DWQ Water Quality Section

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



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NCDENR

Planning Branch
Basinwide Planning Program Unit
August 1, 2002

CHAPTER 2

GENERAL BASIN DESCRIPTION

2.1 PASQUOTANK BASIN OVERVIEW

The Pasquotank River basin encompasses 3,697 square miles of low-lying lands and vast open waters, including Albemarle Sound, in the state's northeast outer coastal plain. It includes all or portions of Camden, Currituck, Dare, Gates, Hyde, Pasquotank, Perquimans, Tyrrell and Washington counties. It contains numerous small watersheds that drain into Albemarle, Currituck, Croatan, Roanoke and Pamlico sounds. One of these watersheds is the Pasquotank River for which the basin is named. A small portion of the basin extends up into Virginia. Figure 2.1 illustrates the boundary of the whole basin in both states. Figure 2.2 provides a more detailed map of that portion of the basin that is within North Carolina.

The Albemarle Sound is a large fresh to brackish estuarine waterbody in northeastern North Carolina. Major tributaries are the Chowan, Roanoke, North, Pasquotank, Little, Perquimans, Scuppernong, and Alligator rivers. Salinities in the Albemarle Sound are low due to dilution from the large inflow of freshwater relative to the sound's volume. Likewise, the large inputs of freshwater from the Chowan and Roanoke rivers into the sound result in a relatively short retention time.

Major tributaries on the northwestern side of Albemarle Sound are the Pasquotank, Little and Perquimans rivers. The Pasquotank River below Elizabeth City is estuarine and fresh above. The Little River is a slow-flowing coastal stream. The Perquimans River originates in the Great Dismal Swamp and flows south before emptying into Albemarle Sound. The largest town in its watershed is Hertford. Land use in the area is mainly agriculture with widespread use of drainage canals.

On the southeastern side of Albemarle Sound are the Alligator and Scuppernong Rivers. The Alligator River is a large blackwater river, with a surface area of 64,000 acres that has been designated as Outstanding Resource Waters. It is remote from any urban areas and is bordered by wooded swamps and pocosins. The Alligator River National Wildlife Refuge extends along the entire eastern shore of the river. The river's outstanding resource is its function as a major spawning area for anadromous fish, principally river herring, and the national wildlife refuge. The Scuppernong River watershed is mainly forested wetlands and agriculture with widespread use of canals which drain wetlands.

Currituck Sound is a shallow, fresh to brackish estuarine waterbody in the northeastern portion of the basin whose circulation is influenced largely by wind movement. In the past, Currituck Sound was a viable large mouth bass fishery and waterfowl hunting ground. A vast marsh area bordering a large portion of the Currituck Sound serves as a critical part of the Atlantic Flyway for migratory waterfowl. Thousands of wintering ducks, geese and swans contribute to the sound's reputation for waterfowl hunting. The Northwest River is a major tributary of Currituck Sound. It receives drainage from number of canals leading out of the Great Dismal Swamp. Most of the waters in this subbasin are estuarine, including Currituck Sound and the North River.

CURRITUCK SOUND AND PASQUOTANK RIVER/ALBEMARLE SOUND DRAINAGE BASIN

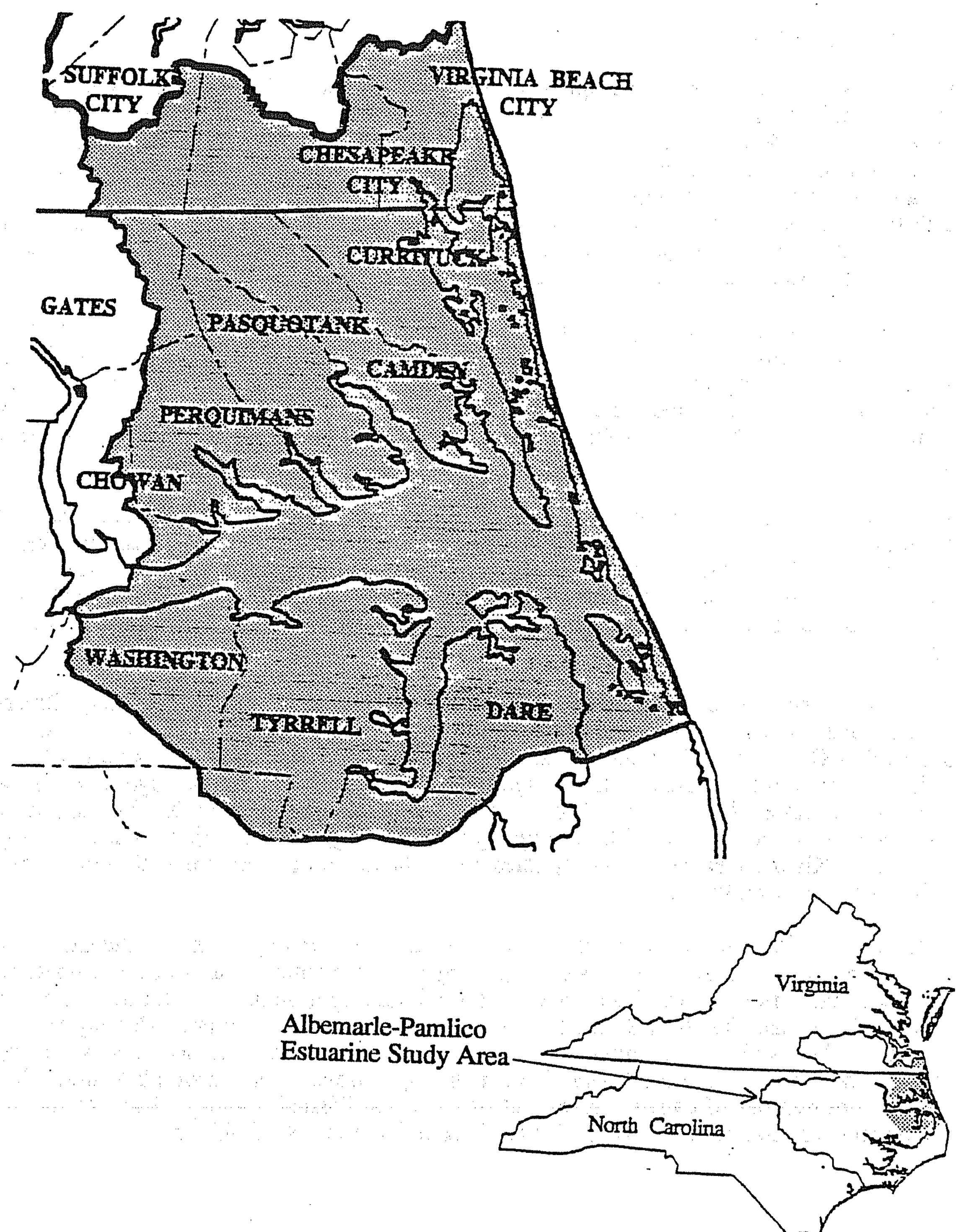

Figure 2.1. Map Showing Pasquotank River Basin Boundary in North Carolina and Virginia (Source: APES Comprehensive Conservation and Management Plan, 1994) *NOTE: Lower portion of the basin boundary does not correspond to DWQ's basin boundary. These represent the basin's lines as used in the APES study.*

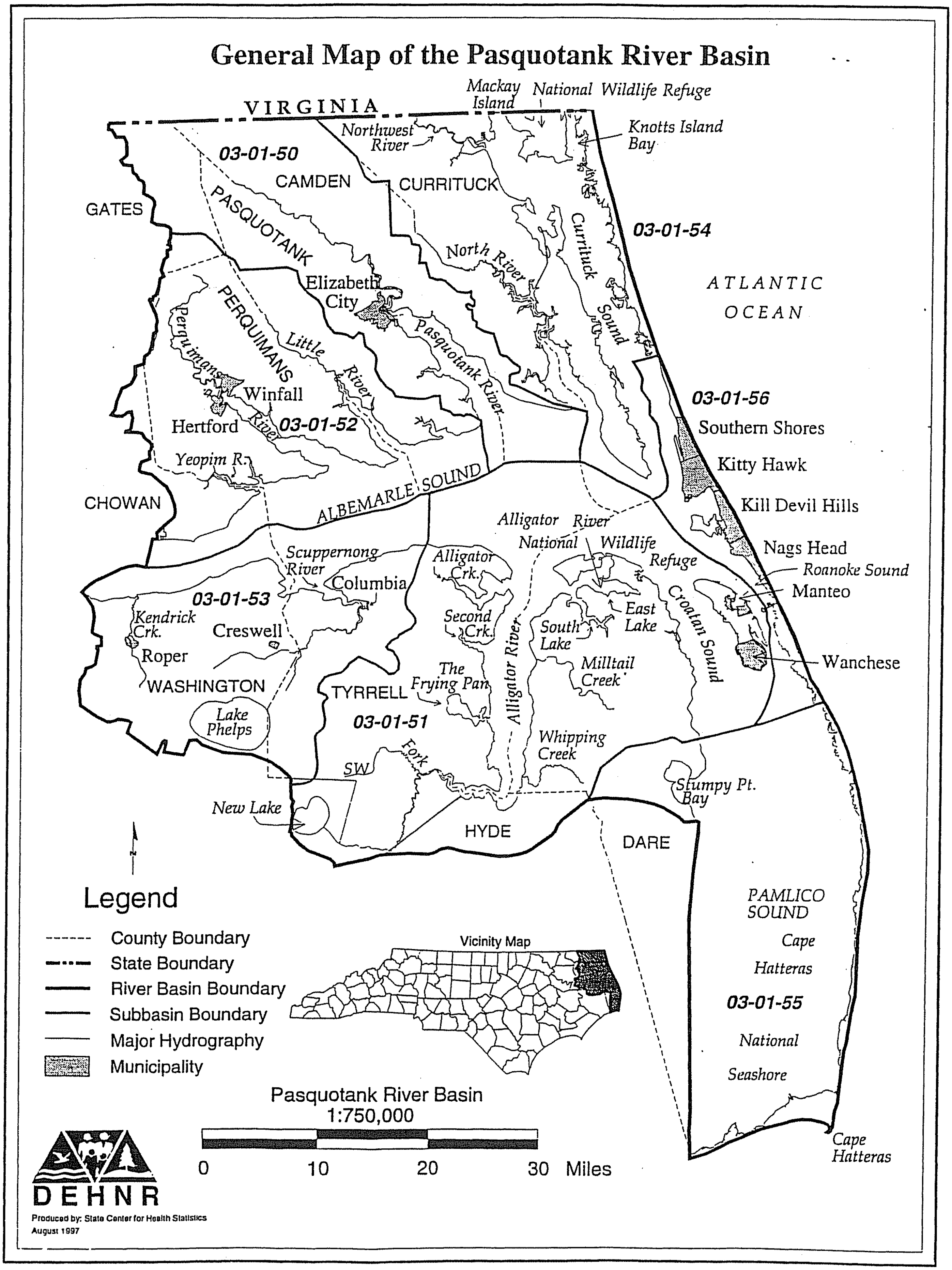

Figure 2.2. General Map of the Pasquotank River Basin in North Carolina

The Pasquotank River basin also includes waters along the Outer Banks south of Currituck Sound, including Roanoke Sound, Croatan Sound and Pamlico Sound from Oregon Inlet to Hatteras Inlet. Roanoke Island, with the cities of Manteo and Wanchese, and the Outer Banks from Nags Head to Southern Shores are the most developed areas. Land use in these areas is primarily residential and commercial. All waters in this subbasin are estuarine, with the exception of a few small lakes in the maritime forest of the outer banks. Much of the area lies within the Cape Hatteras National Seashore and Pea Island Wildlife Refuge.

The Pasquotank River basin is part of the Albemarle-Pamlico Estuarine system, the second largest estuarine system in the United States. In 1987 this estuarine system became part of the Environmental Protection Agency's National Estuary Program and was the subject of a major study known as the Albemarle-Pamlico Estuarine Study (APES). The results of research conducted as part of APES culminated in the Comprehensive Conservation and Management Plan (CCMP) which is currently being implemented, and is discussed further in Chapters 5 and 6. Basinwide management is part of this implementation.

Land cover data generated under APES revealed that 42% of the basin was open water. This was followed by agriculture (21%), wetlands (18%) and forest (17%).

Based on data from the US Department of Agriculture Natural Resources Conservation Service (NRCS), land cover changes from 1982 and 1992 showed a 58% increase in the amount of urban/built-up land, and a 67% increase in pastureland.

The Pasquotank River basin has an estimated population of 97,215 people based on 1990 census data. Population density for the basin is 46 persons/square mile. However, in Elizabeth City and the Kill Devil Hills/Nags Head area of the outer banks it is 305 persons/square mile. The coastal areas, particularly around Nags Head, Kitty Hawk and Kill Devil Hills, have experienced tremendous growth in the twenty years between 1970 and 1990. According to figures from the NC Department of Administration, the counties of Currituck and Dare (which encompass the coastal area) are anticipated to experience 56% and 128% levels of population growth respectively from 1990 into the year 2020.

Water use in the basin comes from both surface and ground water sources, but the vast majority (94%) comes from ground water sources. From 1992 to the year 2020, water use is expected to rise significantly, growing by 89%.

2.2 COMPARISON OF STATE AND FEDERAL HYDROLOGIC AREAS IN THE PASQUOTANK BASIN

Most federal government agencies, including the US Geological Survey and the US Natural Resources Conservation Service (NRCS) use a system of defining watersheds that is different from that used by the Division of Water Quality (DWQ) and many other state agencies in North Carolina. DWQ has a two-tiered system in which the state is subdivided into 17 river basins, and each basin is subdivided into subbasins. The Pasquotank River basin is subdivided by DWQ into seven subbasins. These subbasins (030150 through 030156) are numbered on the general map of the basin (Figure 2.2).

By contrast, a nationally uniform hydrologic unit system was developed in 1974 by the US Geological Survey's Office of Water Data Coordination (USDA, NRCS, Nov. 1995). This system divides the country into 21 regions, 222 sub-regions, 352 accounting units and 2,149 cataloging units based on surface hydrologic features. Under the federal system, the North Carolina portion of the Pasquotank basin is divided into two hydrologic areas referred to as cataloging units. Each cataloging unit is defined by an 8-digit number. Subbasins 50 through 54 and 56 of the Pasquotank River Basin in North Carolina are contained in one cataloging unit with the number 03010205. However, subbasin 55 which extends along the outer banks and encompasses the Pamlico Sound adjacent to the outer banks down to Cape Hatteras falls into

USGS cataloging unit 03020105. This cataloging unit covers all of the Pamlico Sound and some adjacent land areas including the outer banks. Table 2.1 presents the relationship between the state and federal hydrologic areas.

Table 2.1. Hydrologic Divisions in the Pasquotank River Basin

Watershed Name and Major Tributaries	Federal Cataloging Unit. 8-digit Hydrologic Units	DWQ Subbasin 6-digit codes Figure 2.2
Pasquotank River watershed	03010205	030150
Alligator River watershed and Croatan S.	" "	030151
Perquimans, Little and Yeopim Rivers	" "	030152
Scuppernong River and Phelps Lake	" "	030153
Currituck Sound and North River	" "	030154
Roanoke Sound and surrounding areas	" "	030156
Pamlico Sound and Outer Banks	03020105	030155

These comparisons are presented to aid in the interpretation of land cover data summaries in Section 2.4. That section presents land cover information developed by the US NRCS which is summarized for each of the two cataloging units in the basin.

2.3 LOCAL GOVERNMENT AND PLANNING JURISDICTIONS

The basin encompasses all or parts of Camden, Chowan, Currituck, Dare, Pasquotank, Perquimans, Tyrrell and Washington counties and 12 municipalities as presented in Table 2.2. Also included in the table are abbreviations for the Lead Regional Organizations (Council of Governments) and Districts of the North Carolina League of Municipalities.

Table 2.2. Local Governments and Local Planning Units within the Pasquotank River Basin

County	% of county in basin*	Lead Regional Organization	NC League of Munic. Dist.	Municipality
Camden	100%	R	I	Elizabeth City
Chowan	10%	R	I	none in Pasquotank basin
Currituck	100%	R	I	none
Dare	95%	R	I	Kill Devil Hills Kitty Hawk **Manteo** Nags Head Southern Shores
Gates	40%	R	I	none in Pasquotank basin
Pasquotank	100%	R	I	**Elizabeth City**
Perquimans	100%	R	I	**Hertford** Winfall
Tyrrell	100%	R	I	**Columbia**
Washington	60%	R	I	Creswell Roper

*percentages are approximate **bold** denotes county seat
Region R = Albemarle Regional Planning and Development Commission

2.4 LAND COVER, POPULATION AND GROWTH TRENDS

2.4.1 General Land Cover

There are two sources of data used in this section to characterize land cover in the Pasquotank basin. The first set of data is derived from interpretation of 1987 LANDSAT satellite data made available through the North Carolina Center for Geographic Information and Analysis (CGIA) and Research Triangle Institute. The second is the US Department of Agriculture (USDA), Natural Resources Conservation Service's (NRCS) National Resources Inventory (NRI) of 1992 and 1982 (USDA, 1994).

Both sets are presented because they provide different windows into land use in the basin. Each data set subdivides land covers differently and provides snapshots of different years. The NRI data provides the opportunity to compare changes in land use over a ten year span from 1982 to 1992. The LANDSAT data separates wetlands out as a category and provides an estimate of how much area is covered by them. Both data sets are presented in this report for the complimentary information that they have to offer.

<u>LANDSAT Data</u>
The first land cover source is derived from interpretation of 1987 LANDSAT satellite data. This data 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. The categories are defined below in Table 2.3.

Table 2.3. Land Cover Types Described for LANDSAT Data.

Land Cover Type (No.)	Land Cover Description
1) Agriculture	Agriculture, Bare Soil, Grass and Disturbed Land
2) Urban	Greater than 25% paved surfaces
3) Forest	Pine, Hardwood and Mixed Upland Forest
4) Wetlands	Bottomland Hardwoods, Riverine Swamp, Evergreen Hardwood/Conifer, Atlantic White Cedar Low Pocosin, High Marsh, Low Marsh
5) Scrub	Low Density Vegetation
6) Water	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.

The land cover statistics presented in Table 2.4 are consistent with those from the NRI indicating that the majority of the basin's surface area is covered in water, followed by agriculture and forest. However, it also shows that approximately 18% of the land cover is comprised of wetland areas.

The LANDSAT data have been subdivided according the DWQ subbasins. This provides insight into land cover characteristics for these smaller areas. For example, subbasin 030152 which includes the Perquimans, Yeopim and Little rivers has the most acreage in agriculture. The Alligator River drainage (subbasin 030151) contains the most amount of wetlands and forest.

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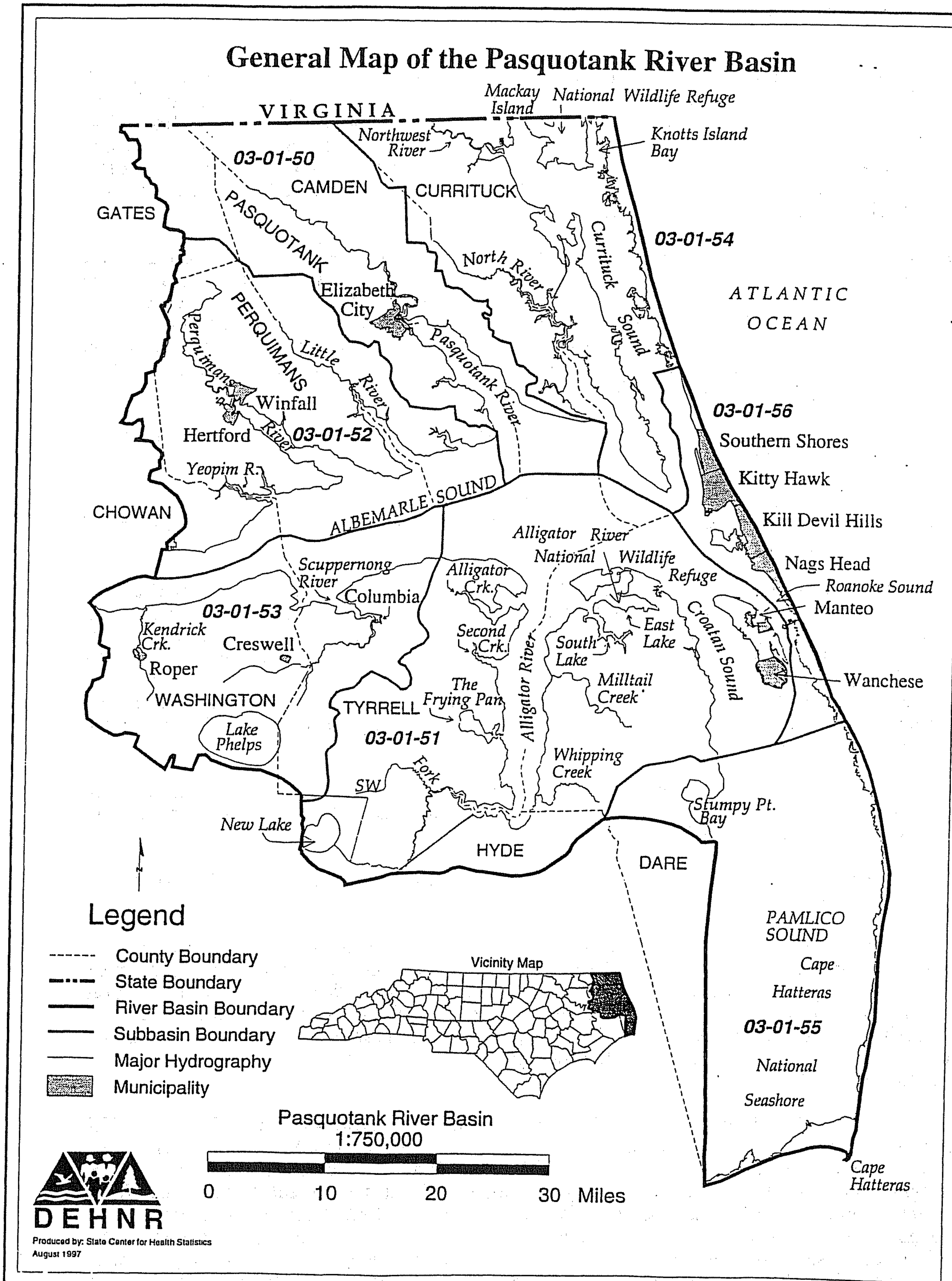

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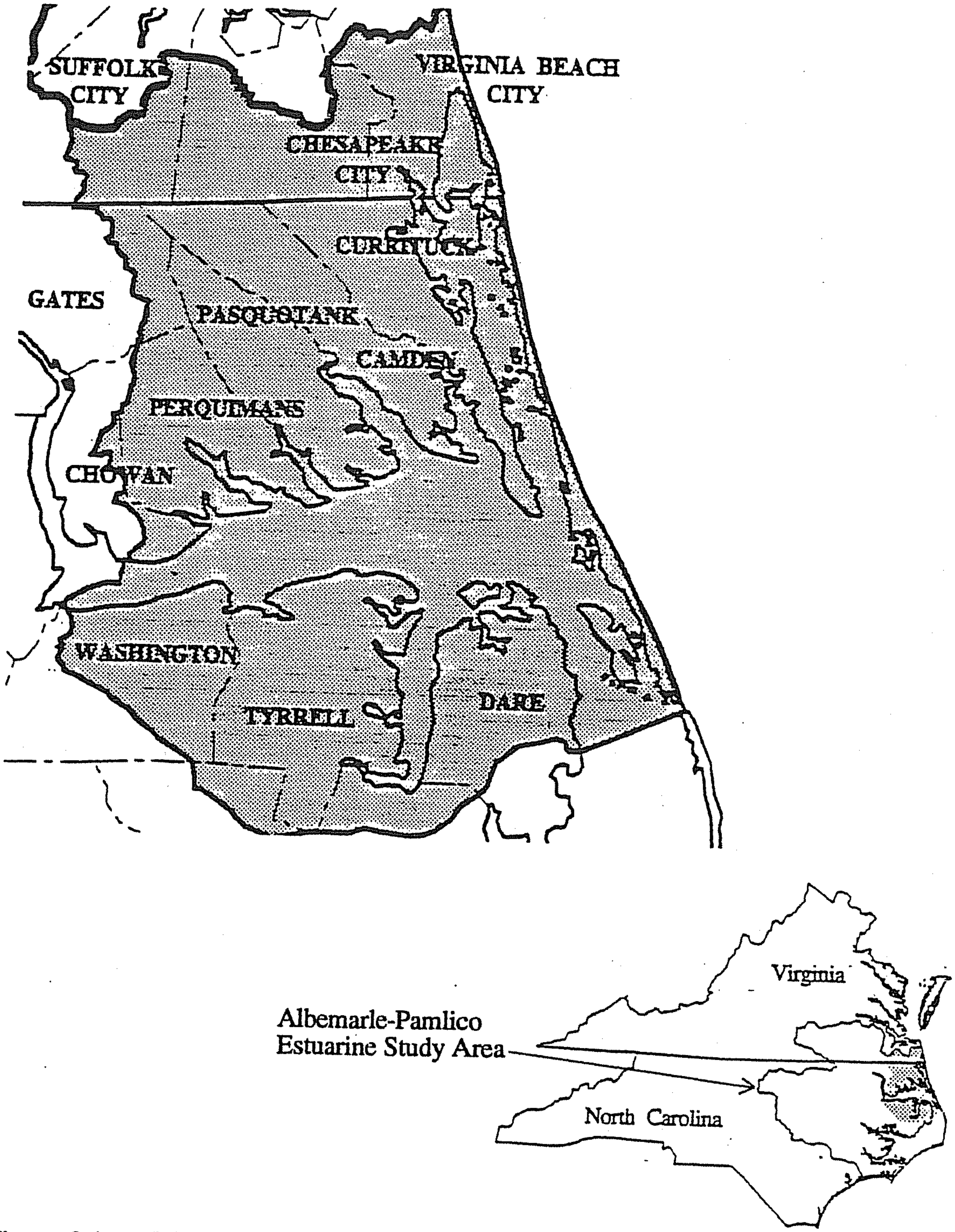
CURRITUCK SOUND AND PASQUOTANK RIVER/ALBEMARLE SOUND DRAINAGE BASIN



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CHAPTER 2

GENERAL BASIN DESCRIPTION

2.1 PASQUOTANK BASIN OVERVIEW

The Pasquotank River basin encompasses 3,697 square miles of low-lying lands and vast open waters, including Albemarle Sound, in the state's northeast outer coastal plain. It includes all or portions of Camden, Currituck, Dare, Gates, Hyde, Pasquotank, Perquimans, Tyrrell and Washington counties. It contains numerous small watersheds that drain into Albemarle, Currituck, Croatan, Roanoke and Pamlico sounds. One of these watersheds is the Pasquotank River for which the basin is named. A small portion of the basin extends up into Virginia. Figure 2.1 illustrates the boundary of the whole basin in both states. Figure 2.2 provides a more detailed map of that portion of the basin that is within North Carolina.

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Table 2.4. Land Cover in the Pasquotank Basin and Subbasins 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 01 50	91,734	42,551	2,714	49,202	52,473	2,254	56	784	*241,768*	*11.0%*
03 01 51	62,742	156,597	397	165,876	244,323	2,528	2,887	2,739	*638,089*	*29.1%*
03 01 52	138,835	58,281	2,221	42,668	95,002	6,870	466	1,155	*345,498*	*15.8%*
03 01 53	93,555	47,420	308	60,572	83,519	4,991	4,760	17	*295,142*	*13.5%*
03 01 54	62,075	43,052	1,286	59,248	107,993	1,805	2,435	735	*278,629*	*12.7%*
03 01 55	5,618	20,882	720	14,359	318,701	510	1,968	134	*362,892*	*16.6%*
03 01 56	2,924	2,611	596	2,647	18,689	208	856	146	*28,677*	*1.3%*
TOTAL ACRES	*457,483*	*371,394*	*8,242*	*394,572*	*920,700*	*19,166*	*13,428*	*5,710*	*2,190,695*	
PERCENTAGES	*20.9%*	*17.0%*	*0.4%*	*18.0%*	*42.0%*	*0.9%*	*0.6%*	*0.3%*	*2,190,695*	*100.0%*

Natural Resources Inventory (NRI) Data

The NRI is a multi-resource national inventory based on soils and other resource data collected at scientifically selected random sample sites. According to the NRCS 1992 NRI Instructions booklet, the 1982 NRI was the most comprehensive study of our nation's natural resources ever conducted. The inventory is considered accurate to the 8-digit cataloging unit scale established by the US Geological Survey (NRCS, 1993). A 1992 update of these data was recently released.

Table 2.5 summarizes acreages and percentage of land cover from the 1992 and 1982 NRI for the two major watershed areas within the basin. One of these areas (USGS cataloging unit 03010205) corresponds to DWQ subbasins 030150 - 54 and 56 and covers the Albemarle and Currituck sounds and all of the areas draining into these water bodies, with the exception of the Chowan and Roanoke drainages. The other area (03020105) encompasses the Pamlico Sound including one subbasin in the Pasquotank basin, but extends beyond the boundaries of the DWQ-defined Pasquotank basin. Therefore, when looking at the numbers for that cataloging unit, it should be recognized that the area is larger than subbasin 55 in the Pasquotank. Comparative statistics between 1982 and 1992 presented in the following discussion are only made using the data from the cataloging unit that covers land within the basin (03010205). Land cover types identified in Table 2.5 by the NRI as occurring in the Pasquotank River basin include cultivated cropland, uncultivated cropland, pastureland, forest land, urban and built-up lands, open water (small water areas and census waters), federal lands and other. These categories are defined in Table 2.6.

Land cover in the basin, as presented in Table 2.5, is dominated by water area. Both hydrologic units described (Pasquotank Basin and Pamlico Sound) have a preponderance of total area covered in water (42% and 60% respectively). After that, the largest percentages of land cover are for cultivated cropland and forest land. There is also a good representation in the amount of federal land ownership which is likely attributable to the numerous National Wildlife Refuges contained in this area.

During the ten year span between 1982 and 1992, some interesting changes in land cover occurred. The numbers for the Pasquotank basin cataloging unit (03010205) indicate that during that ten year period, there was a 191,000 acre (or 297%) increase in the amount of federal land. This occurred as a result of the formation of the Pocosin Lakes National Wildlife Refuge in 1990. The urban/built-up category showed a 58% increase in acreage, and the amount of pastureland was up by 67%. The data also indicate decreases in forest land (down 30%) and cultivated crop land (down 6%). The decline in forest land is misleading in that most of the 204,000 acres of land "lost" can be attributed to the conversion of this privately held land to the 191,000 acre increase in federal land. Most of the forested land still exists, but it is now classified as federal land.

Table 2.5. Estimated Acreage by Broad Land Use for the Pasquotank River Basin in 1992 and 1982. (Source: USDA, NRCS, 1994)

1992 NRI

LAND COVER	Pasquotank Basin 03010205 Acres (1000s)	%	Pamlico Sound 03020105* Acres (1000s)	%	TOTAL ACRES (1000s)	% of TOTAL
Cult. Crop	419.9	18	64.7	6	484.6	15
Uncult. Crop	0	0	0	0	0	0
Pasture	8.5	<1	0	0	805	<1
Forest	468.3	20	132.4	13	600.7	18
Urban/Built-up	59.9	3	11.6	1	71.5	2
Federal	255.8	11	124.1	12	379.9	11
Water	965.11	42	631.6	60	1,596.71	48
Other	130.19	6	79.7	8	209.89	6
Totals	2,307.7	100	1,044.1	100	3,351.8	100
DWQ Subbasins	03-01-50 - 54, & 56		03-01-55			

1982 NRI

LAND COVER	Pasquotank Basin 03010205 Acres (1000s)	%	Pamlico Sound 03020105* Acres (1000s)	%	TOTAL ACRES (1000s)	% of TOTAL
Cult. Crop	446.8	19	66.5	6	513.3	15
Uncult. Crop	1.1	<1	0	0	1.1	<1
Pasture	5.1	<1	0	0	5.1	<1
Forest	672.5	29	170.8	16	843.3	25
Urban/Built-up	37.8	2	5.8	1	43.6	1
Federal	64.4	3	88.3	9	152.7	5
Water	964.6	42	631.4	60	1,596.0	48
Other	115.4	5	81.3	8	196.7	6
Totals	2,307.7	100	1044.1	100	3351.8	100
DWQ Subbasins	03-01-50 - 54, & 56		03-01-55			

*Note: This cataloging unit includes some area outside of the Pasquotank River basin defined by DWQ. Pasquotank subbasin 030155 is contained within the larger area.

Table 2.6. Description of Land Cover Types (1992 NRI - USDA NRCS)

Land Cover Type (No.)	Land Cover Description
1) Cultivated Cropland	Land used for the production of adapted crops for harvest, including row crops, small-grain crops, hay crops, nursery crops, orchard crops, and other specialty crops. The land may be used continuously for these crops or they may be grown in rotation with grasses and legumes.
2) Uncultivated Cropland	Summer fallow, aquaculture in crop rotation, or other cropland not planted (may include cropland in USDA set-aside or similar short-term program).
3) Pastureland	Land used primarily for production of introduced or native forage plants for livestock grazing. This category includes land that has a vegetative cover of grasses, legumes, and /or forbs, regardless of whether or not it is being grazed by livestock.
4) Forest Land	Land at least 10 percent stocked by single-stemmed trees of any size which will be at least 4 meters at maturity, and land bearing evidence of natural regeneration of tree cover and not currently developed for non-forest use. Ten percent stocked, when viewed from a vertical direction, is a canopy cover of leaves and branches of 25 percent or greater. The minimum area for classification of forest land is 1 acre, and the area must be at least 1,000 feet wide.
5) Urban and Built-up Land	Includes airports, playgrounds with permanent structures, cemeteries, public administration sites, commercial sites railroad yards, construction sites, residences, golf courses, sanitary landfills, industrial sites, sewage treatment plants, institutional sites, water control structure spillways and parking lots. Highways, railroads, and other transportation facilities are considered part of this category if surrounded by other urban and built-up areas. Tracts of less than 10 acres that do not meet this category's definitions (e.g., small parks or water bodies) but are completely surrounded by urban and built-up lands are placed in this category.
6) Water	Small Water Areas: Water bodies less than 40 acres in size and streams less than one-half mile wide. Census Water: Large water bodies consisting of lakes and estuaries greater than 40 acres and rivers greater than one-half mile in width.
7) Federal	Lands owned by the Federal government such as National Wildlife Refuges and Cape Hatteras National Seashore.
8) Other:	This category primarily includes rural transportation. Rural Transportation consists of all highways, roads, railroads, and associated rights-of-way outside Urban and Built-up areas; private roads to farmsteads, logging roads; and other private roads (but not field lanes).

2.4.2 Population and Growth Trends in the Basin

The Pasquotank River basin has an estimated population of 97,215 people based on 1990 census data. Table 2.7 presents census data for 1970, 1980, and 1990 for each of the subbasins. It also includes land and water areas and population densities (persons/square mile of land area) by subbasin. The population density for the basin is 46 persons per square mile but is much higher in the Elizabeth City and Kill Devil Hills/Nags Head area (Figure 2.3).

Figure 2.4 shows the percent population growth by subbasin. The coastal areas, particularly around Nags Head, Kitty Hawk and Kill Devil Hills, have experienced tremendous growth in the twenty years between 1970 and 1990. Subbasin 56 showed a 640% increase over that time. According to figures from the NC Department of Administration, the counties of Currituck and Dare (which encompass the coastal area) are anticipated to experience 56% and 128% levels of population growth respectively from 1990 into the year 2020. Another high growth area is Elizabeth City. Between 1990 and 1994, this municipality experienced a 21% increase in population and was the fourteenth fastest growing municipality in North Carolina (Office of State Planning, 1995). The Virginia Beach area, which is just north of Currituck Sound and influences the northeastern part of North Carolina, has been identified as a 'high growth' area (Holman, 1993), with projections showing continued high rates of growth over the next 20 years.

In using these data, it should be noted that the population figures are estimates because the census block group boundaries do not generally coincide with subbasin boundaries. The census data are collected within boundaries such as counties and municipalities. By contrast, the subbasin lines are drawn along natural drainage divides separating watersheds. Therefore, where a census block group straddles a subbasin line, an estimate has to be made on the percentage of the population that is located in the subbasin. This is done by simply determining the percentage of the census block group area located in the subbasin and then taking that same percentage of the total census block group population and assigning it the subbasin. Use of this method necessitates assuming that population density is evenly distributed throughout a census block group, which is not always the case. However, the level of error associated with this method is not expected to be significant for the purposes of this document. It is also important to note that the census block groups may change for each census so comparisons between years must be considered approximate.

2.5 AGRICULTURAL ACTIVITIES IN THE PASQUOTANK RIVER BASIN

Agriculture is an important industry in portions of the Pasquotank River basin. Based on a 1995 report from the North Carolina Department of Agriculture, there are a total of 707 farms in counties that lie within the Pasquotank River Basin (see Table 2.8). These farms comprise a total of 311,504 acres with the overall average farm size for all of the counties being 473 acres. In 1993, cash receipts for agricultural products in these counties, including both livestock and crop production, totaled $342,583,000. The following sections focus more specifically on livestock operations and crop production in the Pasquotank basin.

Table 2.7. Pasquotank Subbasin Population (1970, 1980 and 1990) and Land Area Summaries

SUBBASIN	POPULATION (Number of Persons)			POPULATION CHANGE (%)			POPULATION DENSITY (Persons/Square Mile)			LAND AND WATER AREAS			
										Total Land and Water Area		Water Area	Land Area
	1970	1980	1990	1970-80	1980-90	1970-90	1970	1980	1990	(Acres)	(Sq. Miles)	(Sq. Miles)	(Sq. Miles)
03-01-50	28,271	29,867	31,369	6	5	11	72	77	80	291,066	455	64	390
03-01-51	5,287	6,220	9,240	18	49	75	9	11	16	625,919	978	410	568
03-01-52	13,603	15,217	18,399	12	21	35	34	38	46	346,203	541	142	399
03-01-53	8,190	8,782	8,836	7	1	8	24	26	26	304,012	475	139	336
03-01-54	8,320	12,525	14,653	51	17	76	27	41	48	322,062	503	199	304
03-01-55	1,763	3,801	3,436	116	-10	95	18	40	36	367,331	574	478	96
03-01-56	1,524	4,807	11,282	215	135	640	41	130	305	70,010	109	72	37
Totals	66,958	81,219	97,215	21	20	45	31	38	46	2,326,603	3,635	1,504	2,130

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

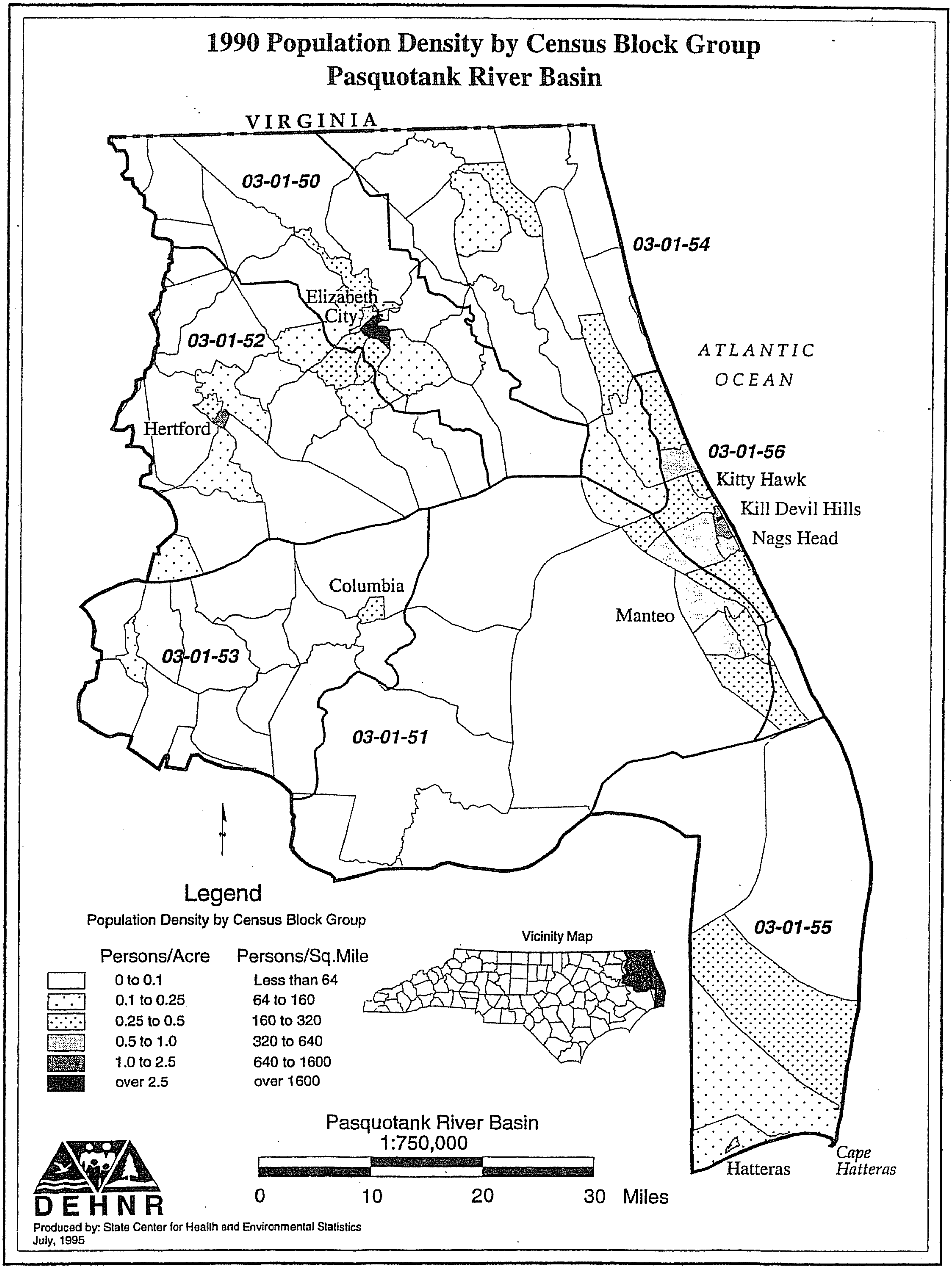

Figure 2.3. 1990 Population Density by Census Block Group for the Pasquotank River Basin

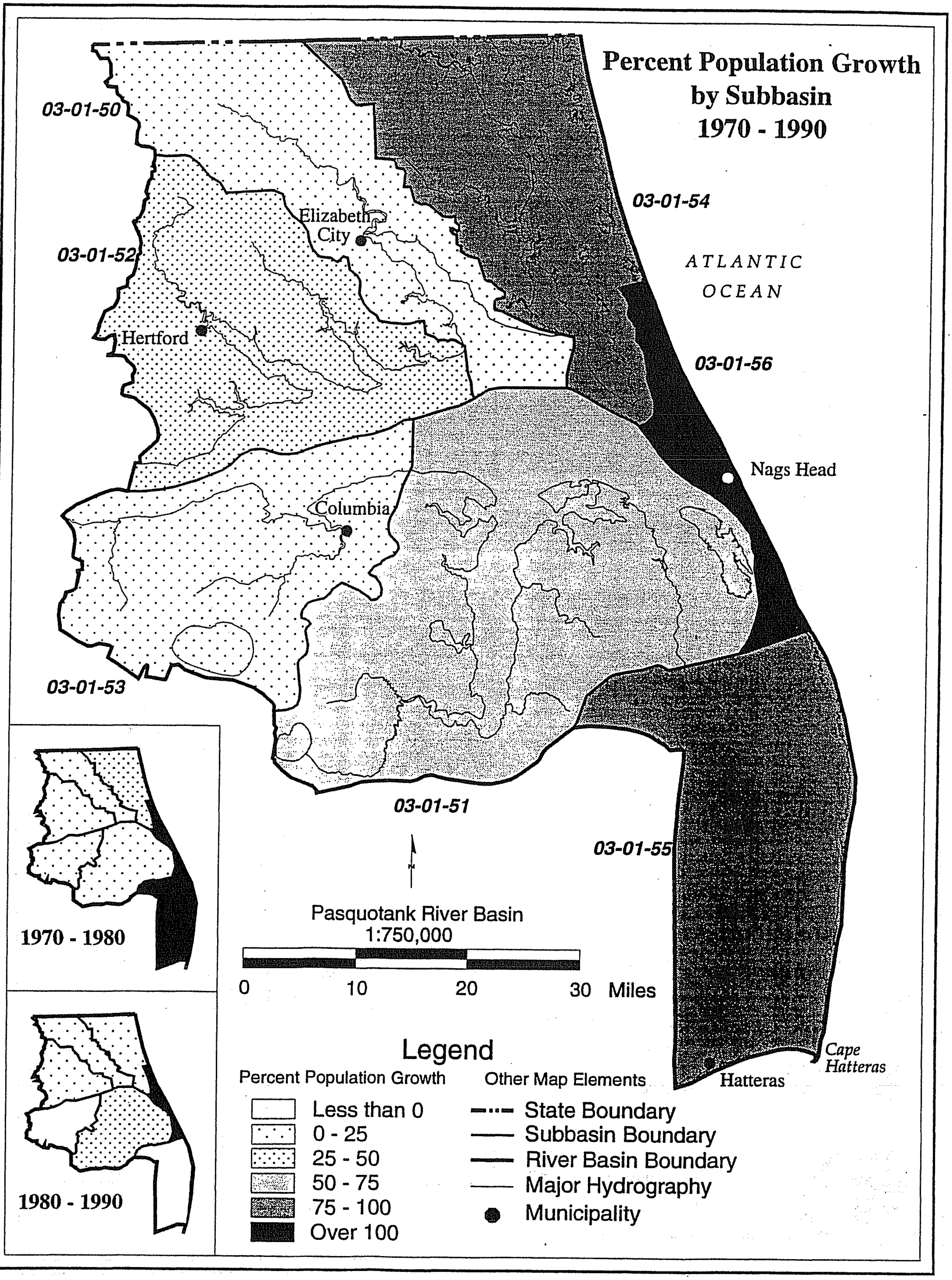

Figure 2.4. Percent Population Growth by Subbasin

Table 2.8. Summary of 1992 Agricultural Statistics for Counties in the Pasquotank River Basin (Source:NC Department of Agriculture, 1995)

County	Number of Farms	Acres of Land in Farms	Average Size of Farm (Acres)	Total Cash Receipts (1993)
Camden	89	43,056	484	$15,336,000
Currituck	90	41,750	464	$16,591,000
Dare	7	7,046	1,007	$598,000
Pasquotank	199	83,218	418	$28,178,000
Perquimans	226	68,736	304	$41,278,000
Tyrrell	96	67,698	161	$240,602,000
TOTALS	707	311,504	473	$342,583,000

2.5.1 Livestock Operations

In 1992, the Environmental Management Commission adopted a rule modification (15A NCAC 2H .0217) to establish procedures for managing and reusing animal wastes from intensive livestock operations (See section 5.3.1 for additional information on rule requirements). The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve more than or equal to the following animal populations: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds (chickens and turkeys) with a liquid waste system. The deadline for submittal of registrations to DWQ for existing facilities was December 31, 1993.

In the counties that lie within the Pasquotank River basin, there are a total of 86 registered livestock operations (as of November of 1996). Eleven of these (or 13%) are certified, meaning they have approved waste management plans. The remainder must have approved plans in place before the end of 1997. As Table 2.9 indicates, the majority of the operations are swine, although there is one poultry operation in Perquimans County. Locations of registered animal operations in the Pasquotank basin are presented in Figure 2.5.

Table 2.9. Summary of Registered Livestock Operations in the Pasquotank River Basin

County	Number of Operations	Type of Animals	Number of Animals
Camden	9	Swine	9,379
Currituck	7	Swine	15,612
Dare	0		0
Pasquotank	8	Swine	5,639
Perquimans	40	Swine	23,334
	1	Poultry	50,000
Tyrrell	21	Swine	19,575

Between the years of 1990 and 1994, the numbers of livestock operations in the Pasquotank River basin decreased (NCDA Veterinary Division, 1995). All but one subbasin has experienced a decline in swine capacity, with the largest decline occurring in subbasin 030151 with a 88% decrease.

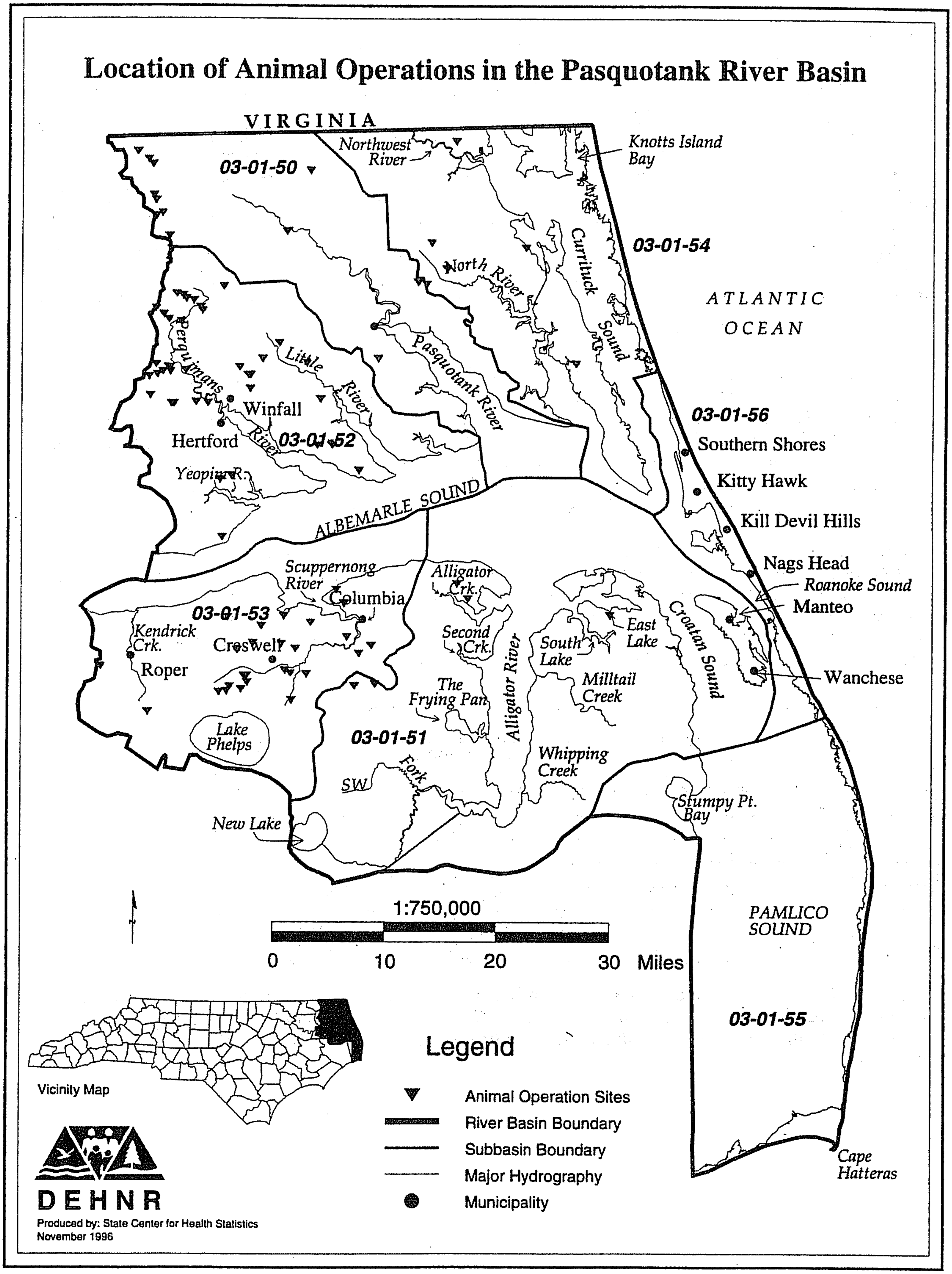

Figure 2.5. Location of Registered Livestock Operations in the Pasquotank River Basin

2.5.2 Crop Production

According to the NC Department of Agriculture (1995), there are a variety of crops grown in the Pasquotank River basin (based on data from counties that overlap that basin). The biggest crop in this region is Irish potatoes. In fact, Pasquotank County is ranked highest in the state for production of potatoes and Tyrrell County is ranked 2nd. Other important crops in the region include corn, soybean, wheat, cotton and sorghum.

2.6 NATURAL RESOURCES IN THE PASQUOTANK RIVER BASIN

2.6.1 Fishery Resources

North Carolina's commercial and recreational fishery resources are both nationally and regionally significant. Commercial harvest of fish and shellfish in North Carolina produces an average of 180.6 million pounds of marketable resource each year (based on figures from 1987 - 1991) (Division of Marine Fisheries (DMF), 1993). The annual economic value of this resource is $1 billion and is a critical component of North Carolina's coastal economy. Management of these fisheries resources has recently become a critical issue in the state as fisheries are threatened by overfishing, habitat loss, and water quality decline.

Estuarine fishery resources can be described by how fish live their lives. There are three major types (DMF, 1993): anadromous fish, resident fish and migratory fish. Anadromous fish spend most of their lives in saltwater but spawn in freshwater streams. Examples of these include river herrings and striped bass. Resident fish and shellfish stay in the same area for their whole life because they need a certain kind of habitat in which to live. Examples of these include catfish, oysters and clams. Migratory species spawn in the ocean and around inlets and some migrate seasonally along the Atlantic coast. These are the most prominent in the estuaries and include menhaden, croaker, weakfish, shrimp and crab.

The extensive Pasquotank watersheds that contain intermittent and tidally flooded wetlands, swamps, hardwood forests, shallow open waters and areas of emergent and submerged aquatic vegetation are considered very important as spawning, nursery and feeding areas for anadromous and resident fish species. Maintenance of the water quality benefits provided by these habitats is critical to fishery resources.

The waters of the Pasquotank River basin are an important habitat for several anadromous fish species. In the state, the Albemarle Sound is considered the most important nursery and spawning area for anadromous and freshwater fish (Epperly, 1984). Anadromous species found in the area include blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), hickory shad (*Alosa mediocris*), American shad (*Alosa sapidissima*), Atlantic sturgeon (*Acipenser oxyrhynchus*) and striped bass (*Morone saxatilis*). The first two species (blueback herring and alewife) are often generally referred to as 'river herring'. All of these fish have a very large range extending along the Atlantic from Canada to northern Florida. Blueback herring that were tagged during the summer in Canada have been recaptured in the Roanoke River in North Carolina, and fish tagged in North and South Carolina waters have been recaptured in Georges Bank, Canada (DMF, 1993). Striped bass are an important recreational and commercial fishery from Maine to North Carolina. In North Carolina, more than 50% of total landings of striped bass have been taken from the Albemarle Sound area (DMF, 1993). Figure 2.6 provides a map illustrating the location of anadromous fish spawning areas in the Pasquotank River basin.

There are several types of fisheries data that can be examined to determine the status of fishery populations. One is commercial landings which is a measure of the number of pounds of fish caught by commercial fishermen. Another is 'catch per unit effort', or CPUE, which is derived from the amount of commercial landings and how much gear, such as pound nets, was used to catch those fish. Also, juvenile abundance indices (JAI) measure the amount of juvenile fish for a

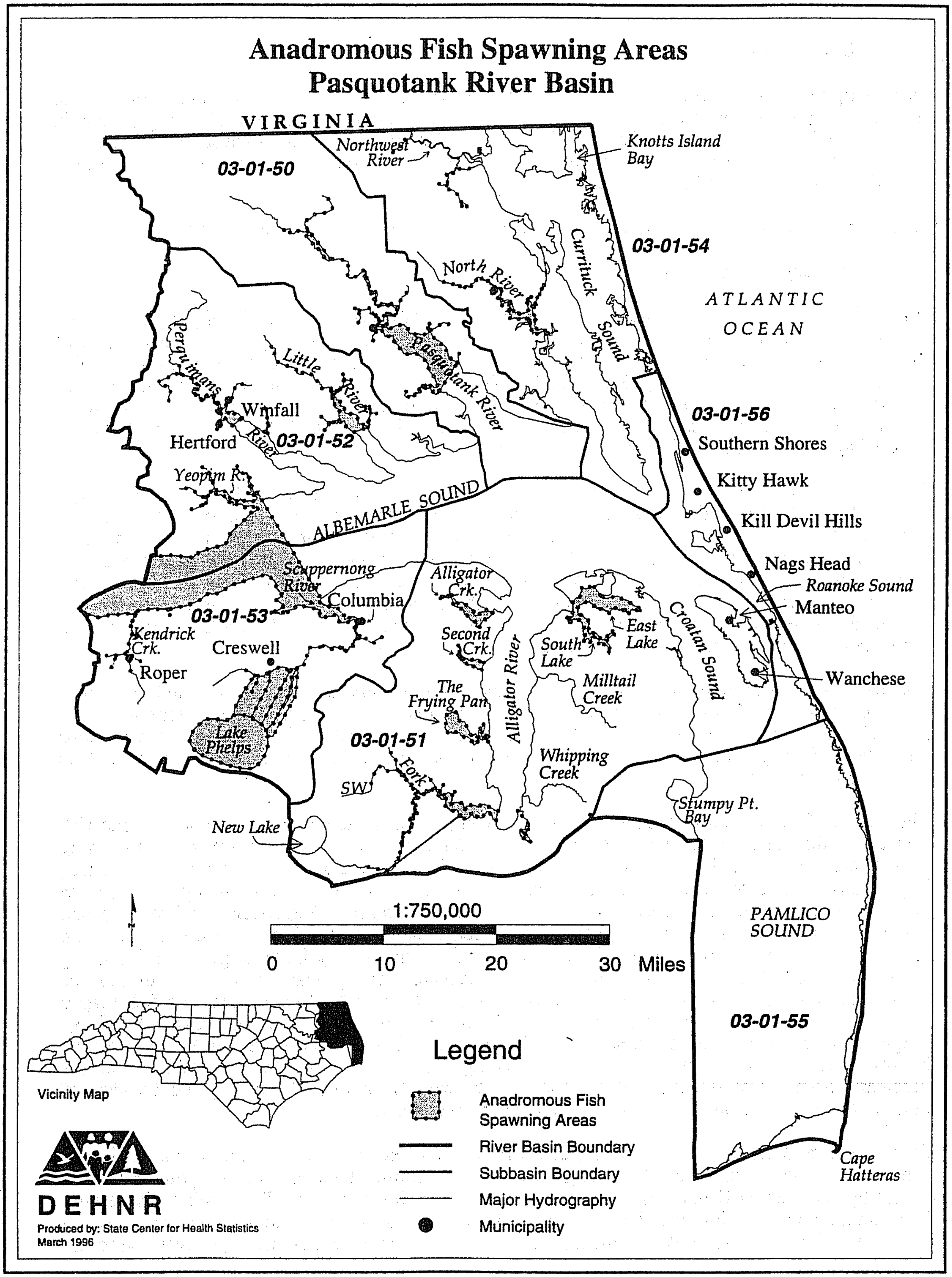

Figure 2.6. Anadromous fish spawning areas in the Pasquotank River Basin.

specific area given a certain amount of effort (for example a one minute trawl). This type of data is used to identify and designate primary nursery areas.

Commercial landings and CPUE data indicate that populations of anadromous fish species that utilize the Pasquotank basin are stressed. A publication of the North Carolina State Museum of Natural History lists the migratory Atlantic sturgeon, herrings and shads as "depleted" (Cooper et. al., 1997). More recent stock status information from the NC DMF lists American shad as stressed declining, hickory shad a s stressed recovering, Atlantic sturgeon as depressed, and river herring in the Albemarle/Chowan basin as depressed.

There are several primary nursery areas in the Pasquotank basin, identified by both NC DMF and the Wildlife Resources Commission (WRC). DMF defines nursery areas for coastal waters and WRC defines them for inland waters. Nursery areas provide the necessary conditions (such as food, cover, bottom type, salinity and temperature) for post-larval development of fish. Coastal primary nursery areas in the Pasquotank include Dough, Scarborough and Broad creeks in the area of Roanoke Sound. The WRC has defined areas of the North River, Alligator River and Currituck Sound as inland primary nursery areas. Currituck Sound is a valuable nursery ground for spot, croaker, mullet, blue crab and flounder.

Juvenile abundance indices for striped bass have been collected in the Albemarle area since 1955. Record low values in the late '70s and early '80s (see figure 2.7) combined with declines in commercial landings and recreational harvest, motivated state and federal authorities to take action to protect striped bass fisheries (DMF, 1993). In 1981 the Striped Bass Fishery Management plan was prepared by the Atlantic States Marine Fisheries Commission (ASMFC) to work toward recovery of Atlantic Coast stocks. Implementation of this plan was required by Congress by the passing of the Atlantic Striped Bass Conservation Act (PL 98-613) in 1984. North Carolina management agencies (DMF and the Wildlife Resources Commission) have been in compliance with the requirements of the plan and continue to work to protect striped bass fisheries in North Carolina.

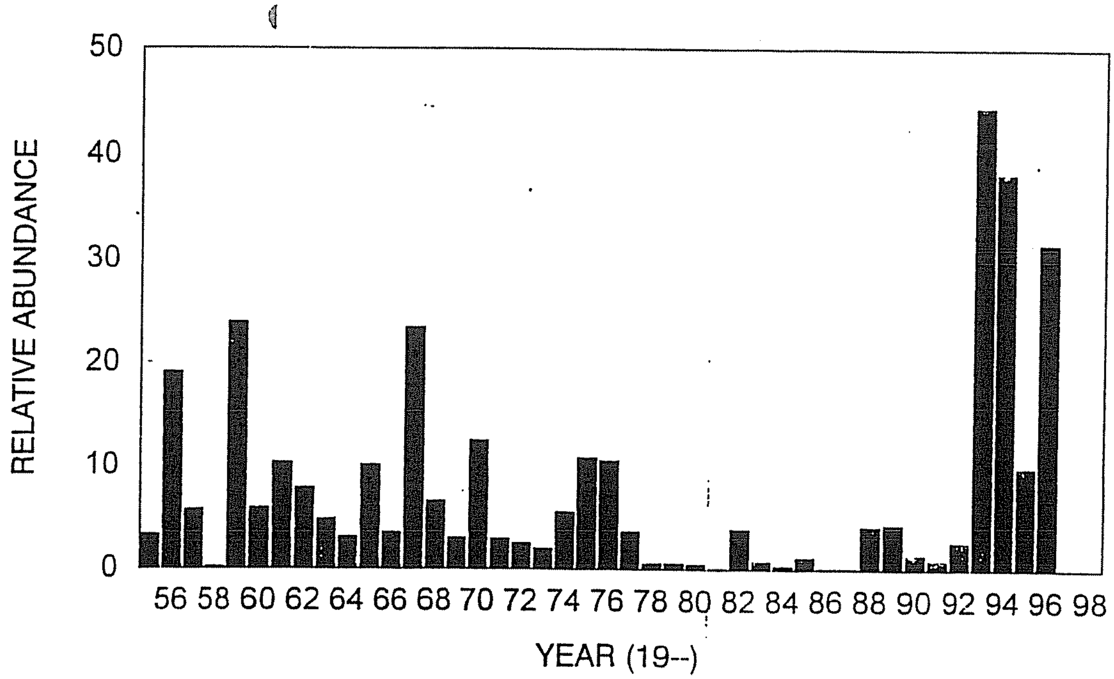

Figure 2.7. Juvenile Abundance Indices for Striped Bass in the Albemarle Sound Area from 1955 - 1996. (Source: Hassler 1955-87; NC DMF 1988-96)

Two other important, non-anadromous fish species in the Albemarle Sound area include catfish and white perch. Several species of catfish including channel, white and yellow and brown bullheads are caught in North Carolina waters. Historically, the Albemarle Sound area has dominated total catch of catfish in the state with over 95% of the commercial landings coming from that area (DMF, 1993). The status of catfish populations is unknown in North Carolina. White Perch is a very popular recreational and important commercial fishery in the Albemarle Sound. The condition of the white perch fishery is presently unknown, although extensive kills were experienced in 1976 as a result of a red sore disease epidemic. Stocks appear to have recovered somewhat since then.

Currituck Sound also supports important fishery populations. Historically, one of the more important fisheries in the sound has been largemouth bass (*Micropterus salmoides*). In the 1960s and 1970s the recreational largemouth bass fishery was very strong and there were even reports of individual fisherman catching and releasing 100 bass per day (Kornegay, 1989). However, it has been suggested that increased salinity levels in Currituck Sound have negatively affected largemouth bass reproduction. As salinity levels approach 3.0 ppt during the spring (March - June) largemouth bass egg and fry survival is low. A survey of fisheries in the sound conducted by Kornegay in 1989 suggest the percentage of estuarine fish species in certain Currituck Sound embayments increased from levels observed in 1977 (see Figure 2.8).

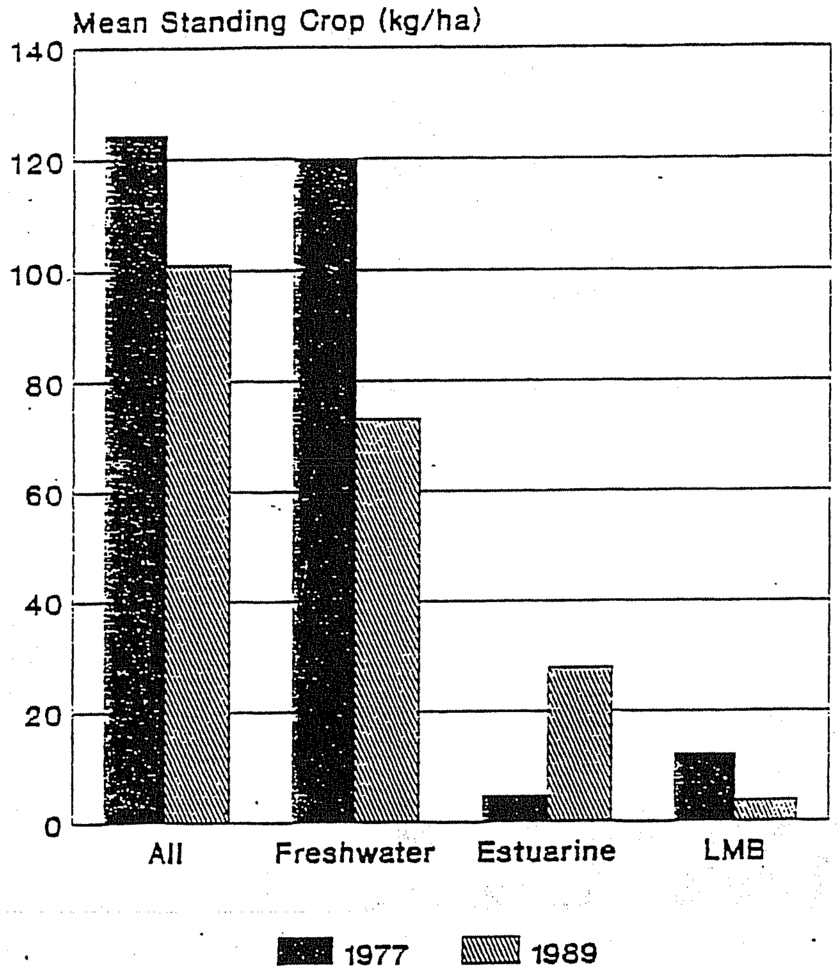

Figure 2.8. Comparison of mean standing crop estimates for all species (All), freshwater species (Freshwater), estuarine species (Estuarine) and largemouth bass (LMB) as determined from rotenone samples on Currituck Sound during 1977 and 1989. (Source: Kornegay, 1989)

Management efforts directed toward the enhancement of Currituck Sound's largemouth bass populations are currently underway. Although egg and fry survival is poor when salinities reach 3.0 ppt, studies conducted in other brackish water systems suggest that largemouth bass fingerlings (2 - 4 inches) can tolerate salinities as high as 9.0 ppt. The Wildlife Resources Commission is currently evaluating the effects of salinities on microtagged largemouth bass fingerlings. Six-thousand microtagged fingerlings were stocked into 4 different embayments of Currituck Sound in June of 1996 and 1997. Salinities in the embayments ranted from 0 ppt to 6.0 ppt. Significant recaptures of tagged largemouth bass populations may be possible during years when spring salinity is high.

2.6.2 Submerged Vegetation

Submerged aquatic vegetation (SAV), also called submersed rooted vascular beds (SRV) provide vital nursery habitat for fish, shellfish and other animals. These underwater plants are vulnerable to physical damage such as high currents produced by storms and boat traffic. Likewise, reductions in biomass of vegetation are related to increases in turbidity from either storms or degraded water. Distribution of plants is correlated with depth, water clarity and salinity. Changes in salinity, light limitation, and over-enrichment are detrimental to SRV. Historical documentation of SRV is difficult in low salinity waters in North Carolina although past accounts indicate that SRV were more widespread.

Water transparency in Currituck Sound in 1995 was slightly higher than in earlier years (1992-93) as demonstrated by higher Secchi values and lower mean turbidity measurements at most stations in 1995. A resurgence in submersed aquatic vegetation in 1995 helps to explain increases in water clarity. Plants help to decrease turbidity by decreasing wave action and settling incoming sediments and vascular plants may shade algae, decreasing algal turbidity.

Eurasian water milfoil (*Myriophyllum spicatum*) an exotic species, was first found in Currituck Sound in the early 1960s and quickly spread throughout the sound. By the 1970s, Eurasian water milfoil had outcompeted many native species. A storm which produced high turbidity levels in 1962 resulted in dominance of Eurasian water milfoil which persisted until 1979. Usually following storms there is quick recovery of diverse flora (Davis and Brinson 1983), however Eurasian water milfoil became dominant after the storm of 1962. Changes in macrophyte communities usually result from episodic turbidity either stemming from storm events or from eutrophication. For unknown reasons water milfoil died back between 1979-1984 and waterfowl populations declined. Yearly changes in density of Eurasian water milfoil are also controlled by water clarity during the spring.

To aid in preservation of SRV, inventory, research and mapping of vegetation was conducted in 1991 through 1993 for Currituck and Albemarle Sounds and aerial photography was taken by NOAA (Ferguson, 1994). In the Currituck Sound, SRV was diverse and moderately widespread with 51% of the stations sampled containing SRV. Currituck Sound has consistently had low Secchi disk values averaging 0.3 meters, indicating limited photosynthesis and decreased survival potential of SRV. Unlike other areas that exhibited low water clarity, Currituck Sound contained a diversity of vegetation. The five most common types of SRVs recorded in the Currituck Sound survey are *Ruppia maritima* (widgeon grass), *Vallisneria americana* (wild celery), *Myriophyllum spicatum* (Eurasian water milfoil), *Najas guadalupensis* (naiad or bushy pondweed) and *Potamogeton pectinatus* (sago pondweed). Widgeon grass was the most common species reported. Researchers recommend monitoring of SRV to be conducted at least every five years although funding is not currently available.

In 1995, SRV were found at 50% of the stations sampled for the basinwide assessment. The same species listed above were found with the addition of *Potamogeton pusillus* (slender pondweed) and *Potamogeton perfoliatus* (red head grass). Widgeon grass was again the most prevalent species. Observations from 1992, 1993 and 1995 indicate that a return of native vegetation was first observed in 1993. Growths of vegetation appeared to be even more dense and abundant in

1995. Personnel from Mackay Island National Wildlife Refuge indicated that the higher numbers of waterfowl observed during the winter of 1995 were indicative of increased SRV growth. Associations in waterfowl abundances and SRVs are examined in a report by USFWS (Wicker and Endres 1993).

2.6.3 State Parks and Natural Areas

The North Carolina state parks system exists for the enjoyment, education, health and inspiration of all citizens and visitors. The mission of the state parks system is to conserve and protect representative examples of the natural beauty, ecological features, and recreational resources of statewide significance; to provide outdoor recreational opportunities in a safe and healthy environment; and to provide environmental education opportunities that promote stewardship of the state's natural heritage.

According to the NC Division of Parks and Recreation (NC DPR), there are two state parks and two state natural areas in the Pasquotank River basin. Pettigrew State Park is located on the Albemarle-Pamlico peninsula along the border of Washington and Tyrrell counties and includes Phelps Lake. The land portion of the park is 1,143 acres in size and the lake is 16,600 acres in size. Large portions of the park are wetlands and serve as primary wintering areas for ducks, geese, and swans (NC DPR, 1993). Preserving Phelps Lake, which is a registered natural area, is an important function of the park. The lake offers high quality fishing and varied water recreation in an uncrowded setting.

Jockey's Ridge State Park contains 419 acres and is on a barrier island in Nags Head. The park contains the following natural communities: Dune Grass, Maritime Dry Grassland, Maritime Shrub, Maritime Evergreen Forest, Salt Marsh and Maritime Wet Grassland.

Run Hill State Natural Area is adjacent to Nags Head Woods and contains 123 acres. Run Hill is an active dune that is about 75 feet at its highest point. Natural communities in this area include Dune Grass, Brackish Marsh, Maritime Swamp Forest and Maritime Evergreen Forest.

The Dismal Swamp State Natural Area is located in northern Camden County along the North Carolina - Virginia border. It is a vast forested wetland covering approximately 13,500 acres. It contains four noteworthy communities: a Nonriverine Swamp Forest, a Pond Pine Woodland, a Peatland Atlantic White Cedar Forest, and High Pocosin (NC DPR, 1995). The swamp supports a variety of Neotropical birds, mammals (including the threatened Dismal Swamp southeastern shrew, black bear and bobcat), reptiles, and amphibians. The park provides excellent recreational opportunities to those who want to experience an extensive East Coast swamp and pocosin complex.

Other protected areas in the Pasquotank River basin include Currituck National Estuarine Research Reserve, Buxton Woods Natural Area, the 4-H Environmental Education Conference Center and Bull Neck Swamp Research and Demonstration Forest.

2.6.4 National Wildlife Refuges

There are five National Wildlife Refuges in the Pasquotank River Basin (US Fish and Wildlife Service, personal communication). These refuges are managed by the US Fish and Wildlife Service. Locations of most of the areas are included in the general map of the basin (Figure 2.2). The Pocosin Lakes Refuge is not included on that map because the digital data layer has not been updated to incorporate it yet. Each one of the refuges in the basin is generally described below.

1. <u>Mackay Island National Wildlife Refuge</u> - This refuge is located in Currituck County in the extreme northeast corner of NC, with 842 of its 7,762 acres lying in adjacent southeastern VA. It was established in 1960 as a wintering ground for migratory waterfowl, but it also provides recreational opportunities including sport fishing, crabbing, and trapping. In

addition to waterfowl habitat, its expansive emergent estuarine marshes (> 5,000 acres) serve as important nursery grounds for many commercial and anadromous finfish and shellfish. The refuge is bordered by the North Landing River to the west, Back Bay to the north, HWY 615 / 1255 to the east, and Bellows Bay / Currituck Sound to the south. Telephone number (919)429-3100.

2. Currituck National Wildlife Refuge - The 1,824 acres included in Currituck NWR are part of the dynamic and fragile coastal barrier islands that make up part of the Outer Banks. Located in Currituck County, the protected estuarine areas safeguard important fisheries nursery areas for many commercial and anadromous finfish and shellfish; these marshes are also important black duck wintering habitat. The refuge's beachfront is heavily utilized by migrating shorebirds. The federally-endangered piping plover is known to nest and forage on the refuge. The refuge is bounded by the Atlantic Ocean to the east and Currituck Sound to the west. The refuge is administered by Mackay Island NWR, telephone number (919)429-3100.

3. Alligator River National Wildlife Refuge - Established in 1984, the 149,300 acre refuge includes a vast expanse of undisturbed swamp forest and pocosin wetlands in Dare County. This area is the northern limit for the American alligator, is the site of an endangered red wolf reintroduction project, provides habitat for the federally-listed endangered red-cockaded woodpecker, and provides significant black bear habitat. During the spring and summer 1994, a pair of nesting bald eagles was observed along the Alligator River. Nesting by several species of wading birds occurs on the refuge. The refuge is bounded by Alligator River on the west, Albemarle Sound and East Lake to the north, and Croatan Sound to the east. Most waters in the vicinity of the refuge are designated Outstanding Resource Waters. Telephone number (919) 473-1131.

4. Pea Island National Wildlife Refuge - This refuge is made up of 5,843 acres of barrier island beach, dunes, salt flats, and salt marsh. An additional proclamation area of approximately 25,000 acres is adjacent and west of the refuge in the Pamlico Sound. A wide variety of wading birds, waterfowl, and shorebirds utilize the refuge, including the endangered piping plover. The beaches provide nesting habitat for sea turtles such as the threatened Green and Loggerhead sea turtles. The refuge is located on the Outer Banks in Dare County between Rodanthe and Oregon Inlet. It is bounded by the Atlantic Ocean to the east and Pamlico Sound to the West. Telephone number (919) 473-1311.

5. Pocosin Lakes National Wildlife Refuge - Established in 1990 and situated between the Albemarle and Pamlico Sounds in Washington, Hyde, and Tyrrell Counties. The vegetation on the 107,718 acre refuge is predominantly southeastern shrub bog (pocosin), which is a unique habitat that supports a wide variety of mammals, reptiles and amphibians. A diverse fish population including largemouth bass, white perch, bluegill, chain pickerel and the longnose gar can be found in the refuge's lakes, rivers and canals. The refuge is undertaking large-scale restoration of the drained pocosin wetlands with restoration of the hydrology and planting of native wetland vegetation.

2.6.5 Wetlands

The Pasquotank River basin constitutes a significant portion of the North Carolina Coastal Plain known as the Embayed Region. The name Embayed Region refers to the prominence of drowned river valleys which form the large sounds and many bays. The land in the Embayed Region is universally low and flat, and most is poorly drained. This region contains the largest acreage and proportion of wetlands in the state. The extensive reach of the Pasquotank River basin -- from the coastal environment of the outer banks, across estuaries, to embayed rivers and natural lakes -- captures many types of wetland communities. Vast peatlands occupy the centers of peninsulas between the drowned rivers. On the fringes of the peatlands are flat mineral soil wetlands which are kept saturated primarily by rainfall and sheet flow. Additional large areas of organic and mineral soil swamps and marshes lie adjacent to the sounds and tidally-influenced rivers.

Freshwater tidal wetlands are an important component of the landscape in the Pasquotank basin, especially along Currituck Sound and the North and Northwest Rivers. Along the Albemarle Sound, the land-water interface is characterized by Tidal Cypress-Gum Swamp communities.

Nonriverine wetland communities in the Pasquotank River basin include Nonriverine Swamp Forest, Nonriverine Wet Hardwood Forest, High Pocosin, Low Pocosin, Pond Pine Woodland, Peatland Atlantic White Cedar Forest, and Bay Forest. Both the Dismal Swamp and the Dare mainland contain extensive Nonriverine Swamp Forest, and they also support patches of Atlantic White Cedar, Pocosin, and Pond Pine Woodland. The extent of the natural areas in both the Dismal Swamp and the Dare mainland allows for the natural 'shifting mosaic' pattern of these wet peatland communities. The Nonriverine Wet Hardwood Forest community, which is dominated by oaks, is not part of the 'shifting mosaic' pattern, being associated more with mineral soils than organic soils and peatlands. The high productivity of the Nonriverine Wet Hardwood wetland community soils when cleared for agriculture has led to a drastic decline in the acreage of this community type across the state.

Natural Lake Shoreline is a wetland community type composed of the vegetated shoreline zone of large natural lakes. The vegetation may include emergent graminoids and other herbs, shrub thickets, Cypress--Gum Swamps, or various bottomland species. The Natural Lake Shoreline of Phelps Lake in Washington County is a high-quality example of this wetland community type which is protected within Pettigrew State Park.

Nontidal coastal fringe wetlands occur primarily on the outer banks. Wetland communities on the outer banks include Maritime Swamp Forest and Maritime Shrub Swamp, examples of which are protected at Nag's Head Woods; Maritime Wet Grassland, an example of which is found in the Pine Island Audobon Sanctuary in Currituck County; and Interdune Pond, a protected example of which is found at Cape Hatteras National Seashore.

Wetlands can be very important in watershed planning because they perform a variety of services beneficial to society. Wetlands are able to process sediments, nutrients, and other pollutants, provide wildlife habitat, store organic matter and provide other means to protect habitat as well as downstream and on-site water quality. Each of the actions that a wetland performs, regardless of human recognition of that action, is called a function. When these actions are declared important to society as a whole, they are called values. The following discussion primarily concerns wetland values. Some wetland values are ubiquitous to most wetland types, such as wildlife habitat. However, wetland values are ultimately tied to specific wetlands because they depend on site specific factors such as landscape position, size, soil type, and land use. Table 2.10 lists those wetland types that are most common in the Pasquotank basin and provides acreages for those types. These figures were generated by the NC Division of Coastal Management (DCM). DCM is currently working to identify and digitize into GIS wetland areas (by type) in the NC coast. Approximately one-third of the Pasquotank basin has been completed, and the numbers in Table 2.10 represent figures from the completed portion. Table 2.11 provides a brief description of typical values associated with the different wetland types.

Table 2.10. Number of acres of wetlands in the Pasquotank River Basin (not including Currituck, Pasquotank, Perquimans, Hyde and Tyrrell Counties).

Wetland Type	Not Drained or Cleared	Drained	Cleared	Total	Percent of Total
Salt/Brackish Marsh	24,536	3,518	2,906	30,960	8
Freshwater Marsh	4,771	67	583	5,421	1
Estuarine Shrub Scrub	11,090	643	994	12,727	3
Pocosin	86,828	3,937	2,756	93,522	25
Bottomland Hardwood	4,900	517	401	5,817	2
Swamp Forest	113,157	11,451	2,867	127,475	34
Hardwood Flat	19,045	12,045	2,547	33,636	9
Pine Flat	19,909	890	1,075	21,874	6
Managed Pineland	35,494	n/a	n/a	35,494	10
Estuarine Forest	210	0	3	213	<1
Maritime Forest	3,350	17	325	3,692	1
Headwater Swamp	2,485	0	140	2,626	1
TOTAL	325,775	33,085	14,597	373,457	100
PERCENT	87	9	4	100	

Table 2.11. Wetland types common in the Pasquotank Basin.

Wetland Type	Values
Headwater Forests	overland pollutant removal, wildlife habitat, timber production
Bottomland Hardwood Forests	water storage, shoreline stabilization, pollutant removal, wildlife habitat, aquatic habitat, outdoor recreation/ education, timber production, hunting leases
Swamp Forests	water storage, overland and overbank pollutant removal, wildlife habitat, aquatic habitat, outdoor recreation/ education, timber production, hunting leases
Wet Flats	special ecological attributes, wildlife habitat, outdoor recreation/education, timber production, hunting leases
Pocosins	wildlife habitat, hunting leases, water storage
Brackish Marshes	water storage, wildlife habitat, aquatic habitat, outdoor recreation/ education, hunting leases
Saltwater Marshes	water storage, shoreline stabilization, wildlife habitat, aquatic habitat, outdoor recreation/ education, estuarine nutrient cycling

Bottomland hardwood and headwater wetlands perform valuable water quality functions including flood water storage, nutrient and sediment retention and nutrient transformation. However, their effectiveness is diminished if the stream waters can no longer inundate adjacent floodplains or if nutrient loads exceed the assimilative capacity of the wetland. As these wetlands are lost upstream, the potential for erosion, flooding, sedimentation, algal blooms, and fish kills increase downstream. Those wetlands adjacent to intermittent streams are especially important in filtering nonpoint pollution from agricultural and urban runoff.

Wet flats and pocosins in the coastal plain also may have a considerable influence on the water quality of the region. In general, wet flats and pocosins do not store as much water or retain as many pollutants as wetlands directly associated with streams, such as bottomland hardwood forests. However, wet flats and pocosins occupy extensive areas of interstream divides, and, based on sheer magnitude of coverage in the coastal plain, the cumulative effects of these wetlands may be vital to water quality of coastal plain streams. Consequently, the conversion of these wetlands may significantly affect the hydrology or water quality of the region. Between 1994 and 1996, wet flats received the greatest impacts from permitted wetland fill activities in the Pasquotank basin (Table 2.12). These areas were primarily converted for DOT projects and ponds. The Division of Water Quality is currently assessing the cumulative impacts on water quality of incremental fill of wet flats and pocosins.

Table 2.12. Fill activities in the Pasquotank Basin by wetland type. (1994-1996)

Wetland Type	Acres Wetland Fill Permitted
Bottomland Hardwood Forest	5.81
Salt Marsh	16.51
Wet Flat	39.36
Pocosin	0.37
Other	68.95
TOTAL	131.43

Note: Numbers have not yet been completely QA'd. However, it is not anticipated that they will change significantly upon completion of that process.

2.6.6 Threatened and Endangered Aquatic Faunal Species

In the Pasquotank River basin, there are eleven species that are listed by North Carolina as either Threatened, Special Concern, or Significantly Rare. Threatened species are considered likely to become endangered within the foreseeable future. Endangered species are those species that are in danger of becoming extinct. Species of Special Concern have limited numbers and vulnerable populations and are in need of monitoring. Significantly Rare species are those whose numbers are small and whose populations need monitoring. Figure 2.9 shows the location fo rare species in the Pasquotank River basin. Table 2.13 lists the species in the Pasquotank River basin that have received a State or Federal listing because of limited or vulnerable populations.

The Pasquotank basin has several threatened and endangered turtle species. The endangered manatee has also been known to occur in these waters on rare occasions. The American Alligator has received the classification of 'Threatened Due to Similarity of Appearance' due to the similarity between the alligator and the endangered crocodile.

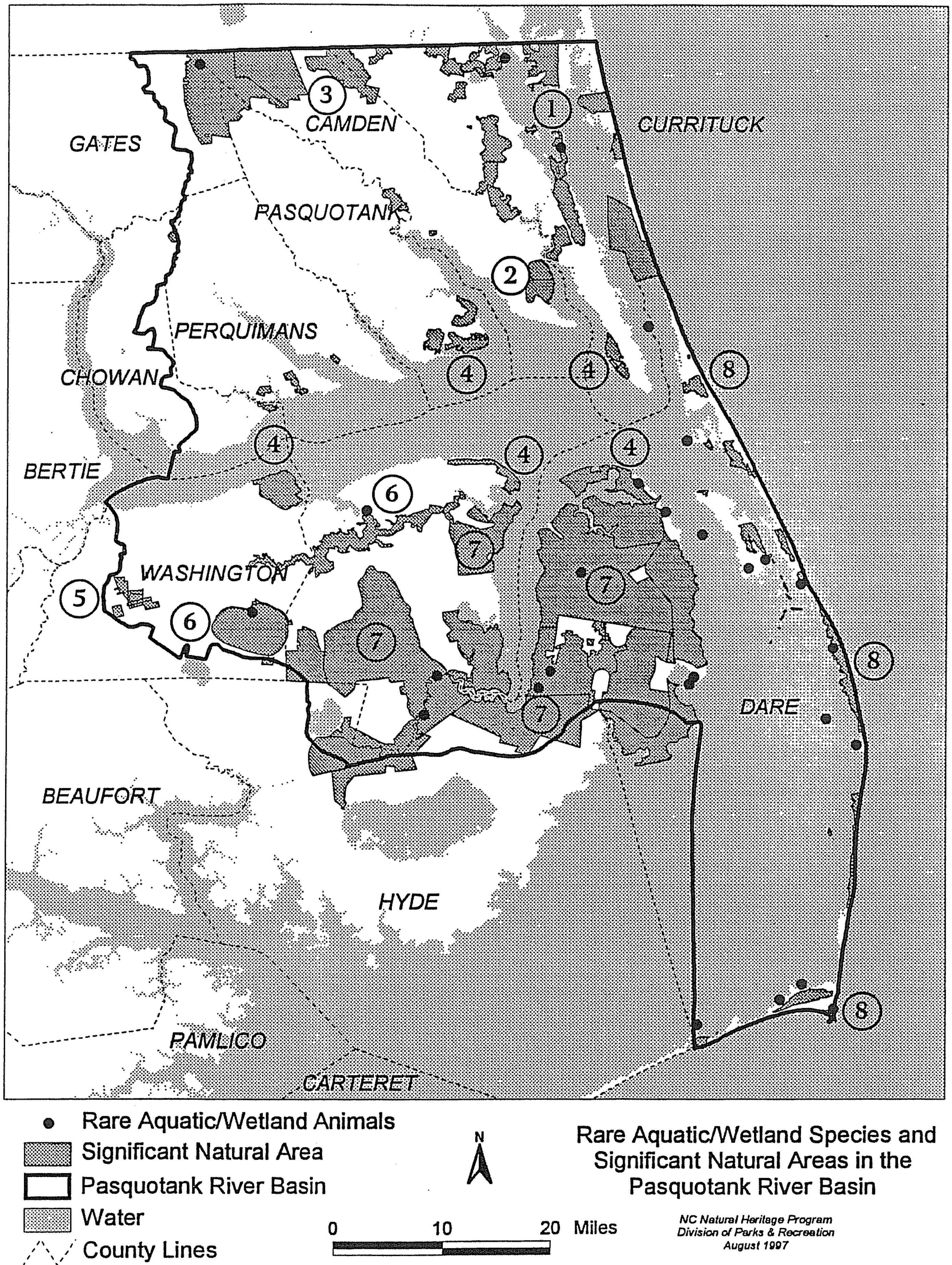

Figure 2.9 Rare Species and Significant Natural Areas in the Pasquotank River Basin

Table 2.13. Threatened and Endangered Species in the Pasquotank River Basin (Source: NC Natural Heritage Program)

Common Name	Scientific Name	Subbasins where found	Listing Status: State	Federal
REPTILES				
Loggerhead Turtle	*Caretta Caretta*	55, 56, ocean	T	T
Leatherback Turtle	*Dermochelys coriacea*	55, 56, ocean	E	E
Green Turtle	*Chelonia mydas*	55, 56, ocean	T	T
Hawksbill Turtle	*Eretmochelys imbricata*	55, 56, ocean	E	E
Atlantic Ridley Turtle	*Lepidochelys Dempii*	55, 56, ocean	E	E
Lyre Goby (fish)	*Evorthodus Lyricus*	55	SR	
Carolina Salt Marsh Snake	*Nerodia sipedon williamengelsi*	51, 54, 55, 56	SC	
American Alligator	*Alligator mississippiensis*	51	T	T(S/A)
MAMMALS				
Manatee	*Tichechus manatus*	55, 56	E	E
FISHES				
Lyre Goby	*Evorthodus lyricus*	51, 55, 56	SR	
Waccamaw Killifish	*Fundulus waccamensis*	53	E	T

Abbreviations: E = Endangered, T = Threatened, SR = Significantly Rare, SC = Species of Concern, T(S/A) = Threatened Due to Similarity of Appearance.

2.6.7 Significant Natural Areas in the Pasquotank River Basin

The North Carolina Natural Heritage Program (NHP) compiles the N.C. Department of Environment, Health and Natural Resources' (DEHNR) list of Significant Natural Heritage Areas as required by the Nature Preserve Act (NCGS Chapter 113-A-164 of Article 9A). The list is based on the program's inventory of natural diversity in the state (DEHNR 1997). Natural areas are evaluated on the basis of the occurrences of rare plant and animal species, rare or high-quality natural communities, and geologic features. The global and statewide rarity of these elements and the quality of their occurrence at a site relative to other occurrences determines a site's significance rating. The sites included on this list are the best representatives of the natural diversity of the state, and therefore have priority for protection. Inclusion on the list does not imply that any protection or public access exists.

The Embayed Region has large acreages in public ownership. Pocosin Lakes, Alligator River, Great Dismal Swamp, and Mackay Island National Wildlife Refuges; Dare Bombing Range; Dismal Swamp State Natural Area; Pettigrew State Park; and Northwest River and North River Game Lands protect large acreages of pocosin, nonriverine swamp, and marsh from development. Yet there are large, highly significant sites in this region that are in need of acquisition or other protection action. The series of sites along the Northwest River, the North River, the Scuppernong River, and a number of smaller sites have little or none of their area protected. Protection is particularly urgent for Nonriverine Wet Hardwood Forests and Peatland Atlantic White Cedar Forests. No examples of Nonriverine Wet Hardwood Forest are protected in the region, and only one small example is protected anywhere in the state.

Figure 2.9 shows the Significant Natural Heritage Areas (SHNA) in the Pasquotank basin. The numbers in the figure correspond to the items described in the text below. Certain sites that contribute to the maintenance of water quality in the Pasquotank Basin are highlighted below. They are grouped by region, and the names of individual Significant Natural Heritage Areas that constitute the grouping are bulleted. More complete information on Significant Natural Heritage Areas may be obtained from the Natural Heritage Program.

1. Currituck Sound Significant Natural Heritage Areas

- Great Marsh
- Pine Island/Currituck Club Natural Area
- Northwest River Marsh Game Land
- Gibbs Woods/Tull Bay Marshes
- Nellie Bell Ponds, Marsh, and Cedar Swamp
- Troublesome Point/Gibbs Point Marshes
- Currituck Banks Corolla Natural Area
- Currituck Banks/Swan Island Natural Area
- Buckskin Creek/Great Swamp
- Maple Swamp Gordonia Forest
- Church Island Marsh
- Maple Swamp Gordonia Forest
- Northwest Backwoods

The Currituck Sound region includes the Northwest River, North Landing River, and Currituck Banks. Many of the Significant Natural Heritage Areas in Currituck Sound are Tidal Freshwater Marsh and Nonriverine Swamp Forest/Nonriverine Wet Hardwood Forest communities surrounding the estuarine shoreline and drowned river mouths. Several of the sites in this region are extensive, such as Great Marsh (6,037 acres), Pine Island/Currituck Club Natural Area (11,709 acres), and Buckskin Creek/Great Swamp (5,044 acres). These high-quality natural areas provide water quality benefits as well as outstanding wildlife habitat.

2. North River Significant Natural Heritage Areas

- North River/Deep Creek Marshes and Forest
- North River/Crooked Creek Wetlands
- Hunting Creek Pocosin and Marsh
- Broad Creek Marshes
- Indiantown Creek/North River Cypress Forest

Significant Natural Heritage Areas in the North River are characterized by vast, high-quality Tidal Freshwater Marshes and Cypress--Gum Swamps, as well as nonriverine wetland communities of Swamp Forest and Atlantic White Cedar. However, only a small fraction of the area is protected.

3. Great Dismal Swamp Significant Natural Heritage Areas

- Dismal Swamp State Natural Area
- The Green Sea
- Great Dismal Swamp National Wildlife Refuge

The combined acreage of the Dismal Swamp State Natural Area and the Great Dismal Swamp National Wildlife Refuge is over 41,000 acres. This vast area extends into Virginia and consists mostly of Nonriverine Swamp Forest, High Pocosin, Atlantic White Cedar, and other associated nonriverine wetland communities. Together with the Green Sea, a 9,592-acre natural area to the east, the Great Dismal Swamp provides habitat for rare plant and animal species and is home to wildlife such as black bear that require large undeveloped areas for survival. Sizeable portions of the Dismal Swamp State Natural Area and the National Wildlife Refuge are Registered Natural Heritage Areas, yet drainage of adjacent lands has significantly affected the hydrology of these areas.

4. Albemarle Sound Significant Natural Heritage Areas
- Bull Neck Swamp
- Big Flatty Creek Forests and Marshes
- Little Flatty Creek Forests and Marsh
- Menzies Pond
- Albemarle Sound Low Shoreline
- Durant Island
- Mamie Marshes and Ponds
- Harbinger Marshes

The Significant Natural Heritage Areas that border Albemarle Sound are areas of high-quality Tidal Freshwater Marsh, Nonriverine Swamp Forest, Maritime Forests, and important Nonriverine Wet Hardwood Forests. These areas, though scattered, serve important roles as natural vegetated buffers for Albemarle Sound, in addition to providing habitat for wildlife. Completing protection of river buffers could improve water quality in Albemarle Sound.

5. East Dismal Swamp Significant Natural Heritage Areas
- East Dismal Swamp

East Dismal Swamp is a 3,868-acre remnant of a Nonriverine Swamp Forest that once stretched over 100,000-acres in Washington and Beaufort counties. Certain old-growth forests characteristics of the East Dismal Swamp make it an attractive stop over for neotropical migrant birds. When protected, the East Dismal Swamp will contribute to the overall ecosystem function of natural areas in the region.

6. Scuppernong River/Phelps Lake Significant Natural Heritage Areas
- Scuppernong River Swamp Forest
- Phelps Lake State Lake
- Pettigrew State Park

Emptying into Albemarle Sound, the Scuppernong River drains northern Washington and Tyrrell counties. The high-quality communities bordering the river comprise over 14,000 acres and include Coastal Plain Small Stream Swamp (Blackwater Subtype), Cypress--Gum Swamp (Blackwater Subtype), Atlantic White Cedar, and Nonriverine Swamp Forest. Phelps Lake, one of the Coastal Plain's few natural lakes, drains into the Scuppernong River via canals. Phelps Lake is noteworthy for its unique shoreline community.

7. Alligator River, Dare/Tyrrell/northern Hyde counties Significant Natural Heritage Areas
- Roper Island
- New Lake Fork Pocosin
- Roanoke/Stumpy Point Marshes and Pocosin
- Mashoes Marshes
- Pine Road Swamp
- Taylor Road Natural Area
- Alligator River Swamp Forest
- Alligator River Refuge/Central Section
- Alligator River/Swan Creek Swamp Forest
- Alligator River Refuge/Southeast Marshes
- US 264 Low Pocosin
- Faircloth Road Pond Pine Pocosin
- Alligator Creek/Second Creek Forest
- Buck Island Bay Forest
- Upper Alligator River Marshes and Forests
- Upper Alligator River Pocosin
- Harvester Road Tall Pocosin

This large area is made up of extensive peatlands on either side of Alligator River. This region has the greatest extent of peatland communities in North Carolina, and probably in the whole eastern United States. Nonriverine communities -- Swamp Forests, Pocosins, Pond Pine Woodland, Atlantic White Cedar Forests -- dominate the landscape here, although they are quite rare outside the Pasquotank basin. Some areas along the shores of the Albemarle Sound and the Alligator River support marshes and Tidal Cypress--Gum Swamps. Much of the land in this region is publicly-owned. Protection of Roper Island, Buck Island Bay Forest, and Alligator River/Swan Creek Swamp Forest in southern Tyrrell and northern Hyde counties could add significantly to the ecological integrity of the area by acting as a link between protected natural areas on either side of Alligator River.

8. Coastal Region Significant Natural Heritage Areas

- Jockey's Ridge State Park
- Nags Head
- Kitty Hawk Woods
- Southern Shores Cypress Swamp
- Colington Woods
- Buxton Woods
- Bodie Island Lighthouse Pond
- Cape Hatteras Point
- Hatteras Island Middle Section
- Hatteras Inlet Bird Nesting Islands
- Hatteras Sand Flats
- Pea Island National Wildlife Refuge
- Oregon Inlet/Roanoke Sound Bird Nesting Islands
- Fort Raleigh Maritime Forest
- Roanoke Island Juncus Marsh

The Coastal Region includes the barrier islands and peninsulas, along with their associated marshes. These narrow ridges of unconsolidated sediment are among the most dynamic environments in the state, subject to reworking by erosion and overwash by storms as well as the more regular effects of tides, surf, salt spray, and wind. Significant Natural Heritage Areas in the coastal region of the Pasquotank basin include communities of Maritime Grassland, Maritime Forest, Sand Flats, and Salt Marshes. Protection exists for portions of several of these sites, such as Buxton Woods, Jockey's Ridge State Park, Pea Island National Wildlife Refuge, Nags Head Woods, and part of Kitty Hawk Woods. Because of the extreme rarity of these barrier island communities, protection should be a priority for the unprotected Significant Natural Heritage Areas.

2.7 SURFACE WATER CLASSIFICATIONS AND STANDARDS

2.7.1 Program Overview

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

The Water Quality Standards program in North Carolina has evolved over time and has been modified to be consistent with the Federal Clean Water Act and its amendments. Water quality classifications and standards have also been modified to promote protection of surface water supply watersheds, high quality waters and the protection of unique and special pristine waters with outstanding resource values. Classifications and standards have been broadly interpreted to provide protection of uses from both point and nonpoint source pollution.

2.7.2 Statewide Classifications and Water Quality Standards

All surface waters in the state are assigned a primary water classification, and they may also be assigned one or more supplemental classifications (Table 2.14).

Table 2.14. Primary and Supplemental Classifications Applicable to the Pasquotank River Basin

PRIMARY CLASSIFICATIONS	
Class	Best Uses
C/SC	Aquatic life propagation/protection and secondary recreation
B/SB	Primary recreation and class C/SC uses
SA	Commercial shellfishing and all other tidal saltwater uses
WS	Water supply
SUPPLEMENTAL CLASSIFICATIONS	
Class	Best Uses
Sw	Swamp Waters: recognizes waters that will naturally be more acidic (have lower pH values) and have lower levels of dissolved oxygen
HQW	High Quality Waters: Waters which are rated as excellent based on biological and physical/chemical characteristics or waters which have received some other special designation from another agency (such as wild trout waters or primary nursery areas (PNAs). HQWs in the Pasquotank River basin have been so classified because they have been designated as PNAs by the Division of Marine Fisheries. Waters classified as SA are considered to be HQW by definition.
ORW	Outstanding Resource Waters: Unique and special waters that are of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses. These waters have been identified as having excellent water quality in conjunction with at least one important resource value.
CA	Critical area surrounding the intake of a surface water supply

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

2.7.3 Surface Water Classifications in the Pasquotank River Basin

The waters of the Pasquotank River basin are assigned several different classifications. The basin includes both fresh and salt waters. The vast majority of the waters are estuarine and classified with primary saltwater classifications such as SC and SB. Since these types of water tend to be wide and open, a numerical characterization of their size is best presented as acreages. Table 2.15 presents acres of primary saltwater and supplemental classifications representing the majority of the waters in the basin.

Table 2.15. Acres of saltwaters by primary and supplemental classifications in the Pasquotank River Basin* (Numbers are approximate.)

	Primary Classifications			Supplemental Classifications		
Classification	SA	SB	SC	HQW	ORW	Swamp
Acres	393,421	310,721	211,444	33	43,622	91,610
% of Total Water Area	43%	34%	23%	<1%	5%	10%

***Note:** Only the primary classification categories are mutually exclusive of each other. Primary and supplemental classification are often combined for individual waters (for example, Alligator River is classified SC ORW; so the acreage for Alligator River is included in the figures for SC and for ORW).

In addition to the information presented above, there is one classified surface water supply area (WS-IV) related to an intake on the Pasquotank River. The Albemarle Sound is classified for primary recreational activities (SB) and the Alligator River is a designated ORW. Class SA (shellfishing) waters in the basin are found in the Roanoke, Croatan and Pamlico sounds. There are no SA waters in the Albemarle Sound. A complete listing of classifications for all surface waters in the basin can be found in a DWQ publication entitled "Classifications and Water Quality Standards Assigned to the Waters of the Pasquotank River Basin". Figure 2.10 provides a map highlighting the water supply, ORW and the limited number of HQWs (designated as such because of their DMF classification as primary nursery areas) in the basin.

2.8 WATER SUPPLY USE IN THE PASQUOTANK RIVER BASIN

2.8.1 State Water Supply Plan Database

The Division of Water Resources is compiling a State Water Supply Plan (SWSP) Database that contains information from Local Water Supply Plans pursuant to GS 143-355 (l) and (m). As of July 30, 1996, 18 of an expected 21 systems that are wholly (or partly) in the Pasquotank River basin are represented in the SWSP Database. The following summary of current and future population and water use is based on these 18 water systems.

Table 2.16 presents the 1992 and projected serviced population for these systems through to the year 2020. Based on this table it may be expected that the population serviced by these systems will increase by 77% percent over the next few decades.

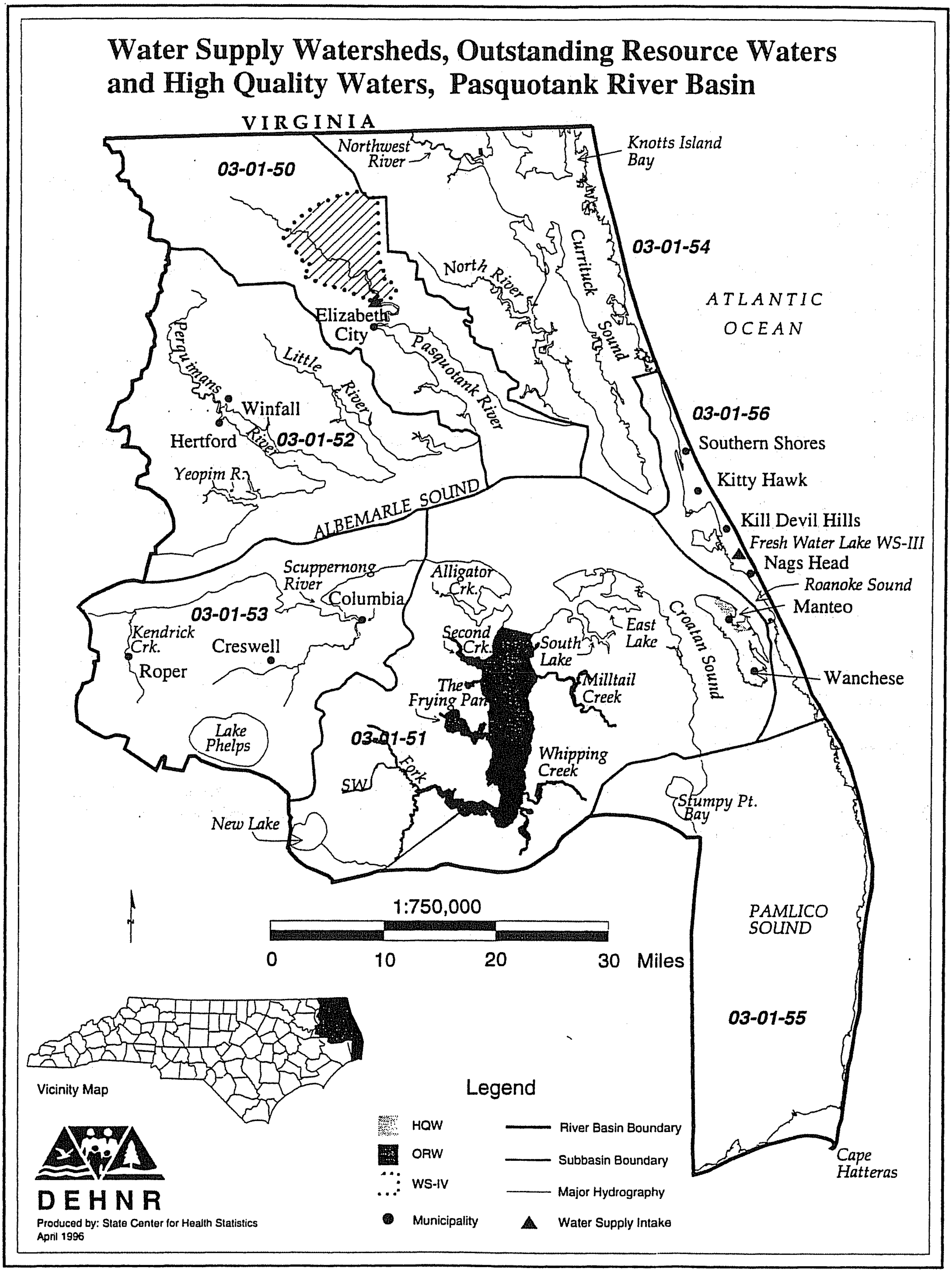

Figure 2.10 Protective Surface Water Classifications in the Pasquotank River Basin.

Table 2.16. 1992 and Projected Service Populations for Water Suppliers in the Pasquotank River Basin that Have Provided Information to the NC Division of Water Resources.

SYSTEM NAME YEAR	1992	2000	2010	2020
SOUTH MILLS	3,413	4,373	5,573	6,000
SOUTH CAMDEN W&S DIST	0	3,100	3,800	n/a
CURRITUCK COUNTY	7,280	9,531	10,031	10,531
NAGS HEAD	1,838	3,308	4,778	4,778
KILL DEVIL HILLS	6,678	8,201	10,662	13,118
MANTEO	1,200	2,000	2,500	4,000
CAPE HATTERAS	6,900	9,000	11,000	12,000
DARE CO	3,658	4,804	6,246	7,684
DARE CO RWS	0	0	0	0
OCRACOKE SANITARY DIST	713	779	829	890
ELIZABETH CITY	14,292	17,000	22,000	29,000
PASQUOTANK CO	12,000	14,520	18,876	24,539
HERTFORD	2,350	2,585	2,843	3,127
WINFALL	501	510	520	530
INTER COUNTY WATER ASSOC	1,325	1,560	1,850	2,140
PERQUIMANS CO	6,469	6,550	7,000	7,200
COLUMBIA	900	1,000	1,200	1,400
TYRRELL CO	3,856	3,717	3,540	3,353
ROPER	669	679	689	699
CRESWELL	n/a	n/a	n/a	n/a
WASHINGTON COUNTY WATER SYSTEM	n/a	n/a	n/a	n/a
TOTAL	74,042	93,217	113,937	130,989

SOURCE: SWSP Database, Division of Water Resources, DEHNR, Not Published

Based on the information submitted by the water suppliers, total average daily use is 680,000 gallons per day. Approximately 78% of the total amount of water supplied goes to residences, while the remaining 22% is used for industrial and commercial purposes.

As Figure 2.11 illustrates, overall projected water use in million gallons per day is expected to steadily increase in the next two decades to almost double the amount of use in 1992. This represents a projected increase of 89% between 1992 and 2020.

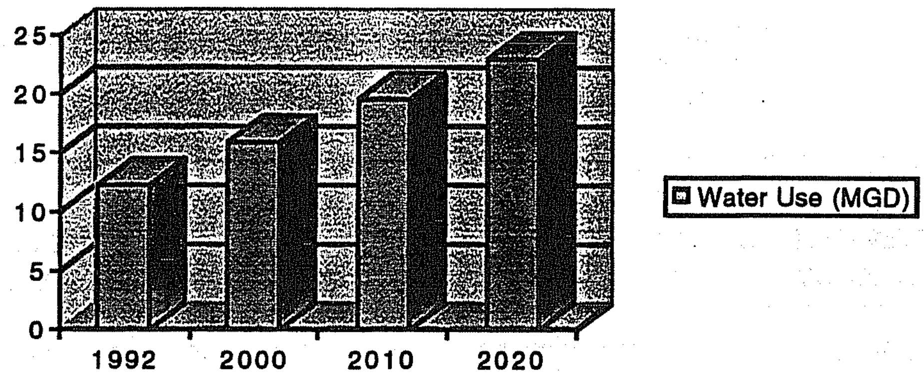

Figure 2.11. Projected Water Use (MGD) in the Pasquotank River Basin
(Source: SWSP Database, Division of Water Resources, DEHNR, Not Published)

2.8.2 US Geological Survey Water Use Information

The US Geological Survey (USGS) maintains a water use database that characterizes whether the source of the water is surface or ground water, as well as what the purpose for which the water is used. Table 2.17 summarizes the USGS data for the Chowan River Basin.

Table 2.17. 1990 Water Withdrawals in the Chowan River Basin in MGD.
(Source: USGS Water Use Database, Not Published, file retrieved from ftp site at... 130.11.144.77 in /var/ftp/pub)

Withdrawal Category	Ground Water	Surface Water	Ground + Surface	Percent of Total
Public Water Supply	77.88	3.63	81.51	95%
Commercial	0.30	0	0.30	<1%
Domestic	1.17	0	1.17	1%
Industrial	0	0.79	0.79	1%
Livestock	0.79	0.13	0.92	1%
Irrigation	0.30	0.78	1.08	1%
Totals	**80.44**	**5.33**	**85.77**	**100**
Percent	**94**	**6**	**100**	

Note: All withdrawal categories other than Public Water Supply are self-supplied. For example, the domestic category represents residents that supply their own water.

The information contained in table 2.17 indicates that the vast majority (94%) of water used in the basin is coming from groundwater sources. A small amount of surface water is used for public water supply purposes as well as for agricultural and industrial uses. Ninety-five percent (95%) of all water used in the basin is devoted to supplying the public with water.

2.8.3 North Albemarle Water Availability Study

The Division of Water Resources has targeted the North Albemarle region for a water resource availability study. The study area encompasses the six counties that lie north of the Albemarle Sound, including Currituck, Camden, Pasquotank, Perquimans, Chowan, and Gates counties. This region continues to experience lower economic growth and higher levels of poverty than the rest of the State. One explanation is the lack of manufacturing jobs. Growth in the manufacturing sector, however, will require additional water supplies. Development of new water sources are hindered by fluctuating chloride levels, high levels of organics and color, algal blooms, falling ground water levels, and limited freshwater aquifers.

In 1993, the Albemarle Commission created a Water Resources Availability Survey Steering Committee to investigate potential sources for expanding the available water supply. The Division of Water Resources has worked with the Committee to assess supply options including expanded ground water development, regional approaches to resource development, dewatering operations of the PCS Phosphate mine, and the Lake Gaston pipeline. One surface water source, the Pasquotank River, has been dismissed as a supply source after monitoring indicated high salinity and organic levels. Recently, the Albemarle Commission released a report by an outside consultant detailing current and potential water resources in the region (Johnston and Weatherly, 1996).

As a part of this effort, the Ground Water Branch of the Division of Water Resources is involved in a regional study of the hydrogeology and ground water resources of the North Albemarle area. The purpose of the study is to assist the region in locating new ground water sources. Ground water supplies identified to date in this region are inadequate to provide for future industrial growth. The ground water study will seek to identify new sources, or provide leads for further exploration work.

The initial task is to define the hydrogeologic framework of the area. The framework involves the delineation and description of the major aquifers and confining units in the study area, definition of ground water flow and hydraulic properties of the system, and determination of the position of the fresh water/salt water interface. Application of a three dimension finite element groundwater model will help in defining ground water flow through the system and the effects of pumping on the fresh water/salt water interface. Of particular concern are the drawdown effects of high volume pumping in the Franklin, Virginia area, located eight miles north of the state line.

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CHAPTER 3

CAUSES AND SOURCES OF WATER POLLUTION

3.1 INTRODUCTION

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

3.2 CAUSES OF POLLUTION

Causes of pollution refers to the substances which enter surface waters from point and nonpoint sources and result in water quality degradation and impairment. The major causes of water quality impairment include biochemical oxygen demand (BOD), sediment, nutrients, toxicants (such as heavy metals, dioxin, chlorine, pH and ammonia) and fecal coliform bacteria. Table 3.1 provides a general overview of causes of impairment and the activities that typically lead to their introduction into surface waters. Each of these causes is discussed in the following sections.

Table 3.1 Causes and Sources of Water Pollution

Cause of Impairment	Potential Source of Pollution
Sediment	Construction and mining sites, disturbed land areas, streambank erosion and alterations, cultivated farmland
Nutrients	Fertilizer on agricultural, residential, commercial and recreational lawns, animal wastes, effluent from aquaculture facilities, leaky sewers and septic tanks, atmospheric deposition, municipal wastewater
Toxic and Synthetic Chemicals	Pesticide applications, disinfectants (chlorine), automobile fluids, accidental spills, illegal dumping, urban stormwater runoff, industrial effluent
Oxygen-Consuming Substances	Wastewater effluent, organic matter, leaking sewers and septic tanks, animal waste
Fecal Coliform Bacteria	Failing septic tanks, animal waste, runoff from livestock operations, wildlife, improperly disinfected wastewater effluent
Road Salt	Applications to snow and ice
Oil and Grease	Leaky automobiles, industrial areas, illegal dumping
Salinity Variations	Hydrological modifications that influence the amount of fresh or saline waters entering a system
Thermal Impacts	Heated landscape areas, runoff from impervious areas, tree removal along streams, wet detention ponds

3.2.1 Fecal Coliform Bacteria

Fecal coliform bacteria are typically associated with the intestinal tract of warm-blooded animals. They are widely used as an indicator of the potential presence of waterborne pathogenic, or disease-causing, bacteria and viruses (e.g., those which cause such diseases as typhoid fever, dysentery, and cholera) because they are easier and less costly to detect than the actual pathogens. The coliform standard, which has been used to indicate the microbiological quality of drinking water, swimming waters, and shellfish harvesting waters for more than 50 years, has often been questioned. Increasing evidence collected during the past several decades suggest that the coliform group may not adequately indicate the presence of pathogenic viruses or parasites in water. Yet, the detection and identification of specific bacteria, viruses and parasites, such as *Giardia* , *Cryptosporidium* , and *Shigella* require large volumes of sample and very sophisticated laboratory techniques which are not commonly available.

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 (DWQ) standard for fecal coliform bacteria is 200 MF/100 ml for all waters except SA waters where the standard is 14 MF/100 ml. (MF is an abbreviation for the Membrane Filter procedure for determining fecal coliform concentrations.) The 200 MF/100 ml standard is intended to ensure that waters are safe enough for water contact recreation. The standard of 14 MF/100 ml in SA waters is intended to ensure that shellfish (oysters) harvested from these waters are safe to eat. The Division of Environmental Health (DEH) applies the same numerical standard to shellfish growing areas (14), but they are required to use a different method of analysis. DEH's standard is a median or geometric mean fecal coliform Most Probable Number (MPN) not greater than 14/100 ml, and not more than 10% of the samples in excess of 43 MPN/100 ml. The MPN is derived from using the multiple-tube method of sample analysis.

DEH's Shellfish Sanitation Program (Fowler, 1994) - DEH has subdivided all coastal waters in the state into shellfish growing areas. For each growing area, DEH must conduct a sanitary survey once every three years. A sanitary survey is comprised of a shoreline survey, a hydrographic survey, and a bacteriological survey. The shoreline survey is used to identify potential pollution sources. The hydrographic survey evaluates meteorological and hydrographic features of the area that may affect the distribution of pollutants and the bacteriological survey assesses water quality using fecal coliform sampling. Based on the results of the survey, the waters are classified by DEH into one of the following categories:

- Approved Area - an area determined suitable for the harvesting of shellfish for direct market purposes.
- Conditionally Approved Open - waters that are normally open to shellfish harvesting but are closed on a temporary basis in accordance with management plan criteria.
- Conditionally Approved Closed - waters that are normally closed to shellfish harvesting but are open on a temporary basis in accordance with management plan criteria.
- Restricted Area - an area from which shellfish may be harvested only by permit and subjected to an approved depuration process or relayed to an approved area.
- Prohibited Area - an area unsuitable for the harvesting of shellfish for direct market purposes.

An area is considered approved for shellfish harvesting only if the median fecal coliform MPN or the geometric mean MPN does not exceed 14/100 ml and if no more than 10 percent of the samples exceed a MPN of 43/100 ml. Numerous closed areas have median levels below 14 but fail to meet the second criteria due to periodic contamination usually occurring after moderate to heavy rainfall.

Fecal colform bacteria enter surface waters from nonpoint source runoff, but they also come from improperly treated discharges of domestic wastewater. Common potential nonpoint sources of fecal coliform bacteria include leaking or failing septic systems, leaking sewer lines or pump station overflows, runoff from livestock operations, urban stormwater and wildlife. Fecal coliform bacteria in treatment plant effluent are controlled through disinfection methods including chlorination (often followed by dechlorination), ozonation or ultraviolet light radiation.

Fecal Coliform Bacteria in the Pasquotank River Basin
Fecal coliform bacteria are contributing to the impairment of 4,862 acres of estuarine waters in the Pasquotank River Basin. Although this is a sizable number of acres, it represents less than 1% of the total acreage of estuarine waters in the basin. All of the estuarine waters in the Pasquotank that are impaired due to fecal coliform concentrations are designated SA (shellfishing) areas that have been closed to shellfish harvesting by DEH. The main areas of closed shellfish (SA) waters in the basin are in Roanoke Sound and Croatan Sound. The activities that have been identified as contributing to the impairment are urban runoff, failing septic tank systems and marinas.

Management strategies for addressing fecal coliform bacteria are presented in Chapter 6.

3.2.2 Toxic Substances

Regulation 15A NCAC (North Carolina Administrative Code) 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 and pesticides) heavy metals and pH. 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 1) monitoring indicates that the parameter may be causing toxicity or, 2) federal guidelines exist for a given discharger for an action level substance. This process of determining action levels exists because these toxic substances are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics and/or associated waste characteristics. Water quality based limits may also be assigned to a given NPDES permit if data indicate that a substance is present for which there is a federal criterion but no water quality standard.

Whole effluent toxicity (WET) testing is required on a quarterly basis for major NPDES dischargers (≥ 1 MGD) 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 follow-up testing is called a toxicity reduction evaluation (TRE). WET testing is discussed in Section 4.2.1 of Chapters 4. Other testing, or monitoring, done to detect aquatic toxicity problems include fish tissue analyses, chemical water quality sampling and assessment of fish community and bottom-dwelling organisms such as aquatic insect larvae. These monitoring programs are discussed in Chapter 4.

Each of the substances below can be toxic in sufficient quantity or concentration.

Dioxin

Dioxin contamination is found throughout the world. Dioxins and similar contaminants such as furans and polychlorinated benzenes (PCB) are present as trace impurities in some commercial products. Dioxin is generated through processes such as:

- Production of chlorinated phenols and their derivatives (i.e. herbicides),
- High temperature combustion processes (i.e. incinerators), and
- Chemical bleaching of pulp (in the production of paper).

Dioxins are not intentionally generated, but are unwanted by-products in the production of other items. These contaminants occur everywhere in the environment from sediment and living organisms to consumer products such as bleached paper products. Due to recent research and tighter standards, production of dioxins has been greatly reduced.

Dioxin is chemically stable and bioaccumulates in animal tissues. This means that organisms higher up in the food chain tend to have greater concentrations of the chemical. The biological effects on humans that have been associated with dioxin include, but are not limited to:

- death (high doses),
- chloracne (similar to skin rash) from direct contact to skin,
- carcinogenicity (cancer),
- wasting syndrome,
- thymus atrophy, and
- reproductive impairment including fetal toxicity and testicular atrophy.

Dioxin is very hydrophobic (does not mix with water) and, as a result, it binds tightly with sediment, food particles and organic matter in the water column, leaving extremely low concentrations dissolved in water. When these particles are taken into an aquatic organism such as fish, the dioxin tends to accumulate in the organism's lipids (fats). Due to dioxin's low rate of breakdown, organisms exposed to continuous sources of dioxin tend to bioaccumulate dioxin. That fact is why larger fish such as bowfin and bass tend to have higher levels of dioxin in their bodies than fish which eat lower in the food chain (algae or plants) and higher in the water column.

Dioxin in the Pasquotank River Basin

The Albemarle Sound west of a line from Bull Bay (at the mouth of the Scuppernong River) to Harvey Point (near the mouth the Perquimans River) (see Figure 3.1) is under a fish consumption advisory because of dioxin contamination. Two major river systems that feed the head of the sound, the Roanoke and Chowan rivers, are contaminated with dioxin from upstream paper mills. These facilities have upgraded their facilities and eliminated dioxin from their effluent, but the pollutant has not yet worked its way out of the system. The current advisory recommends that the general population consume no more than two meals per person per month and that children and pregnant or nursing women consume no fish until further notice. Herring, shellfish and shad (including roe) are not included in the advisory.

pH

Changes in pH to surface waters can result from point and nonopoint sources discharges, pH levels can be naturally low in areas of the coastal plain, including the Pasquotank River basin. As the pH of a water body decreases, metals are more bioavailable within the water column and are therefore more toxic to the aquatic organisms. As the pH increases, metals are precipitated out of the water column and less toxic to aquatic organisms. If a surface water has had chronic introductions of metals and the pH gradually or dramatically decreases, the metals in the substrate will become more soluble and be readily available in the water column. While lower pH values

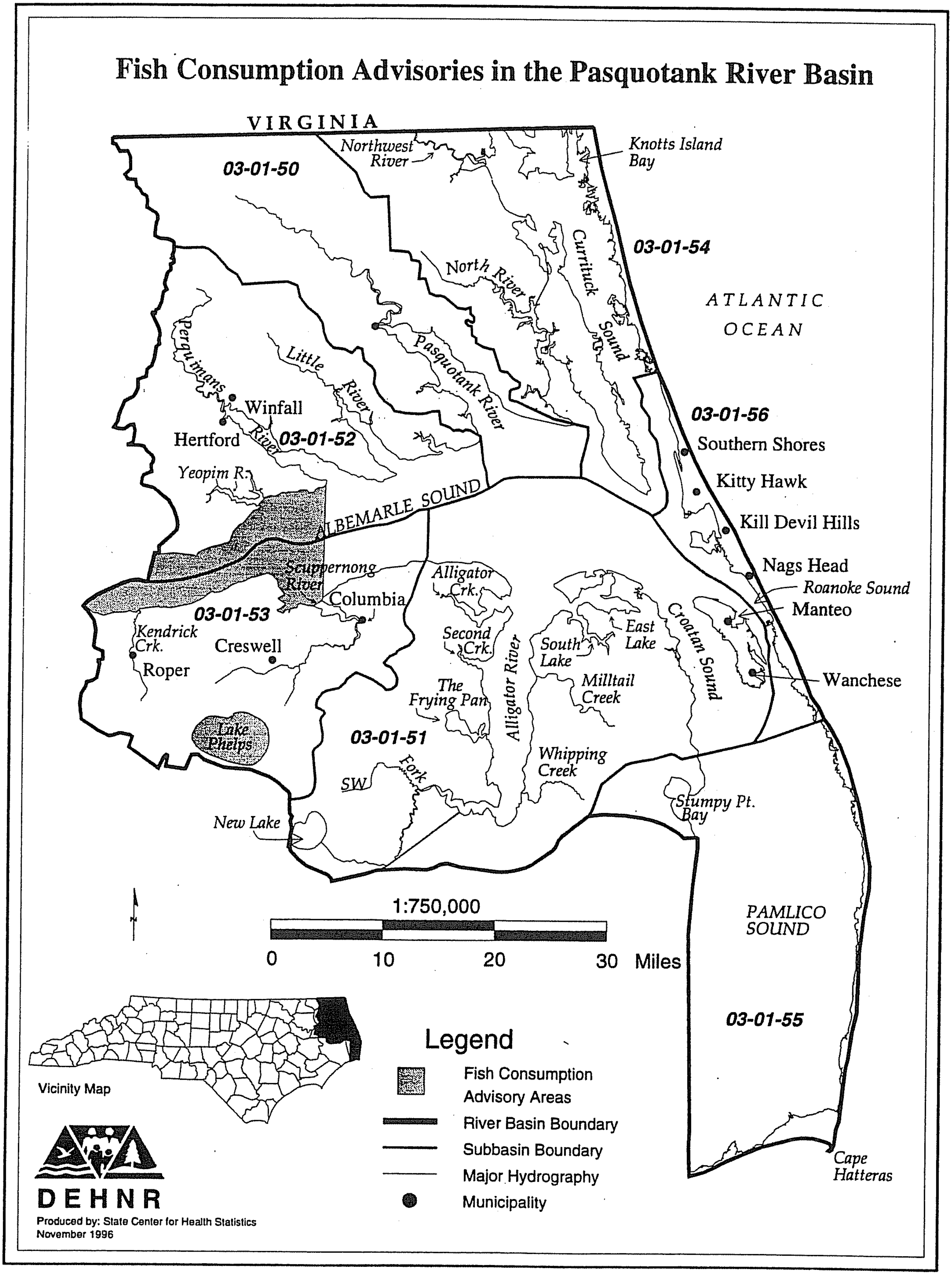

Figure 3.1. Location of Fish Consumption Advisories in the Pasquotank River Basin

may not be toxic to the aquatic organisms, the lower values can have chronic effects on the community structure of macroinvertebrates, fish, and phytoplankton. Macroinvertebrates will show a shift from tolerant species to intolerant species and have less community diversity.

The NC standard for pH in fresh waters is from 6.0 to 9.0 SU (standard units). For salt waters the criterion is 6.8 to 8.5 SU because salt waters are generally less acidic. The supplemental 'swamp' (Sw) classification is applied to waters that have naturally acidic waters and allows for lower pH levels.

pH in the Pasquotank Basin

Many waters in the Pasquotank basin are supplementally classified as swamp waters and can have naturally acidic pH values. Ambient monitoring, in fact, does indicate that pH levels tend to be lower than the standard criterion in the swamp waters in the basin. However, there are waters not classified as swamp waters that have pH levels that exceed the standards. These include (along with the percentage of deviations from pH criterion): 1) Pasquotank River at Elizabeth City (25%); 2) Perquimans River at Hertford (>70%); 3) Kendricks Creek at Mackeys (>80%); and 4) Scuppernong River near Columbia (>20%). It is likely that the pH is naturally low and that these pH violations do not indicate a man-induced problem. However, DWQ should investigate these waters to determine whether they should receive a swamp (Sw) supplemental classification.

Metals

Municipal and industrial dischargers and 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 in municipal permits are cadmium, chromium, copper, nickel, lead, mercury, silver and zinc. Standards are listed in Appendix I. Each of these, 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 are employed to determine allowable concentrations for a permit limit. Municipalities with significant industrial users discharging wastes to their treatment facilities limit the heavy metals from these industries through a *pretreatment program*. Source reduction and wastewater recycling at WWTPs also reduces the amount of metals being discharged to a stream. Nonpoint sources of pollution are controlled through best management practices.

In North Carolina, as well as many other areas of the country, mercury contamination in fish is causing the need to post widespread fish consumption advisories. The source of the mercury, which is found all along the east coast from Maine to Florida, is unclear. There is suspicion that it is entering surface waters through atmospheric sources, and there are studies underway to determine whether or not this is the case.

Metals in the Pasquotank Basin

Mercury contamination is most prevalent in Pasquotank subbasins 50, 53 and 54 with a significant portion of fish tissue samples in these drainages containing mercury above the EPA and/or FDA action levels. Elevated mercury levels were most often associated with long lived piscivores (bass and bowfin) collected from surface waters with low productivity and low pH.

Significant mercury contamination was identified at Lake Phelps with over 50% of fish samples containing levels above human health standards. Mean mercury levels for bass and bowfin collected at Lake Phelps were 1.16 ppm and 1.4 ppm respectively. The FDA action level for mercury is 1.0 ppm and the EPA screening values is 0.6 ppm. Phelps Lake is unique in the fact that it possesses a minimal drainage area, receives most of its hydrologic input from the atmosphere, and represents a minimally impacted system. Atmospheric mercury deposition may therefore be a significant source for the observed mercury levels, although mercury is known to occur naturally in the high organic peat soils of North Carolina. The Division of Air Quality has initiated a year-long study to assess atmospheric mercury deposition in the Phelps Lake area. The study will focus on the measurement of ambient mercury levels in the atmosphere around Phelps, as well as deposition rates of mercury through precipitation. In June of 1996 the State Health Director issued a fish consumption advisory for bass and bowfin in Phelps Lake due to elevated mercury (see Figure 3.1). The advisory recommends that the general population consume no more than 2 meals of the fish per month, and child-bearing women and children consume no fish. On June 12, 1997, a statewide consumption advisory on bowfin was issued due to unsafe mercury levels. The advisory recommends that the general population consume no more than 2 meals of the fish per month, and child-bearing women and children consume no fish.

Chlorine

Chlorine is a commonly used disinfectant at NPDES discharge facilities which have a domestic (i.e., human) waste component. These discharges are a major source of chlorine in the State's surface waters. Chlorine dissipates fairly rapidly once it enters the water, but its toxic effects can have a significant impact on sensitive aquatic life such as trout and mussels. An action level has been established for all waters. A standard for all waters may be adopted in the 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 (NH_3)

Point source dischargers are one of the major sources of ammonia. In addition, decaying organisms which may come from nonpoint source runoff and bacterial decomposition of animal waste also contribute to the level of ammonia in a waterbody. At this time, there is no numeric standard for ammonia in North Carolina. However, DWQ has developed 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.

3.2.3 Oxygen-Consuming Wastes

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

The concentration of dissolved oxygen (DO) in a water body is one indicator of the general health of an aquatic ecosystem. Dissolved oxygen concentrations are affected by a number of factors. Higher dissolved oxygen is produced by turbulent actions, such as waves, which mix air and water. Lower water temperatures also generally allows for retention of higher dissolved oxygen concentrations. Low dissolved oxygen levels tend to occur more often in warmer, slow-moving waters. In general, the lowest dissolved oxygen concentrations occur during the warmest summer months and particularly during low flow periods. Water depth is also a factor. In deep slow-moving waters, such as reservoirs or estuaries, dissolved oxygen concentrations may be very high near the surface due to wind action and plant (algae) photosynthesis but may be entirely depleted (anoxic) at the bottom.

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

Industrial discharges with oxygen consuming wasteflow may be resilient instream and continue to use oxygen for a long distance downstream.

Oxygen-Consuming Waste in the Pasquotank River Basin

In the Pasquotank River basin, portions of the Little River, Kendricks Creek and the Scuppernong River are considered impaired and one of the problem parameters identified is dissolved oxygen. In all of these waters, low dissolved oxygen is coupled with acidic pH levels, suggesting swamp water conditions. Many other small tributary creeks and upper river areas exhibit the same low dissolved oxygen conditions and pH levels.

Point Source Wasteflow and BOD changes from 1987 to 1996

Wasteflow and BOD data from the discharge monitoring reports (DMR) for 1987 and 1996 were evaluated for point source inputs to the basin. Average daily loads for BOD were pulled from the DMRs, multiplied by 365 and added together to get the total annual point source load for BOD. The estimated wasteflow increased from 803 million gallons per year in 1987 to 1,223 million gallons per year in 1996 (34% increase). Although the wasteflow increased, the estimated BOD loads decreased from 239,477 pounds per year to 203,349 pounds per year (15% decrease). The increases in wasteflow to the system are largely due to existing facilities expanding their wasteflow.

3.2.4 Nutrients

The term *nutrients* in this document refers to two major plant nutrients, phosphorus and nitrogen. These are common components of fertilizers, animal and human wastes, vegetation, effluent from aquaculture facilities and some industrial processes. Nutrients in surface waters come from both point and nonpoint sources. Nutrients are beneficial to aquatic life in small amounts. However, in over-abundance and under favorable conditions, they can stimulate the occurrence of algal blooms and excessive plant growth in quiet waters such as ponds, lakes, reservoirs, creeks, rivers and estuaries.

Nutrients in the Pasquotank River Basin

Although no waters in this subbasin have been supplementally classified as nutrient sensitive, there are areas where nutrients are elevated and algal blooms occur. The Chowan River, which has been designated as Nutrient Sensitive Waters, is a major tributary to the Albemarle Sound. The Pasquotank River, the upper Alligator River, Tulls Creek, the North Landing River and Currituck Sound have all been identified as having elevated nutrient levels. Some of these areas are also experincing algal blooms associated with nutrient enrichment. Nonpoint sources of pollution have been identified as the major contributor of high nutrient levels. The following nutrient budget for the Pasquotank River Basin provides a general characterization of relative loadings to the waters from different contributing activities.

Estimated Nutrient Loads in the Pasquotank River Basin

In the interest of characterizing the relative contributions of nutrients to the Pasquotank River Basin from different sources within the entire watershed, an updated nutrient budget was developed for the total basin. Phosphorus and nitrogen loading estimates were calculated and summarized for each of the six Pasquotank subbasins designated by DEHNR. (For purposes of this analysis subbasins 030155 and 030156 were combined due to their adjacent locations and the relatively small land area in 030156.) Table 3.2 summarizes the loading estimates and relative contributions from and within each subbasin according to the land uses/areas and point source discharges in them. Point source loads represent the annual loads from permitted dischargers in the basin under current conditions (calendar year 1996). Nonpoint source loads represent the net export of

TABLE 3.2
NUTRIENT LOADS FOR SIX SUBBASINS IN THE PASQUOTANK RIVER BASIN

	PHOSPHORUS LB/YR	PHOSPHORUS % of Load	NITROGEN LB/YR	NITROGEN % of Load	AREA %
Subbasin 03 01 50 (238,214 ac)					
DEVELOPED LAND	2,578	2%	18,211	1%	1%
AGRICULTURE	80,726	56%	801,755	48%	39%
FOREST/WETLAND	11,281	8%	195,535	12%	40%
POINT SOURCE	19,697	14%	58,675	4%	
ATMOSPHERIC DEPOSITION	30,434	21%	580,351	35%	22%
Total	144,716	100%	1,654,527	100%	100%
Subbasin 03 01 51 (632,066 ac)					
DEVELOPED LAND	377	<1%	2,664	<1%	0%
AGRICULTURE	55,213	23%	548,365	14%	10%
FOREST/WETLAND	39,000	16%	676,002	17%	51%
POINT SOURCE	1,437	1%	3,558	<1%	
ATMOSPHERIC DEPOSITION	141,707	60%	2,702,212	69%	39%
Total	237,734	100%	3,932,801	100%	100%
Subbasin 03 01 52 (341,656 ac)					
DEVELOPED LAND	2,110	1%	14,903	1%	1%
AGRICULTURE	122,175	63%	1,213,418	48%	41%
FOREST/WETLAND	12,938	7%	224,264	9%	32%
POINT SOURCE	198	<1%	12,218	<1%	
ATMOSPHERIC DEPOSITION	55,101	29%	1,050,722	42%	28%
Total	192,522	100%	2,515,525	100%	100%
Subbasin 03 01 53 (290,057 ac)					
DEVELOPED LAND	293	<1%	2,067	<1%	0%
AGRICULTURE	82,328	57%	817,671	41%	32%
FOREST/WETLAND	13,558	9%	235,005	12%	39%
POINT SOURCE	285	<1%	3,185	<1%	
ATMOSPHERIC DEPOSITION	48,441	33%	923,720	47%	29%
Total	144,905	100%	1,981,648	100%	100%
Subbasin 03 01 54 (274,173 ac)					
DEVELOPED LAND	1,222	1%	8,629	<1%	1%
AGRICULTURE	54,626	42%	542,536	28%	23%
FOREST/WETLAND	12,493	10%	216,538	11%	38%
POINT SOURCE	0	0%	0	0%	
ATMOSPHERIC DEPOSITION	62,636	48%	1,194,403	61%	39%
Total	130,977	100%	1,962,106	100%	100%
Subbasin 03 01 55 & 56 (388,465 ac)					
DEVELOPED LAND	1,250	1%	8,830	<1%	0%
AGRICULTURE	7,517	4%	74,657	2%	2%
FOREST/WETLAND	4,946	2%	85,731	2%	11%
POINT SOURCE	109	<1%	1,228	<1%	
ATMOSPHERIC DEPOSITION	195,686	93%	3,731,533	96%	87%
Total	209,508	100%	3,901,979	100%	100%

nutrients from areas of varying land use or land cover within each subbasin. The nonpoint source loads were calculated using an export coefficient model utilizing land cover information derived from 1988 Landsat (satellite image) data and nutrient export estimates derived from previous studies in central and eastern North Carolina. Atmospheric loadings from areas of open water were also calculated using export coefficients. The specific methodology utilized is discussed in further detail in Appendix VII.

It is important to note that these loading estimates do not take into account any contribution from the Virginia portion of the basin. (DWQ has endeavored to obtain this information from the Virginia Department of Environmental Quality, but this information was not made available in time for inclusion in this analysis). It is also important to note that this method of calculating nutrient loads does not estimate the amount of a nutrient **delivered** to a certain point in the river. For instance, if a pound of nitrogen is put in the headwaters of the Scuppernong River the entire pound will not be carried down to the Albemarle Sound. Rather, some portion of that pound will be broken down and/or utilized by the natural system as it is being transported. Interpretation of the satellite data also introduces some uncertainty into the export coefficient approach. For example, most large areas of open land such as golf courses and school yards are grouped into the agricultural land cover category. By the same token, cotton fields are often lumped into the scrub land category which is grouped in with forests in terms of the export coefficient that is applied yielding a lower estimate of nutrients delivered than would be appropriate for cotton fields.

As shown in Figures 3.2 and 3.3 , the current nutrient budget indicates that loading to the North Carolina portion of the basin is dominated by contributions from atmospheric deposition. This is primarily due to extensive areas of open water in the basin. Atmospheric deposition accounts for a full 64% of the nitrogen load to the basin, or about 10 million of the 16 million pounds per year TN (total nitrogen) load. Subbasin 030155 alone accounts for 4 million pounds per year of the basinwide TN load and over 200,000 pounds per year of the basinwide TP (total phosphorus) load because it is predominantly composed of large open areas of Pamlico Sound (over 300,000 acres). Large contributions of nitrogen and a significant amounts of phosphorus originate from the other subbasins with significant portions of open water. Scientifically speaking, our understanding of atmospheric deposition and its role in the overall nutrient cycle of estuaries is somewhat limited, but recent and ongoing studies are underway in North Carolina to address this issue.

With regard to the agricultural nutrient contribution to the basin, it is important to note that its magnitude and proportion may be overestimated by this method because the export coefficients do not account for specific land management practices on a localized basis. As a result, reductions obtained from the use of agricultural BMPs, such as no-till farming or flow control structures, are not reflected in the load estimates. However, even with such reductions taken into account, agriculture would remain a significant source of nitrogen and phosphorus in the Pasquotank River basin due to the amount of agricultural land area in the watershed.

Due to the elimination of several municipal wastewater discharges in favor of spray irrigation systems during the 1980s the portion of the nutrient load from point sources has declined steadily over the past 10-15 years to the current estimate of about 1 and 2% of the total load for nitrogen and phosphorus, respectively. Of the 22,000 lbs/yr TP and 79,000 lbs/yr TN contributed by point sources, the discharge from the Elizabeth City Wastewater Treatment Plant contributes 20,000 lbs/yr or roughly 90% of the point source TP and 59,000 lbs/yr, about 75% of the point source TN for 1996. However, an extensive upgrade of the Elizabeth City facility is currently under way, and it is expected that the improvements will result in lower levels of nutrient loading.

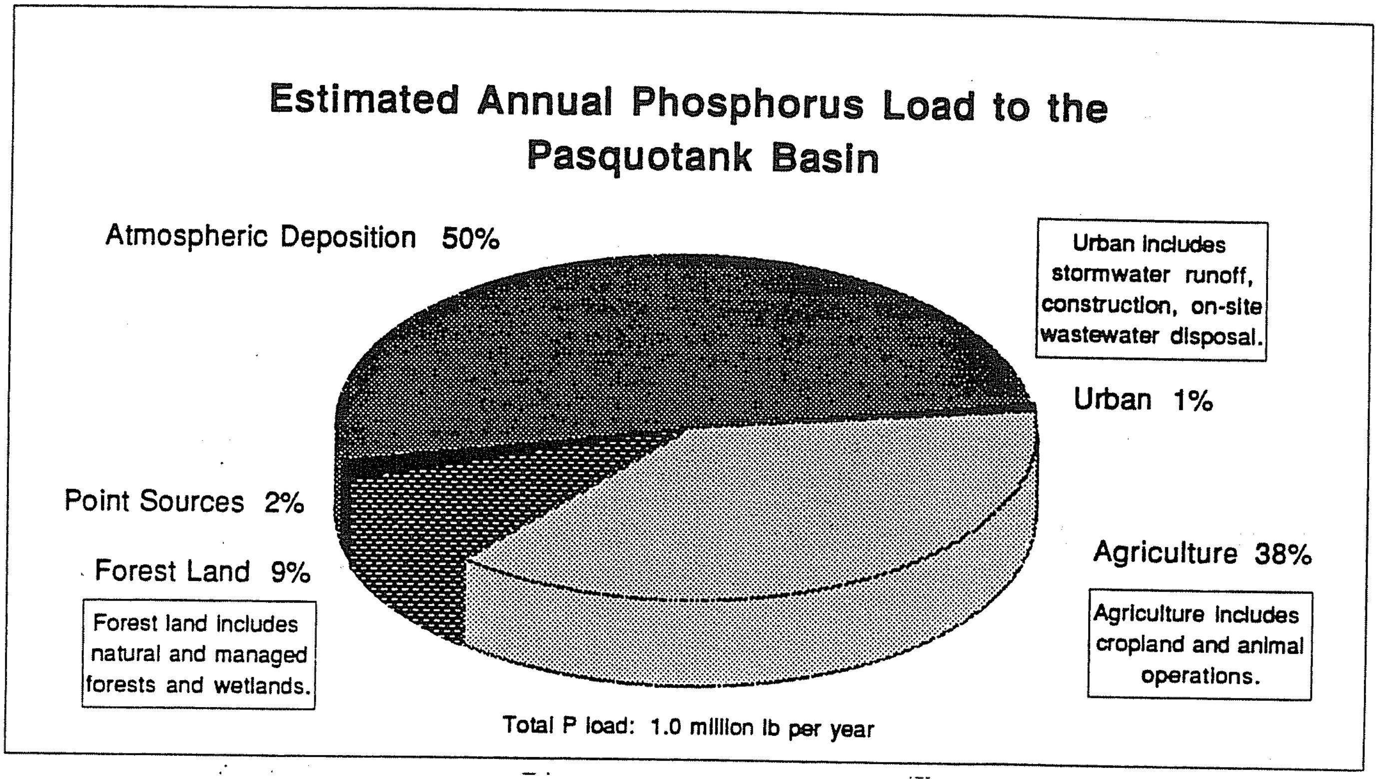

Figure 3.3 Estimated annual nitrogen load to the Pasquotank basin.

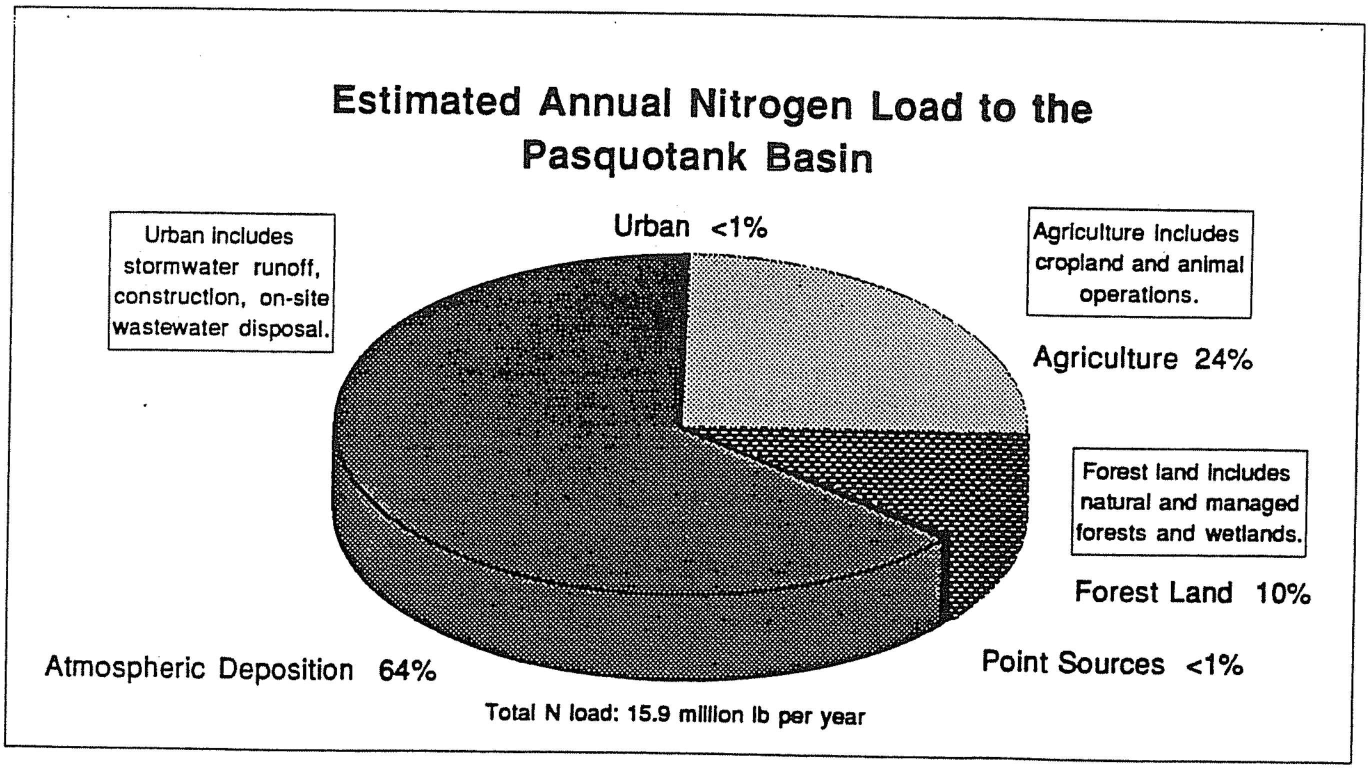

Figure 3.2 Estimated annual phosphorus load to the Pasquotank basin.

Figures 3.4 and 3.5 illustrate the estimated nutrient loads per unit area for each of the four subbasins. The largest phosphorus and nitrogen loads proportional to land area come from subbasin 030152, due to it having the highest percentage of agricultural land (41%). The smallest nutrient loads per unit area are estimated to come from the largest subbasin by land area, 030151, primarily due to the fact that it has the highest proportion of forest/wetland area (51%).

Basinwide Point Source Nutrient Changes from 1987 to 1996
Total point source phosphorus and nitrogen loads to the Pasquotank River were evaluated for years 1987 and 1996. Data from the discharge monitoring reports (DMR) were pulled to determine changes in loading to the system over the years. Average daily loads for phosphorus and nitrogen were used for this analysis and multiplied by 365 then added together to get the estimated total yearly point source loading for nitrogen and phosphorus. The estimated total nitrogen load decreased from 105,380 pounds per year in 1987 to 78,864 pounds per year in 1996 (26% decrease). The estimated total phosphorus load increased slightly from 21,162 pounds per year in 1987 to 21,726 pounds per year in 1996 (3% increase). These changes in nutrient output occurred while the wasteflow in the basin increased 34%, therefore this reflects an improvement in treatment technology. In addition, the slight increase in phosphorus loading from point sources can be attributed to the lack of effluent data for nutrients (this may also account for the a small % decrease in nitrogen from 1987 to 1996) reported in the DMRs in 1987. The decrease in nitrogen was in large part due to the reduction from the Elizabeth City facility, where ongoing improvements may cause further nutrient reductions in the near future.

3.2.5 Extreme or Unnatural Salinity Variations

In the Pasquotank River basin, Currituck Sound has been effected by hydrological changes that have modified salinity levels in the sound. Although salinity is natural to coastal waters, unnatural alterations that increase or decrease the amount of freshwater entering a system, can affect aquatic life (fish species as well as vegetation) that are suited to specific levels of salinity. In Currituck Sound salinity changes have had an impact upon a variety of important biological resources. In recent years, fluctuations in salinity levels have resulted in significant losses of the once diverse and extensive submerged aquatic vegetation (SAV) beds and have contributed to reductions in fish and waterfowl populations (see discussion below).

The Currituck Sound system is a long, narrow, shallow estuary stretching north to south for about 50 miles, but averaging only 4 miles in width, east to west (Figure 3.6). Its northernmost portion, Back Bay, originates with headwaters in the highly urbanized Tidewater Area of southeastern Virginia. The south border of the Currituck Sound is an open mouth to the slightly more saline Albemarle Sound. Because this border is about 25 miles north of Oregon Inlet, lunar tides have little to no effect on the Currituck, except in the most southern portion. Instead, tides are almost entirely wind driven with significant flushing and mixing events caused by storms and other periods of high wind. The main body of Currituck Sound has 100,000 surface acres of fresh to brackish waters with salinities rarely exceeding 3.0 ppt historically (Currituck Sound Task Committee, 1980). The Sound has an average depth of about 5 feet. Back Bay has an additional 26,000 surface acres with an average depth of only 4 feet. The entire watershed covers approximately 733 square miles. Land use in the watershed is widely mixed with the urban and suburban City of Virginia Beach to the north and the predominantly rural landscape of Currituck County to the south. The rural portions support a great deal of row crop agriculture as well as some forestry production. Urban growth pressure may be the biggest challenge to water quality in the sound, with the rapid development occurring on the Currituck portion of the outer banks and the continued suburban sprawl of Virginia Beach. Figures from the 1990 census indicated that Currituck was the eighth fastest growing county in North Carolina and that Virginia Beach was the second fastest growing city in the United States.

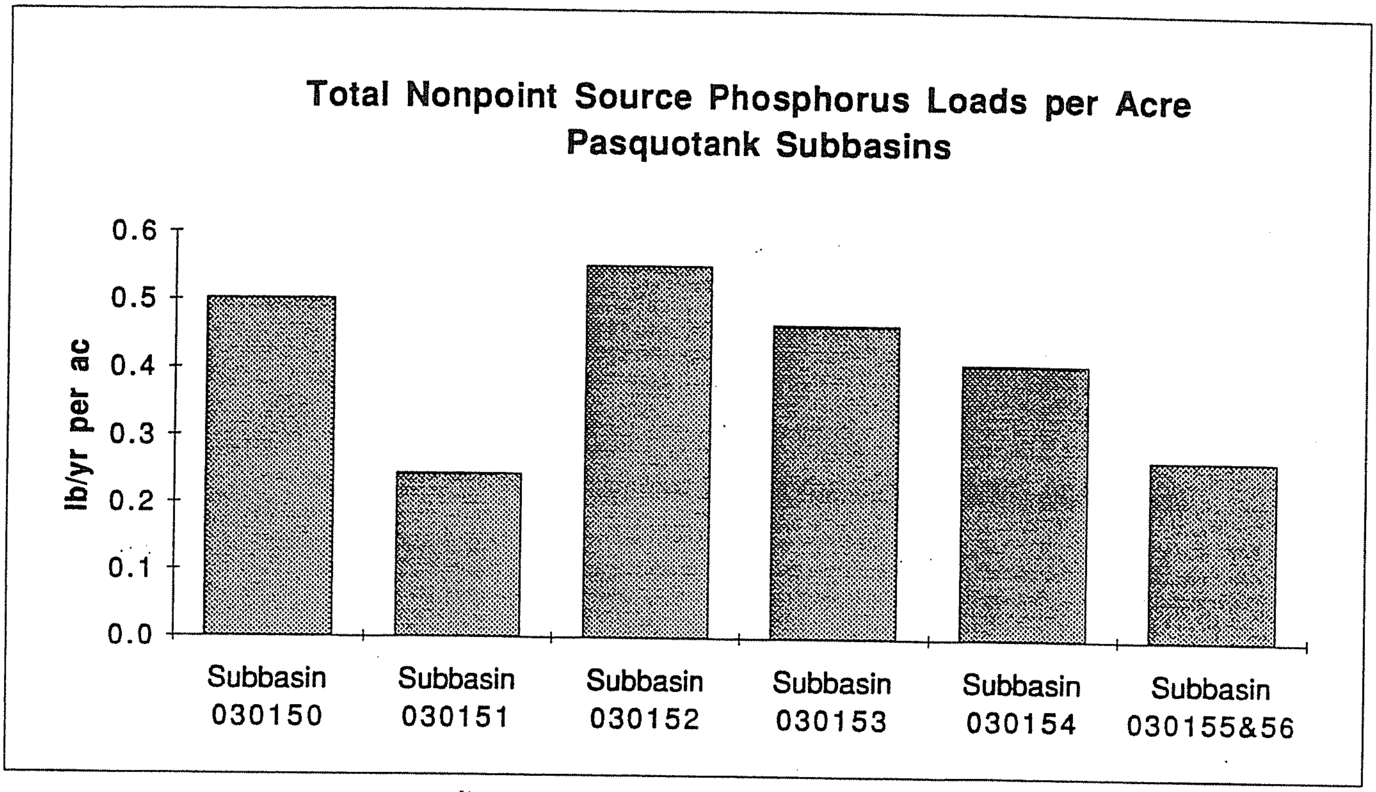

Figure 3.4 Total nonpoint source phosphorus loads per acre - Pasquotank subbasins.

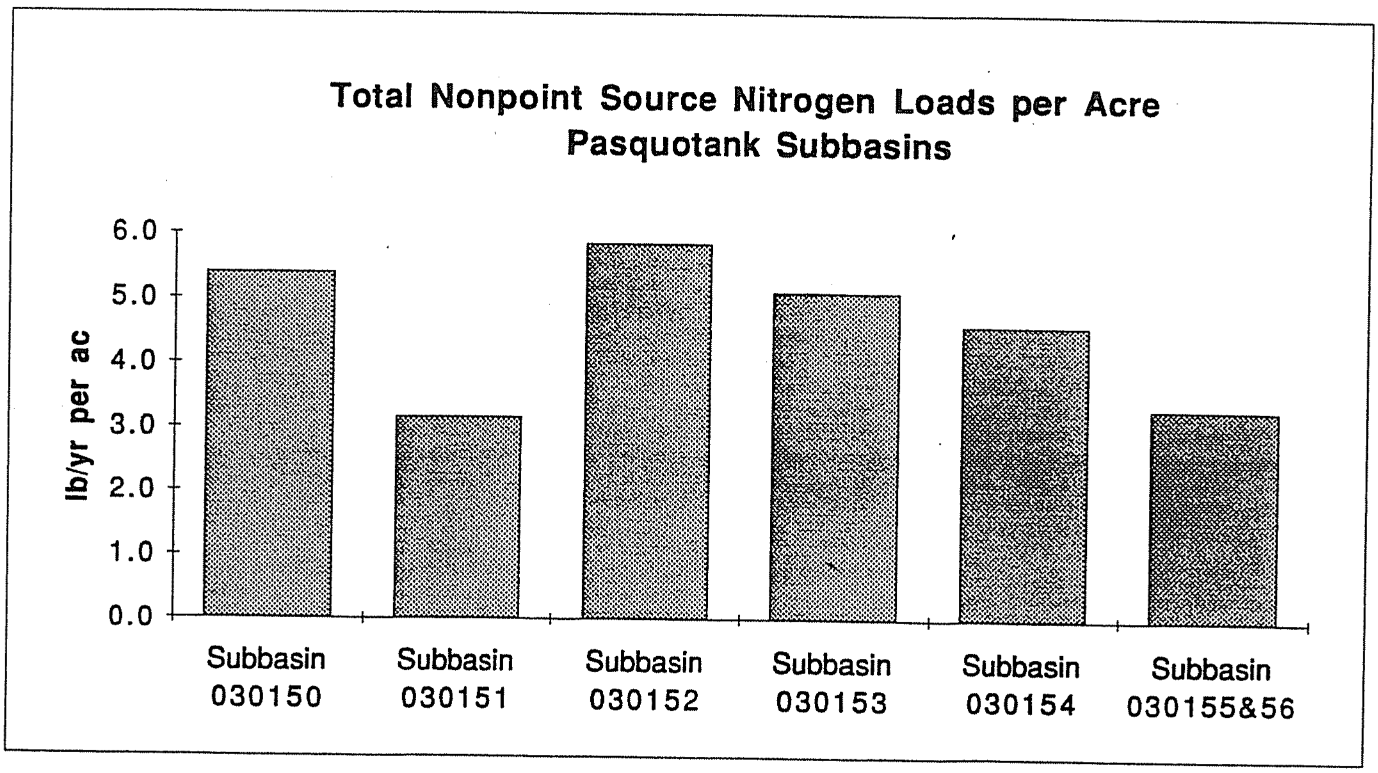

Figure 3.5 Total nonpoint source nitrogen loads per acre - Pasquotank subbasins.

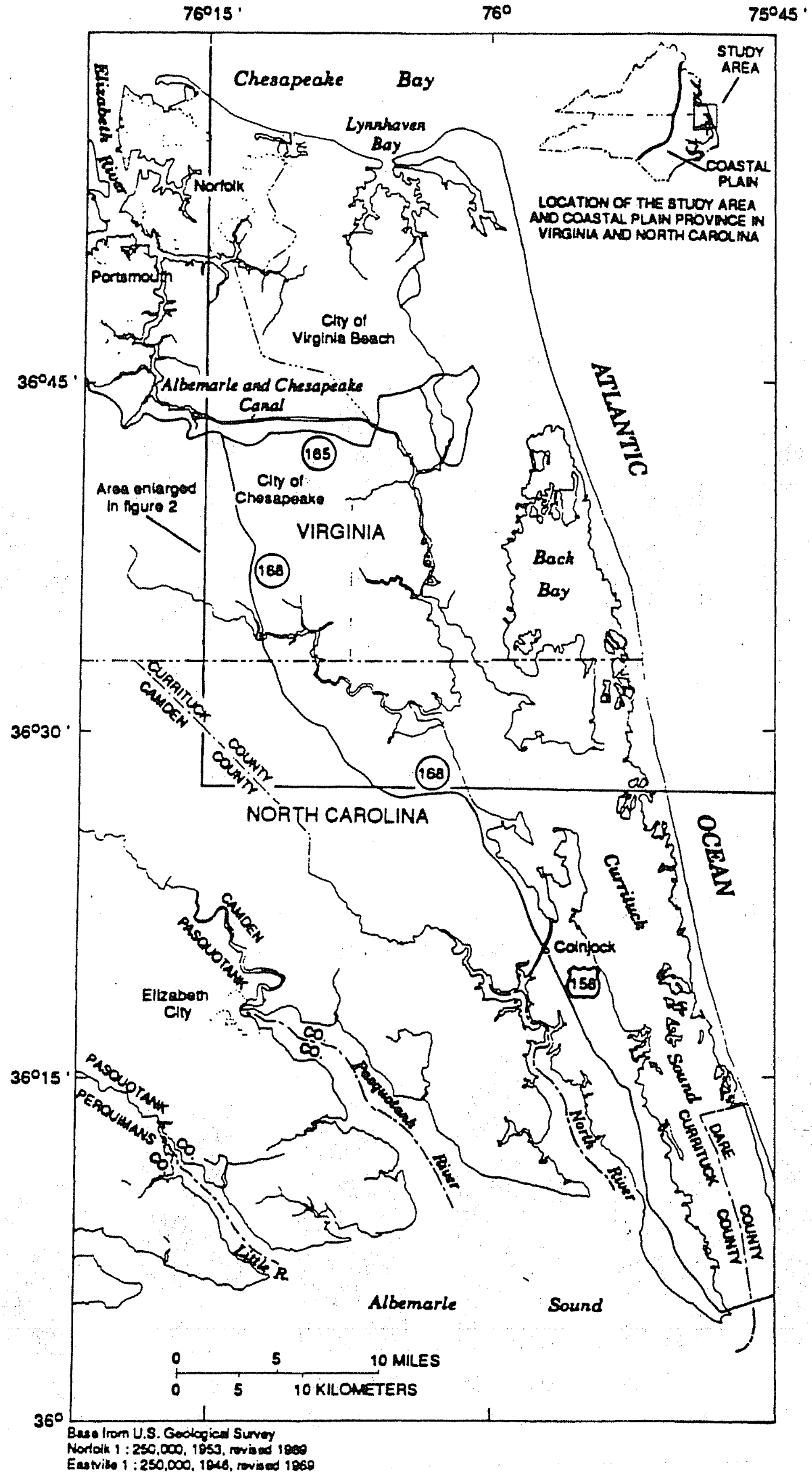

Figure 3.6. US Geological Survey map of Currituck Sound, tributaries and vicinity.

History of Hydrological Conditions in Currituck Sound

Up until the early 1800's the sound was a more tidal salt water estuary due to the Old Currituck Inlet just below the North Carolina - Virginia border. However, construction of the Dismal Swamp Canal diverted a significant portion of the freshwater flow in the sound's tributaries further south to the Albemarle Sound, which allowed the inlet to close in 1830, and the sound began the transition to a brackish water system (Yates Barber, personal communication).

In the 1850's the first portions of the Atlantic Intracoastal Waterway (AIWW) were dug from the southern branch of the Elizabeth River to the upper North Landing River (Albemarle and Chesapeake Canal) in Chesapeake, Va. and from Coinjock Bay to the North River (Coinjock Canal) in Currituck County. The northern connection linked Currituck Sound to the saline waters of the Elizabeth River, a tributary to the Chesapeake Bay, but the intrusion of salt water was minimized by the construction of a lock at Great Bridge. However, beginning in 1917, the lock was left open for several years, allowing free movement of saline water into Currituck Sound along with large volumes of fine silt dredge spoils from the canal (Davis and Brinson, 1989). The fluctuations in salinity and the dramatic increase in turbidity from suspended solids wiped out the extensive SAV and devastated water quality and the dependent natural resources in the sound. The lock was closed again in 1932, allowing the sound to recover (Yates Barber, personal communication).

In the early 1960's an exotic species of aquatic vegetation, Eurasion Water Milfoil (*Myriophyllum spicatum*) invaded Currituck Sound and by about 1966, had spread throughout the entirety of the sound, becoming the dominant species of SAV for several years. Although the milfoil provided a great deal of valuable fish habitat and a potential food source for waterfowl, the dense, broadly dispersed beds of the exotic vegetation significantly altered the flushing patterns of the sound. Prior to the milfoil invasion, a nor'easter would push as much as half the sound's volume out to the south flushing much of the accumulated nutrients with it. With the flushing action diminished, nutrient concentrations increased, which in turn increased the frequency and severity of algal blooms observed in the sound (Yates Barber, personal communication). For reasons not completely understood, the aquatic vegetation in the sound, including the milfoil, declined drastically in the early 1980's. Significant increases in suspended sediment turbidity and a period of increased salinity levels, due to several years of low rainfall, are suspected causes of this decline (Davis and Brinson, 1989), but little field data beyond anecdotal accounts exists to support this theory.

Also in the 1960's, a canal linking the headwaters of the North Landing River to Lynnhaven Bay, another Chesapeake Bay tributary, was constructed by the U.S. Soil Conservation Service to provide flood control for the Lynnhaven area of Virginia Beach. Based on the recommendations of a 1980 U.S. Army Corps of Engineers study concluding that the canal was no longer an adequate flood control mechanism, a larger bypass canal was constructed adjacent to the original to increase the volume of water that could be transported by the canal system, known collectively as Canal Number Two. A subsequent study of the potential impacts on salinity in Currituck Sound from this canal system indicated that for the 294 days in the study period during 1991, a net southward transport of over 34,000 tons of salt to the sound occurred (Bales and Skrobialowski, 1994). Canal Number Two currently remains as an unrestricted source of salt water and urban runoff to the sound.

More recent diversions of fresh water flow from its tributaries have also served to increase salinity levels in the sound. Historically, thousands of acres of the Great Dismal Swamp drained to the North River, but in recent years, extensive drainage modification and land clearing activities for agriculture have diverted much of that fresh water inflow south to the Pasquotank River, allowing the North River headwaters to become more saline (Waterwise, 1994). In turn, these more saline waters can encroach on Currituck Sound through Coinjock Canal. Salinity monitoring performed by Yates Barber and the N.C. Wildlife Resources Commission supports this theory. Their monitoring, after 6 inches of rain in a 10 day period, showed salinities of 2.5 to 3.0 ppt in the canal and 3.0 to 3.5 ppt in the North River at the mouth of the canal, when significantly lower salinity values would be expected as a result of the fresh water input to the system. Samples taken a few miles further up the North River showed elevated levels of salinity near the bottom and fresher water at the surface, indicative of the upstream movement of a salt wedge. (Waterwise, 1994). In addition to diversion of fresh water from the North River, it should be mentioned that the City of Chesapeake withdraws up to 10 MGD of fresh water daily from the headwaters of the Northwest River.

In addition to the above sources of salt water intrusion into Currituck Sound, from 1965 to 1987 the City of Virginia Beach intermittently pumped sea water over the outer banks into Back Bay. The city pumped the sea water over at a rate of approximately 13-15 MGD in the interest of enhancing aquatic plant growth (Currituck Sound Task Committee, 1980). After several years of pumping it was found that the sea water had an adverse effect on water quality and SAV (Norman and Southwick, 1987), so the practice was discontinued in August of 1987.

Current Salinity Levels

Data collected in 1995 and 1996 by the N.C. Division of Water Resources (DWR) yields an average salinity of 3.7 ppt. The DWR data also shows several open water monitoring sites having median salinity levels of 3.5 ppt or more. Figure 3.7 shows box plots of the salinity data recorded by DWR at several Currituck Sound monitoring sites, including tributaries. The middle line in each box plot denotes the median value.

Effects of Salinity Variations on Natural Resources

As was mentioned in Chapter 2 in the discussion of the basin's fisheries, increased salinity levels have caused a decline in Currituck Sound's once strong largemouth bass populations which cannot reproduce at salinities of 3.5 ppt or more (Tebo and McCoy, 1964). (The WRC is currently evaluating the success of supplemental stockings of microtagged largemouth bass fingerlings at various salinity levels.) In addition, increases in salinity as little as 2-3 ppt above current levels have the potential to drastically affect the abundance of many species of submerged aquatic vegetation (SAV). The overall abundance and diversity of species of SAV have been key factors in maintaining the rich natural resources of Currituck Sound. Historically, significant declines in SAV in the sound have coincided with declines in the largemouth bass populations and in wintering waterfowl populations that depend on it for food. Surveys of the frequency and distribution of SAV in the Albemarle-Pamlico Estuarine System by Ferguson and Wood (1994) have yielded substantial insights into the affects of salinity levels on SAV survival. When plotted with salinity, frequency distributions of the various species of SAV indicated a division of two distinct groups of aquatic vegetation. The survey found that wild celery, bushy pondweed, sago pondweed and eurasian water milfoil were only found at survey stations with low salinities, less than 5.0 ppt. Although literature values form past studies show species from this low salinity group surviving in salinity levels as high as 8.0-10.0 ppt, the study by Ferguson and Wood appears to indicate that the competitiveness of these species may be impaired at salinities as low as 5-7 ppt. Conversely, eelgrass and shoal grass were only present at stations with higher salinities, 10.0 ppt or more. The survey found that only one species, widgeon grass, was present at stations with intermediate salinity levels of 5.0-10.0 ppt. In addition, the study compared areas of stable and fluctuating salinity and found that the areas with greater variability in salinity had the lowest number of stations in which the presence of any SAV was noted.

The results of the SAV survey could have significant implications in regard to salinity levels and the SAV community that is essential to the aquatic ecosystem in Currituck Sound. If salinities continue to increase as they have in recent years in the sound, median levels will soon begin to fall in the intermediate 5-10 ppt range where survival of most species of SAV other than widgeon grass becomes marginal. As shown in figure 3.7 several stations already exhibit regular occurrences of

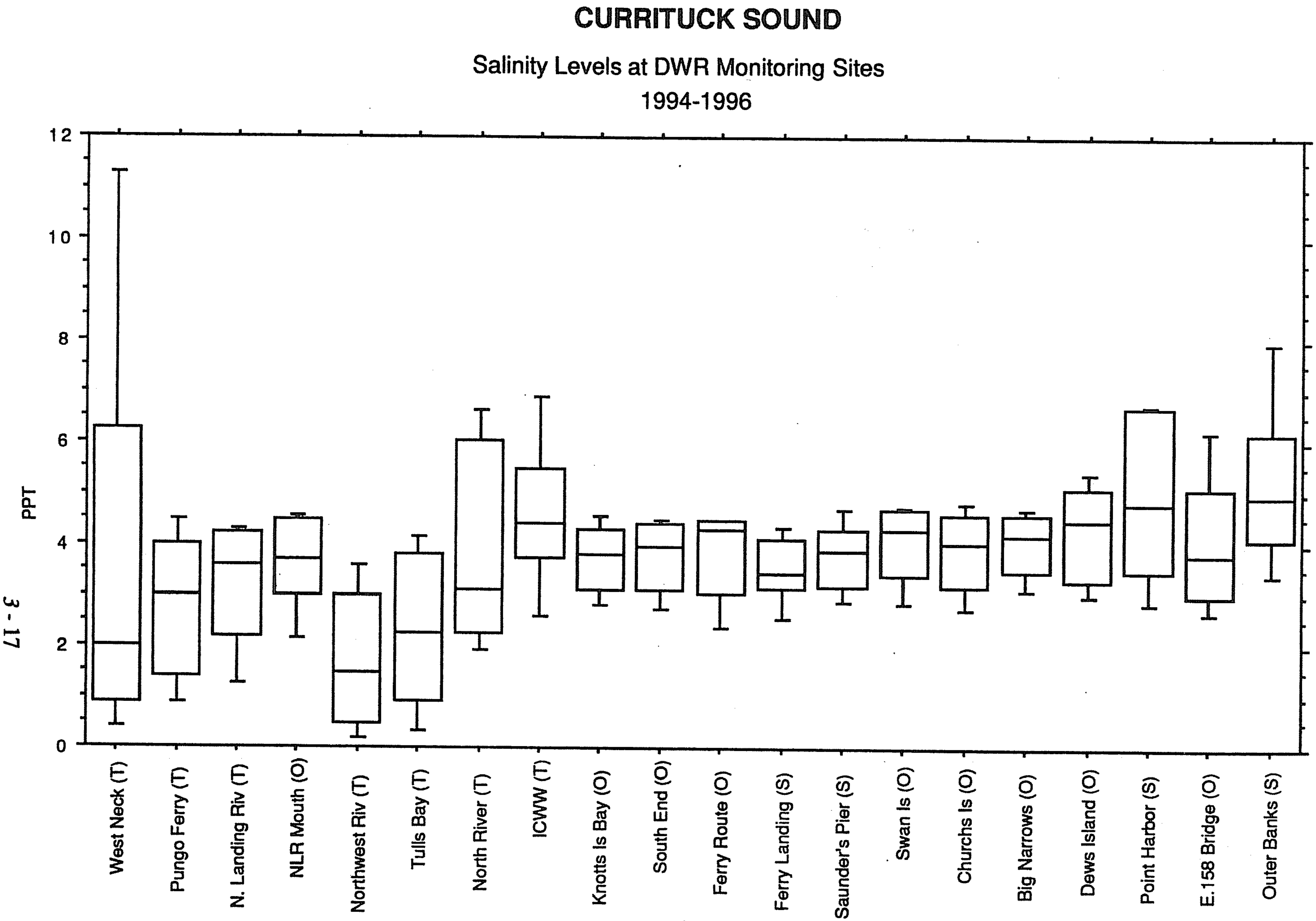

Figure 3.7. **Box plots of salinity data recorded by the Division of Water Resources at several stations in Currituck Sound - 1994 through 1996. (T = tributary station; O = open water station; and S = shore station)**

levels approaching 5.0 ppt. If median salinities increase by another 2 ppt or more from current levels, the diversity and distribution of SAV recently observed in the sound could be dramatically reduced. Such reductions would likely diminish the quality and quantity of habitat for a variety of fish species, some of which are already stressed by the increased salinities. Reductions in SAV also significantly reduce available food sources for waterfowl.

Currituck Sound Salinity Survey
In response to concerns about the effects of changing salinity levels, the Currituck Sound Salinity Survey project has been initiated by the Division of Water Resources to examine salinity trends in Currituck Sound. A principal study task is to compile historical salinity data into a central database. Since the early 1900s, numerous agencies have monitored salinity and other water quality indicators in Currituck Sound. Where available, this data will be entered into a standard database format. The final data set will be made available to interested parties across the Internet.

A second task is monthly sampling of salinity levels at over 25 sites on the sound and its tributaries. The first year of monitoring was completed in August, 1996. Following data collection, staff will analyze the data to determine historical and current salinity trends. A final report will summarize key findings and identify potential resource management issues.

Efforts to increase long-term salinity monitoring are underway. Currituck County was recently awarded a Marine Fisheries grant to place permanent salinity and velocity gages on West Neck Creek (Canal No. 2). Funding is also being sought for permanent gages on Coinjock Canal and at the Wright Memorial Bridge.

As requested by DEHNR in February, 1996, the U.S. Army Corps of Engineers recently completed a Section 1135 review of the Canal No. 2 flood control project in order to determine if modifications to the project were warranted for improvement of the environment. Specifically, the intent of the review was to investigate DEHNR's concern that the canal system is causing increased salinity levels and damage to the natural resources of Currituck Sound. In an October, 1996 letter and summary report to DEHNR the Army Corps concluded from their initial investigation that no Federal action should be taken to initiate a feasibilty study on modification of the canal system. As a basis for the no action conclusion the report states that a hydraulic connection between Lynhaven Bay and Currituck Sound already existed prior to construction of the project. In addition the report futher contends that Canal No. 2 has not caused increases in salinty beyond that which would have been experienced in the absence of the project, and that no evidence has been found to suggest that modification of the project would significantly reduce salinity levels in the upper portion of the sound.

3.2.6 Sedimentation

Sedimentation is the most widespread cause of nonpoint source pollution in the state and results from land-disturbing activities including agriculture, building and highway construction, uncontrolled urban runoff which erodes streambanks, mining and timber harvesting. Unpaved roads and driveways on steep slopes are also significant sources of sediment. Sedimentation is often divided into two categories: *suspended load* and *bed load.* Suspended load is composed of small particles that remain in suspension in the water. Bed load is composed of larger particles that slide or roll along the stream bottom. Suspension of load types depends on water velocity and stream characteristics. Biologists are primarily concerned with the *concentration* of the suspended sediments and the *degree of sedimentation* on the streambed (Waters 1995).

The concentration of suspended sediments affects the availability of light for photosynthesis, as well as the ability of aquatic animals to see their prey. Several researchers have reported reduced feeding and growth rates by fish in waters with high suspended solids. In some cases it was noted that young fish left those stream segments with turbid conditions. Suspended sediments can clog the gills of fish and reduce their respiratory abilities. These forms of stress may reduce the tolerance level of fish to disease, toxicants and chronic turbid conditions. Suspended solids are reported as Total Suspended Solids or as Turbidity. They are measured in parts per million or milligrams per liter (Waters 1995).

The degree of sedimentation affects both the habitat of aquatic macroinvertebrates and the quality and amount of fish spawning and rearing habitat. Degree of sedimentation can be estimated by observing the amount of streambed covered, the depth of sedimentation, and the percent saturation of interstitial space or embeddedness. Eggs and fry in interstitial spaces may be suffocated by the sediments thereby reducing reproductive success (Waters 1995).

The impact of sedimentation on fish populations depends on both concentration and degree of sedimentation, but impact severity can also be affected by the duration (or dose) of sedimentation. Suspended sediments may occur at high concentrations for short periods of time, or at low concentrations for extended periods of time. The greatest impacts to fish populations will be seen at high concentrations for extended time periods. The use of a dose-response matrix in combination with field investigations can help predict the impact of suspended sediments on various life stages of fish populations (Newcombe 1996).

Sedimentation impacts streams in several other ways. Eroded sediments may gradually fill lakes and navigable waters and may increase drinking water treatment costs. Sediment also serves as a carrier for other pollutants including nutrients (especially phosphorus), toxic metals, pesticides, and road salts.

Statistics compiled by the US Department of Agriculture, Natural Resource Conservation Service (formerly known as the Soil Conservation Service) indicate a statewide decline in cropland erosion from 1982 to 1992 (USDA, NRCS, 1992) as shown in Table 3.3.

Table 3.3 Overall Erosion Trends in North Carolina

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

The NRCS statistics also indicate a statewide reduction per acre on cropland erosion using the Universal Soil Loss Equation (Table 3.4).

Table 3.4. USLE Erosion on Cultivated Cropland in North Carolina

	1982	1987	1992
Cropland Area (1,000 acres)	6,318.7	5956.8	5538.0
Gross Erosion (1,000 tons/yr)	40,921.4	37475.3	30,908.3
Erosion Rate (Tons/Yr/Ac)	6.5	6.3	5.6

As can be seen in Table 3.5, compared to other areas of the state, erosion in eastern North Carolina (tidewater area, Atlantic coast flatwoods, southern coastal plain) is much lower than in mountain areas where slopes are greater.

Table 3.5. North Carolina Erosion on Major Land Resource Areas (MLRA)

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

Streambank erosion is a natural process, but one that is accelerated by human activities. Streambank erosion results from two processes: high flows and bank failures. Growth is associated with an increase in impervious surfaces, resulting in higher volumes and rates of flow into receiving streams. Bank failures can occur due to these high flows, or from heavy use of streambanks for cattle or vehicle crossings. Loss of buffer strips along streambanks can greatly contribute to bank erosion. The use of structural techniques such as: bank sloping, use of tree roots for stabilization, buffer strips, and fencing cattle out of streams can greatly reduce streambank erosion. Average annual soil loss has been shown to be decreased by 40% after cattle were fenced away from streams. This decrease resulted in nearly a 60% reduction in average sediment concentration during stormflow events (Owens, et al 1996). Stormwater management measures for urban development areas can also lessen the potential for streambank erosion.

Most sediment-related impacts are associated with nonpoint source pollution. Recommendations aimed at addressing sedimentation are listed in Chapter 6 and programs are briefly described under nonpoint source pollution controls in Chapter 5. Nonpoint sources are considered to be in compliance with the turbidity standard if approved best management practices (BMPs) have been implemented.

<u>Sedimentation and Erosion in the Pasquotank River Basin</u>

Although sedimentation has not been identified as a source of impairment for water bodies in the Pasquotank River basin, that does not mean that there are no localized impacts from sediment runoff. Sedimentation is more difficult to identify in coastal plain areas because of the waters' naturally sandy substrate.

3.3 POINT SOURCES OF POLLUTION (Including Non-discharging Land-Application Facilities)

3.3.1 Defining Point Sources

Point sources refers to discharges that enter surface waters through a pipe, ditch or other well-defined point of discharge. The term applies to wastewater and stormwater discharges from a variety of sources. Wastewater point source discharges include municipal (city and county) and industrial wastewater treatment plants and small domestic wastewater treatment systems that may serve schools, commercial offices, residential subdivisions and individual homes. Stormwater point source discharges include stormwater collection systems for medium and large municipalities which serve populations greater than 100,000 and stormwater discharges associated with industrial activity as defined in the Code of Federal Regulations [40 CFR 122.26(a)(14)]. The primary pollutants associated with point source discharges are oxygen-demanding wastes, nutrients, sediment, color and toxic substances including chlorine, ammonia and metals.

Point source dischargers in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state. Discharge permits are issued under the NPDES program which is delegated to North Carolina by the US Environmental Protection Agency (EPA). See Chapter 5 for a description of the NPDES program and permitting strategies.

Although not technically a "point" source of pollution, some treatment facilities apply their waste to the land as opposed to discharging it to surface waters. These facilities are also required to to obtain an permit from the state for these operations. They are described in more detail in subsection 3.3.4.

3.3.2 Point Source Discharges in the Pasquotank River Basin

There are 93 permitted NPDES wastewater dischargers in the Pasquotank River basin. Only two facilities are considered "major" facilities. These are facilities that are either large (> 1 MGD (million gallons per day)) or industrial discharges that have toxic material in its discharge (this latter category is determined to be major on a discretionary basis). The wastewater treatment plants for Elizabeth City and Manteo are major facilities in the Pasquotank basin. There are 35 dischargers covered under individual permits and 21 dischargers covered under general permits. Figure 3.8 shows the location of permitted facilities in the basin (not including stormwater permits which are discussed below). Permit renewals are conducted at five year intervals. Permits for the Pasquotank River basin are scheduled to be renewed in February and March of 1998.

Total permitted flow for all facilities is 6.08 million gallons per day (MGD). The average actual flow from all facilities is 3.91 MGD. Table 3.6 provides the total and average discharge for each category of permitted facility. Definitions and examples of the various categories can be found in 3.7.

3.3.3 Stormwater Point Source Discharges in the Pasquotank River Basin

Excluding construction general permits, there are 37 general permits and 4 individual stormwater permits issued within the river basin. Activities covered under the general stormwater permits include: construction; mining/borrow pits; metal waste recycling and manufacture of metal products and equipment; manufacture of timber products; manufacturing of food products; vehicle maintenance, transportation, and postal service activities, public warehousing and petroleum bulk stations and terminals; used automobile parts and scrap yards; ready mixed concrete production; manufacture of asphalt paving mixtures and blocks; and one marina. Activities covered under individual permits include timber product and food manufacturers. There are currently no municipalities in the Pasquotank River basin that are subject to NPDES stormwater permitting.

The primary source of concern from industrial facilities is the contamination of stormwater from contact with exposed materials. In addition, poor housekeeping can lead to significant contributions of sediment and other pollutants which have a detrimental effect on the water quality in receiving streams. There have been no reported water quality concerns associated with permitted dischargers in this river basin.

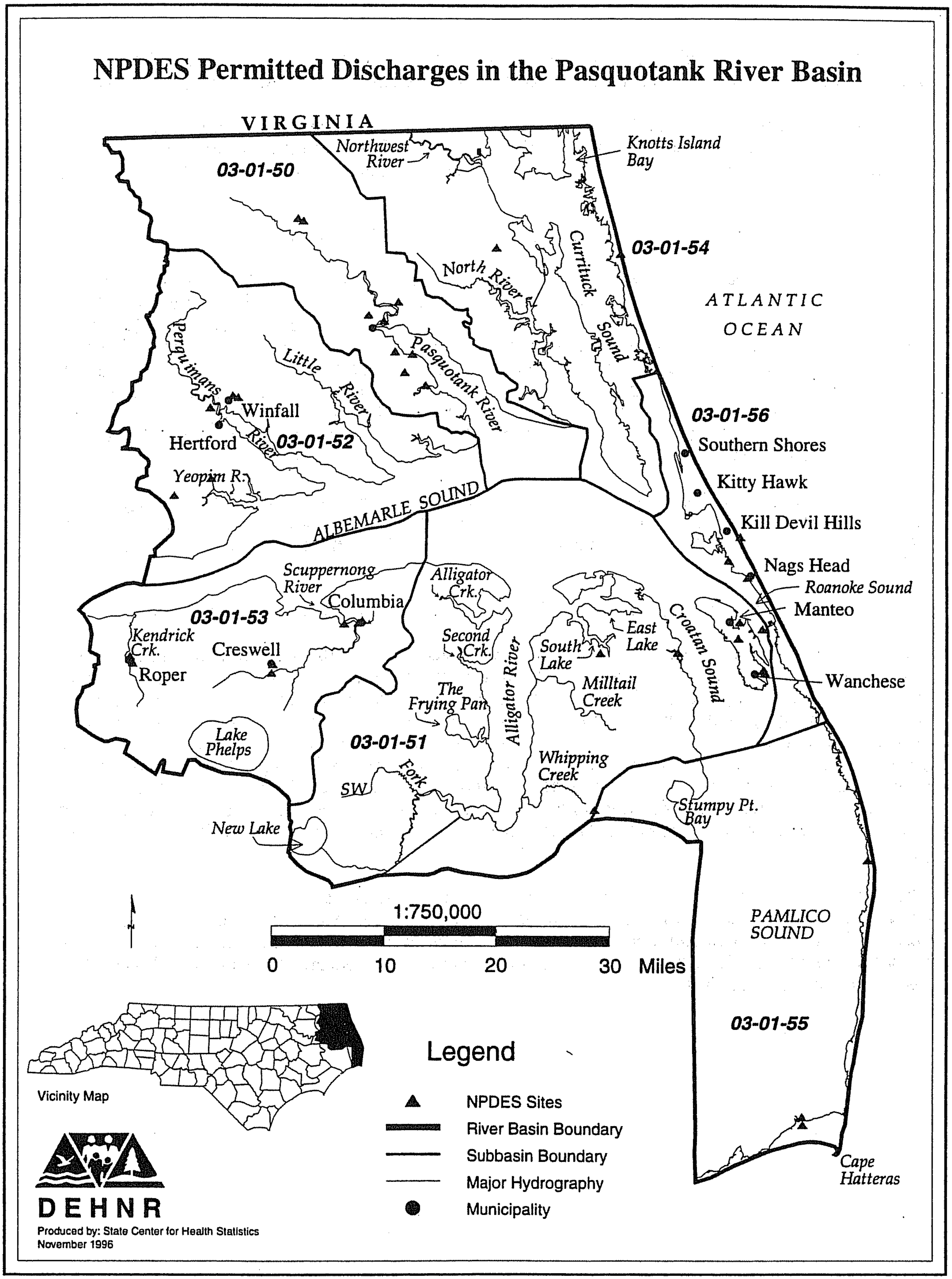

Figure 3.8. Location of NPDES Permitted Wastewater Discharge Facilities in the Pasquotank River Basin.

Table 3.6. Summary of Major/Minor NPDES Dischargers and Permitted and Actual Flows by Subbasin for the Pasquotank River Basin

FACILITY CATEGORIES	SUBBASIN 50	51	52	53	54	55/56	TOTALS
NC00 Individual Facilities	7	7	5	7	2	7	35
Stormwater Facilities	12	4	5	8	4	4	37
NCG General Permit Facilities	5	6	0	2	3	5	21
Total Facilities	24	17	10	17	9	16	93
Total Permitted Flow (MGD)	2.53	0.86	0.40	0.30	0.07	1.92	6.08
# of Facilities Reporting	6	5	3	6	1	6	27
Total Avg. Flow (MGD)	2.14	0.20	0.42	0.23	0.01	0.91	3.91
***Major Discharges**	1	1	0	0	0	0	2
Total Permitted Flow (MGD)	2.5	0.6	0	0	0	0	3.1
# of Facilities Reporting	1	1	0	0	0	0	2
Total Avg. Flow (MGD)	2.01	0.17	0.00	0.00	0.00	0.00	2.18
***Minor Discharges**	6	6	5	7	2	7	33
Total Permitted Flow (MGD)	0.03	0.26	0.40	0.30	0.07	1.92	2.98
# of Facilities Reporting	5	4	3	6	1	6	25
Total Avg. Flow (MGD)	0.13	0.03	0.42	0.23	0.01	0.91	1.73
100% Domestic Wastewater	1	0	0	0	0	1	2
Total Permitted Flow (MGD)	0.01	0.00	0.00	0.00	0.00	0.06	0.07
# of Facilities Reporting	1	0	0	0	0	1	2
Total Avg. Flow (MGD)	0.01	0.00	0.00	0.00	0.00	0.01	0.02
Municipal Facilities	1	1	1	3	0	1	7
Total Permitted Flow (MGD)	2.5	0.6	0.40	0.30	0.00	0.06	3.86
# of Facilities Reporting	1	1	1	3	0	1	7
Total Avg. Flow (MGD)	2.01	0.17	0.34	0.2	0.00	0.03	2.75
Major Process Industrial	0	0	0	0	0	0	0
Total Permitted Flow (MGD)	0	0	0	0	0	0	0
# of Facilities Reporting	0	0	0	0	0	0	0
Total Avg. Flow (MGD)	0	0	0	0	0	0	0
Minor Process Industrial	1	1	0	0	0	0	2
Total Permitted Flow (MGD)	0.02	0.18	0	0	0	0	2
# of Facilities Reporting	1	1	0	0	0	0	2
Total Avg. Flow (MGD)	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Nonprocess Industrial	3	3	2	3	1	4	16
Total Permitted Flow (MGD)	0	0.07	0	0	0.7	1.8	1.94
# of Facilities Reporting	3	3	2	3	1	4	16
Total Avg. Flow (MGD)	0.13	0.03	0.08	0.04	0.01	0.88	1.17

*** NC00 Individual permit facilities**

Table 3.7. Definitions of Categories of NPDES Permits

CATEGORY	DEFINITION	EXAMPLES
Major vs. Minor discharges (NCOO Facilities)	For publicly owned treatment works, any facility discharging over 1 MGD is defined as a Major discharge. For industrial facilities, the EPA provides evaluation criteria including daily discharge, toxic pollutant potential, public health impact and water quality factors. Any facilities which do not meet the criteria for Major status are defined as Minor discharges.	The Elizabeth City and Manteo wastewater treatment plants are the only major facilities in the Pasquotank basin.
100% Domestic	A system which treats wastewater containing household-type wastes (bathrooms, sinks, washers, etc.).	Housing subdivision WWTPs, schools, Mobile Home Parks,
Municipal	A system which serves a municipality of any size.	Elizabeth City
Process Industrial	Water used in an industrial process which must be treated prior to discharge.	Triangle Pacific Corporation
Nonprocess Industrial	Wastewater which requires no treatment prior to discharging[1].	NCG500046 - J.W. Jones Lumber Co. (Non-contact cooling water and cooling tower blowdown)
Stormwater Facilities[2]	Discharges of runoff from rainfall or snow melt. NPDES permits are required for "stormwater discharges associated with industrial activity" and from municipal stormwater systems for towns over 100,000 in population.	"Stormwater discharges associated with industrial activity" include most types of manufacturing plants. Light manufacturing is subject only if they process or store materials outdoors. Landfills, mines, junkyards, steam electric plants, transportation terminals and any construction activity which disturbs 5 acres or more during construction.

1: Non-contact cooling water may contain biocides; however, the biocides must be approved by our Aquatic Survey and Toxicology Unit. The approval process verifies that the chemicals involved have no detrimental effect on the stream when discharged with the non-contact cooling water.

2: Stormwater facilities are covered by General Permits NCG010000 through NCG190000. Facilities which do not fit the categories of these permits are covered under individual stormwater permits NCS000000.

3.3.4 Non-discharging (Land-application) Wastewater Treatment Facilities

The Division of Water Quality also issues permits for the construction and operation of wastewater treatment systems that utilize non-discharging disposal systems. The following are examples of systems that are regulated and permitted:

- wastewater collection systems
- groundwater remediation facilities
- spray irrigation disposal systems
- reuse of reclaimed water disposal systems,
- land application and surface disposal of residuals,
- animal waste management systems.

DWQs review and permitting of these systems insures construction and operation of these facilities will be completed in accordance with the non-discharge regulations (15A NCAC 2H .0200) and the North Carolina General Statutes. Included in this review are details into the assurance that the facility will not discharge when operated. Senate Bill 1217 which was passed by the 1996 NC General Assembly, requires DWQ to permit animal waste facilities over a certain size. All regulated facilities are currently deemed permitted but will receive individual permits over the next five years.

In the Pasquotank basin, there are 26 permitted non-discharge facilities (not including regulated animal operations). These facilities are comprised of industrial spray irrigation, private domestic waste spray irrigation, groundwater remediation, reuse of wastewater (spray irrigation on a golf course) and a constructed wetland system.

3.4 NONPOINT SOURCES OF POLLUTION

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

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

3.4.1 Agriculture

There are a number of activities associated with agriculture that can serve as potential sources of water pollution. Land clearing and plowing make soils susceptible to erosion, which can then cause stream sedimentation. Pesticides and fertilizers (including chemical fertilizers and animal wastes) can be washed from fields, nursery farms or improperly designed storage or disposal sites. Construction of drainage ditches on poorly drained soils enhances the movement of oxygen-consuming wastes, sediment and soluble nutrients into groundwaters and surface waters.

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

Sediment production and transport is greatest from row crops and cultivated fields (Waters 1995; Lenat et al. 1979). Contour plowing, terracing, grassed waterways, conservation tillage, and no-till practices are several common methods used by most farmers to minimize soil loss. Maintaining a vegetated buffer between fields and streams is another excellent way to minimize soil loss to streams. Implementing Nondischarge Rule for Animal Waste Management System decreases the introduction of nutrients and fecal coliform bacteria from animal waste.

In the coastal plain, agriculture is often associated with hydrological modifications such as ditching to insure that fields are properly drained during rain events. These ditches accelerate runoff to surface waters carrying nutrients, pesticides and sediment.

In the Pasquotank River basin, agriculture is thought to be contributing to the impairment of the Little River, the Scuppernong River, Kendricks Creek and Burnt Mill Creek. The Perquimans and Pasquotank Rivers are support-threatened and are suspected to be affected by agriculture. Both row cropping and animal operations are included in these watersheds and may be affecting water quality. Chapter 5 discusses agricultural nonpoint source control programs. A list of BMPs for addressing agricultural runoff is presented in Appendix V.

3.4.2 Urban/Residential

It is commonly known that urban streams are often degraded or impaired streams. Runoff from urbanized areas, as a rule, is more localized but can often be more severe than agricultural runoff. Any type of land-disturbing activity such as land clearing or excavation can result in soil loss and cause sedimentation into the waters in the watershed. 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. This increase in volume and rate of runoff can result in streambank erosion and sedimentation in 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. 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); road salts, and fecal coliform bacteria (from animals and failing septic systems). The diversity of these pollutants makes it very challenging to attribute water quality degradation to any one pollutant.

Replacement of natural vegetation with pavement, removal of soundside buffers and managed lawns reduce the ability of the watershed to filter pollutants before they enter surface waters. The chronic introduction of these pollutants and increased flow and velocity into a stream results in degraded waters. Many waters adjacent urban areas are rated as biologically poor.

The population density map presented in Chapter 2 is an indicator of where urban development and potential urban water quality impacts are likely to occur. Concentrated areas where urban development is thought to be impairing water quality are Manteo, the Kill Devil Hills/Nags Head area and Hatteras. The high growth of these areas may lead to further water quality problems associated with the addition of impervious surfaces next to surface waters. Management strategies for addressing urban runoff are presented in Chapter 6. A list of BMPs for addressing urban runoff is presented in Appendix V.

3.4.3 Onsite Wastewater Disposal

Septic systems contain all of the wastewater from a household or business. The septic tank removes some wastes, but the soil drainfield provides further absorption and treatment. Septic tanks can be a safe and effective method for treating wastewater if they are sized, sited, and maintained properly. However, if the tank or drainfield malfunction or are improperly placed, constructed or maintained, nearby wells and surface waters may become contaminated. Septic tanks can be problematic in coastal areas such as the Pasquotank basin because of high water tables.

Some of the potential problems from malfunctioning septic system include:

- Polluted groundwater: Pollutants in sewage include bacteria, nutrients, toxic substances, and oxygen-consuming wastes. Nearby wells can become contaminated by septic tanks.
- Polluted surface water: Often, groundwater carries the pollutants mentioned above into surface waters, where they can cause serious harm to aquatic ecosystems. Septic tanks can also leak into surface waters both through or over the soil.
- Risks to human health: Septic system malfunctions can endanger human health when they contaminate nearby wells, drinking water supplies, and fishing and swimming areas.

Pollutants assoicated with onsite wastewater disposal 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, including disinfection.

Onsite wastewater disposal is most prevalent in the basin. In the estuarine waters of the Pasquotank River basin, fecal coliform contamination, partly from septic tanks, is resulting in the closure of shellfish waters. Specific areas where septic tanks are thought to be contributing to water quality impairment include Roanoke Sound, Croatan Sound and Stumpy Point Bay, and isolated areas along the soundside of the outer banks. Regulatory programs and BMPs pertaining to onsite wastewater disposal are presented in Appendix V.

3.4.4 Construction

Construction activities that entail excavation, grading or filling (such as road construction or land clearing for development) can produce significant sedimentation if not properly controlled. Sedimentation from developing urban areas can be a major source of pollution due to the cumulative number of acres disturbed in a basin. Construction of single family homes in rural areas can also be a source of sedimentation when homes are placed in or near stream corridors. This latter form of development can be seen throughout the Pasquotank River basin.

As a pollution source, construction activities are typically temporary, but the impacts can be severe and long lasting (see discussion in sediment section above). Construction activities tend 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. In addition, resort development in relatively undeveloped areas can be devastating to previously unimpacted streams.

Construction-related sedimentation is addressed through the Sedimentation Pollution Control Act (see Section 5.5.3 in Chapter 5). A list of BMPs for controlling erosion and sedimentation is presented in Appendix V.

3.4.5 Timber Harvesting

Undisturbed forested areas are an ideal land cover for water quality protection. They stabilize the soil, filter rainfall runoff and produce minimal loadings of organic matter to waterways. In addition, forested stream buffers can filter impurities from runoff from adjoining nonforested areas.

Improper forest management practices can adversely impact water quality in a number of ways. This is especially true in mountainous regions where steep slopes and fragile soils are widespread. Without proper BMPs, large clearcutting operations can change the hydrology of an area and significantly increase the rate and flow of stormwater runoff. This results in both downstream flooding and stream bank erosion. Clearcutting, when compared to selective cutting, can cause a much higher rate of erosion (Waters 1995). Some experts have concluded that sedimentation from timber harvesting is more related to raods and skid trails than it is to the method of harvest (Stone, et. al., 1978).

Careless harvesting and road and stream crossing construction can transport sedimentation to downstream waters. Streams with sedimentation may require many years to restore. Removing riparian vegetation along stream banks can cause water temperature to rise, destabilize the shoreline and minimize or eliminate the runoff protection benefits of the buffer. Sedimentation due to forestry practices is most often associated with the construction and use of logging roads, particularly when roads are built near streams (Waters 1995). Density and length of logging roads can be major factors in the amount of sedimentation produced.

Other adverse effects resulting from forestry operations include: 1) an increase in woody debris clogging stream channels which can alter the stream channel and prevent fish movement; 2) loss of riparian vegetation which can reduce shade cover and raise stream temperatures; 3) loss of canopy which can alter the interface of the aquatic and terrestrial ecosystems. This is especially true where populations of amphibians are concerned.

Timber harvesting is an important industry in the Pasquotank River basin and is sometimes done at the onset of clearing for site development or agricultural activities. However, it is critical that all efforts be made to minimize sediment loss and runoff so as to protect other natural resources in this basin. These resources include fish habitat, drinking water supplies and aesthetics. This is especially important in light of a trend toward increased logging in North Carolina and in the southeast United States, in general.

The NC Division of Forest Resources (DFR) is implementing various measures for protecting water quality statewide. These measures began with the creation of voluntary *Forest Practices Guidelies Related to Water Quality* (FPGs). These measures were voluntarily applied best management practices, which had no enforcement power by any agency. In 1989, the Sedimentation Pollution Control Act (SPCA) was amended to require compliance with nine performance standards in order to remain exempt from the SPCA's permitting requirements. These nine standards are the FPGs whose complinace is accomplished throught the use of BMPs. The *Forestry Best Practices Manual* was published in September, 1989 to guide forestry operations in protecting water quality. The manual and the FPGs are available from the DFR office at no charge.

FPG/BMP inspections are carried out continuously by DFR field personnel in the course of their normal duties. Examinations of 3,318 sites in FY 1995-96 revealed an initial compliance rate of 94%. Two systematic surveys by a DFR staff hydrologist in 1995 and 1996 examined 196 and 223 sites respectively. Compliance with FPGs and BMPs was found to be 92% and 95% for the two years, respectively. A summary of activities and past accomplishments in the Pasquotank River basin is reported in Chapter 5.

Section 5.3.6 describes several programs that are aimed at either encouraging or requiring utilization of forest best management practices at the state and federal level. A list of forest BMPs is presented in Appendix V.

3.4.6 Mining

Mining is a common activity in the Piedmont and Coastal Plain regions and can produce high localized levels of stream sedimentation. Sediment may be washed from mining sites or it may enter streams from the wash water used to rinse some mined products. In addition, abandoned gold mined lands are suspected of being the sources of mercury in stream waters because of its historic use for the amalgamation of gold. Mining has not been identified as a source of pollution in the Pasquotank basin. A list of BMPs to address mining is presented in Appendix V.

3.4.7 Solid Waste Disposal

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

Groundwater and surface water monitoring is required at all permitted Municipal Solid Waste Sites (MSW) and all Construction and Demolition landfills. Monitoring efforts have been required since July 1989. All MSW landfills must have a liner system in place by January 1, 1998. All existing unlined landfills must close at this same time.

Section 5.3.5 briefly summarizes state, local and federal solid waste recycling programs.

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CHAPTER 4

WATER QUALITY AND USE SUPPORT RATINGS IN THE PASQUOTANK RIVER BASIN

4.1 INTRODUCTION

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

Water Quality Monitoring and Assessment

- **Section 4.2** describes seven water quality monitoring programs conducted by the Environmental Sciences Branch of the Division of Water Quality's (DWQ's) Water Quality Section and other groups. Basinwide data summaries are presented for several of the DWQ programs.
- **Section 4.3** presents a summary of the ambient monitoring data for the Pasquotank River Basin.
- **Section 4.4** presents a narrative summary of water quality findings for each of the subbasins in the basin. This summary is based on the monitoring programs described in Section 4.2 Also included are watershed maps which show the locations of monitoring sites.
- **Section 4.5** presents results of phytoplankton studies in the Albemarle Sound.

Use-Support Ratings

- **Section 4.6** introduces the concept of use-support ratings and describes how they are derived. Using this approach, water quality for specific surface waters in the basin is assigned one of the following four use-support ratings: fully supporting uses, fully supporting but threatened, partially supporting or not supporting uses.
- **Section 4.7** presents the use support ratings for many streams and estuaries in the Pasquotank basin through a series of tables and figures. Included is a color-coded 2-page use support map of the basin (Figure 4.18).

4.2 WATER QUALITY MONITORING PROGRAMS

4.2.1 DWQ Programs

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

- Benthic macroinvertebrate monitoring,
- Fish population and tissue monitoring,
- Lakes assessment (including phytoplankton monitoring),
- Aquatic toxicity monitoring,
- Special studies and chemical/physical water quality investigations, and
- Ambient water quality monitoring (covering the period 1991-1995).

Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom of rivers, streams and estuaries. The benthic organisms collected most often in freshwater monitoring are aquatic insect larvae. In estuarine (saltwater) systems the benthic organisms most often collected include molluscs (such as clams and snails), crustaceans (such as crabs and shrimp) and polychaetes (worms). The use of benthos data has proven to be a reliable water quality assessment tool (especially in fresh waters), as these organisms are relatively immobile and sensitive to subtle changes in water quality. Since many organisms in a community have life cycles of six months to one year, the effects of short term pollution (such as an oil or chemical spill) will generally not be overcome until the following generation appears. The benthic community also responds to, and shows the effects of, a wide array of potential pollutant mixtures. Criterion are still being developed for swamp and estuarine systems.

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

For *estuarine* waters the effort to develop a method to assess water quality based on macroinvertebrates started in North Carolina in late 1990. An Estuarine Biotic Index designed for Florida was modified to create the North Carolina Estuarine Biotic Index (EBI) which more closely reflects taxa and tolerences in North Carolina and can accurately rank sites of different water quality. Biocriteria based on these metrics are still being developed, so at the present time estuarine samples cannot be given a water quality rating.

Benthic Macroinvertebrate Sampling in the Pasquotank Basin
Benthic macroinvertebrate sampling has been conducted at 27 sites throughout the Pasquotank basin with results ranging from Poor to Good-Fair. However, 22 (or 81%) of these sites have not received a biological rating because they are estuarine waters or swamp waters (the vast majority are brackish estuarine). The data can however be used to provide general water quality characterization when ratings cannot be assigned. Ratings and characterizations are presented in the individual subbasin discussions in section 4.5.

Fisheries Monitoring

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

Fish Community Structure

As noted above, fish community structure involves assessing the overall health of the fish community as a means of assessing the quality of the ecosystem in which the fish reside. Fish community structure is assessed using a method called the North Carolina Index of Biotic Integrity (NCIBI). This method, which is a modification of Karr's IBI (1981), was developed as a method for assessing a stream's biological integrity by examining the structure and health of its fish community. The index, (which is described in more detail in Appendix II), incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. At this time there is no Index of Biotic Integrity calculated for fish populations in lakes.

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

Fish Community Structure in the Pasquotank Basin

Fish community structure (IBI) analyses were performed on data from 2 sites in the Pasquotank River Basin collected by DWQ. Neither site received a rating because of the swampy nature of the waters sampled.

Fish Tissue Analysis

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

In evaluating fish tissue analysis results, several different types of criteria are used. Human health concerns related to fish consumption are screened by comparing results with federal Food and Drug Administration (FDA) *action levels* and U.S. Environmental Protection Agency (EPA) recommended *screening values* for contaminants.

The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish tissue consumption. A list of fish tissue parameters accompanied by their FDA criteria are presented in Appendix II. At present, the FDA has only developed metals action level criteria for mercury (1.0 ppm).

Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of DWQ.

Fish Tissue Analyses in the Pasquotank Basin
Fish tissue samples were collected at 22 sites from 1983 to 1995 within the Pasquotank River Basin consisting of 447 observations. Samples were collected as part of the DWQ's ambient fish tissue monitoring program or as part of special mercury studies. Results are summarized in Table 4.1.

Mercury contamination was most prevalent in Pasquotank subbasins 50, 53 and 54 with a significant portion of samples in these drainages containing mercury above the EPA and/or FDA action levels. Elevated mercury levels were most often associated with long lived piscivores (bass and bowfin) collected from low productivity, low pH systems. This trend has also been observed throughout other eastern river basins in the state. Significant mercury contamination was identified at Phelps Lake with over 50% of fish samples containing levels above human health standards. Mean mercury levels for bass and bowfin collected at Phelps were 1.16 ppm and 1.4 ppm respectively (the FDA action level for mercury is 1.0 ppm and the EPA screening value is 0.6 ppm). Phelps Lake is unique in the fact that it possesses a minimal drainage area, receives most of its hydrologic input from the atmosphere, and represents a minimally impacted system. Atmospheric mercury deposition may therefore be a significant source for the observed mercury levels. The Division of Air Quality has initiated a year-long study to assess atmospheric mercury deposition in the Phelps Lake area. The study will focus on the measurement of ambient mercury levels in the atmosphere around Phelps, as well as deposition rates of mercury through precipitation. In June of 1996 the State Health Director issued a fish consumption advisory for bass and bowfin in Phelps Lake due to elevated mercury. The advisory recommends that the general population consume no more than 2 meals of the fish per month, and child-bearing women and children consume no fish.

The Albemarle Sound west of a line from Bull Bay (at the mouth of the Scuppernong River) to Harvey Point (near the mouth the Perquimans River) (see Figure 3.1) is under a fish consumption advisory because of dioxin contamination. Two major river systems that feed the head of the sound, the Roanoke and Chowan rivers, are contaminated with dioxin from upstream paper mills. These facilities have upgraded their facilities and eliminated dioxin from their effluent, but the pollutant has not yet worked its way out of the system. The current advisory recommends that the general population consume no more than two meals per person per month and that children and pregnant or nursing women consume no fish until further notice. Herring, shellfish and shad (including roe) are not included in the advisory.

Lakes Assessment Program (including Phytoplankton)

Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. The North Carolina Lakes Assessment Program seeks to protect these waters through monitoring, pollution prevention and control, and restoration activities. Assessments have been made at all publicly accessible lakes, at lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed.

One way to evaluate the health of a lake is to examine the growth of phytoplankton. Phytoplankton are microscopic algae found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton populations respond to the availability of nutrients (phosphorus and nitrogen) and other environmental factors such as light, temperature, pH, salinity, water velocity, and grazing by organisms in higher trophic levels. Phytoplankton may be useful as indicators of nutrient overenrichment (see following paragraph on trophic status) and are often collected with water quality samples from lakes. Prolific growths of phytoplankton sometimes result in

Table 4.1 Fish Tissue Sampling Sites and Data Summary for the Pasqoutank River Basin

Location	Subbasin	Year(s) sampled	Total samples	Samples > EPA Criteria*	Samples > FDA Criteria*	Samples > NC Dioxin Crit.*
Corapeake Ditch	50	83	15	3 mercury	1 mercury	
Pasquotank R. at Elizabeth City	50	89,94,95	42	12 mercury	3 mercury	
Albemarle Sound at Wade Pt.	50	89,90	10	1 mercury		2
New Lake	51	86	11	2 mercury		
Alligator R. at Gum Neck	51	83,94	23			
Frying Pan	51	95	8	2 mercury	1 mercury	
Albemarle Snd. at Alligator R.	51	87,90	9			
South Lake	51	95	15	1 mercury	1 mercury	
Croatan Snd at Manns Harbor	51	89	10			
Stumpy Point Bay	51	89	13			
Perquimans R. at Hertford	52	95	22	2 mercury	2 mercury	
Yeopim R. at Snug Harbor	52	95	14			
Halls Crk at mouth	52	95	21	5 mercury	4 mercury	
Albemarle Snd at Harvey Pt.	52	89,90	15			1
Albemarle Snd near Frog Island	52	81,89,95	12	3 organics		
Kendricks Crk. at SR-1300	53	83,94	35	11 mercury	5 mercury	
Phelps Lake	53	86,94,95	75	40 mercury	28 mercury	
Scuppernong R. at Columbia	53	89,95	46	7 mercury	5 mercury	
Albemarle Snd at Railway Trestle	53	90	8			6
Albemarle Snd at Hwy. 32	53	90-94	26			18
Albemarle Snd at Bull Bay	53	90	23			9
Currituck Snd at Tulls Bay	54	90,94,95	61	11 mercury, 2 organics	1 mercury	
Currituck Snd near Currituck	54	89	8			
Indian Twn Creek	54	95	19	12 mercury		
Currituck Snd at Harbor Pt.	54	89		1 organics		

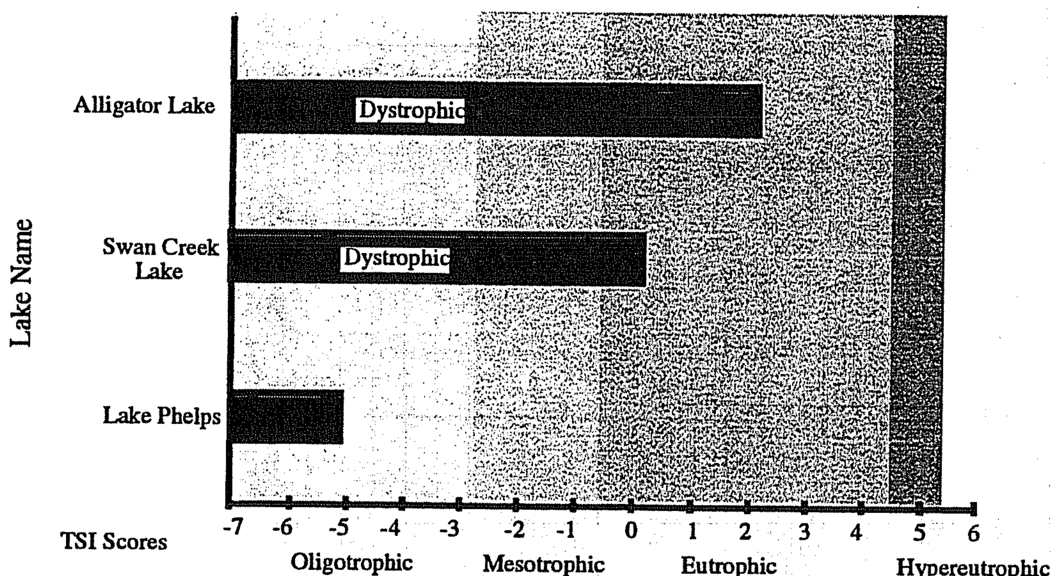
* Number of samples greater than specified critieria.

"blooms" in which one or more species of algae may discolor the water or form visible mats on top of the water. These blooms, which are often due to high concentrations of nutrients, may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. An Algal Bloom Program was initiated in 1984 to document suspected algal blooms with species identification, quantitative biovolume, and density estimates. Usually, an algal sample with a biovolume larger than 5000 mm^3/m^3, density greater than 10,000 units/ml, or chlorophyll-a concentration approaching or exceeding 40 µg/l (the North Carolina state standard) constitutes a bloom. Bloom samples may be collected as a result of complaint investigations, fish kills, or during routine monitoring if a bloom is suspected.

Another measure of water quality in lakes is the North Carolina Trophic State Index (NCTSI). This is a numerical index that is used to evaluate the trophic status of lakes, and it can be used to determine whether the designated uses of a lake have been threatened or impaired by pollution. Trophic status is a relative measure of nutrient enrichment and productivity. The NCTSI index is based on total phosphorus, total organic nitrogen, secchi depth (water clarity indicator) and chlorophyll-a. Basin on this index, a lake is assigned one of five trophic status classifications: Oligotrophic, Mesotrophic, Eutrophic, Hypereutrophic and Dystrophic. Oligotrophic lakes are those that have the lowest levels of enrichment and generally have good clarity and no problems with algal blooms. At the other end of the spectrum are eutrophic and hypereutrophic lakes which have a lot of plant productivity which can cause nuisance problems and have little clarity in the water column. Dystrophic lakes are acidic blackwater lakes scattered throughout the coastal plain. Their NCTSI scores are highly skewed because of their natural discoloration. Further details of the NCTSI can be found in Appendix II.

Lakes Studies in the Pasquotank

In the Pasquotank River basin, there are three lakes: Alligator Lake (New Lake) (subbasin 51), Swan Creek Lake (subbasin 51) and Phelps Lake (subbasin 53). NTSI scores for the three lakes are presented in Figure 4.1. More detailed discussions of each lake are presented in the individual subbasin discussions.



Alligator Lake and Swan Creek Lake were most recently sampled in 1989
Phelps Lake was most recently sampled in 1995.

Figure 4.1. Pasquotank Basin - TSI Scores (Last Assessment Date)

Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of wastewater treatment discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Based on how much of the receiving water is made up of wastewater from the discharge (instream waste concentration), a permit limit is derived for that facility. For example, if there is 50% wastewater in the receiving stream, the test would be run on a mixture of 50% of the discharge's effluent and 50% dilution. The tests look for chronic (long-term) or acute (immediate) effects on the test organisms. Effects include death and the ability to reproduce. Results of these tests have been shown by several researchers to be predictive of discharge effects on receiving stream populations. The Aquatic Survey and Toxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and DWQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

Aquatic Toxicity Monitoring in the Pasquotank

Four (4) facilities in the Pasquotank basin are required to monitor whole effluent toxicity by their NPDES permit. Other facilities may be tested by DWQ's Aquatic Toxicology Laboratory. The facilities currently required to monitor are listed in a table in Appendix II along with information on their monitoring requirements.

Special Studies and Chemical/Physical Characterizations

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

Special Studies and Chemical/Physical Characterizations in the Pasquotank River Basin

There have been a few special studies conducted in the Pasquotank basin to date. The largest of these was an intensive water quality survey of Currituck Sound in response to a request to designate these waters as ORW. It was determined that the sound did not qualify for ORW reclassification because of chronic wide-spread blue-green algae blooms. The details of this study are presented later in this chapter in the section devoted to describing subbasin 030156.

Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data or water quality parameters. 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	HQW & ORW
Baseline Water Supply	

Parametric coverage is tiered by the waterbody's assigned surface water quality classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added based on other classifications. Table 4.2 presents the parameters monitored for the classifications assigned to waters in the Pasquotank River Basin. The next section (4.3) summarizes the results of ambient monitoring done in the Pasquotank basin.

Table 4.2. Ambient Monitoring System Freshwater and Saltwater Parametric Coverage.

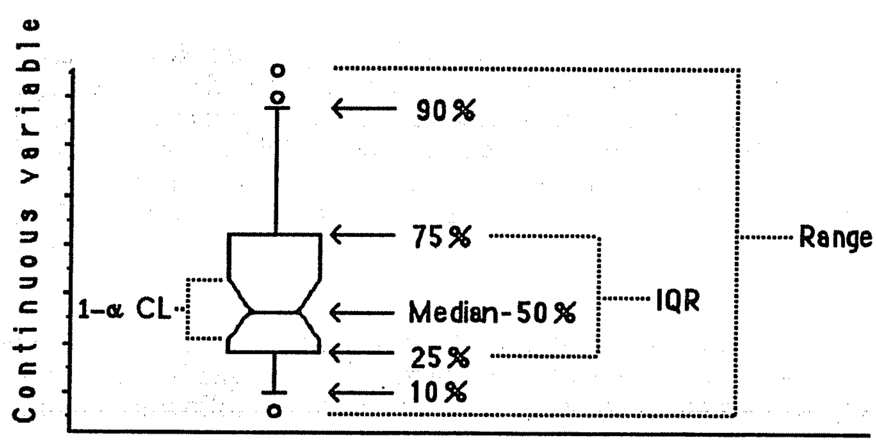
Class C, SC and Class B, SB Waters (minimum monthly coverage for all stream stations)
Field Parameters: dissolved oxygen, pH, conductivity, temperature, chlorine,
Nutrients: total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite
Physical Measurements: total suspended solids, turbidity, hardness
Bacterial: fecal coliforms (Membrane Filter method)
Metals: aluminum (no present water quality standard), arsenic, cadmium, chromium, copper*, iron*, lead, mercury, nickel, silver*, zinc*
Nutrient Sensitive Waters
Chlorophyll-a (where appropriate)
PLUS any additional parameters of concern for individual station locations.

*Action level water quality standard.

Ambient water quality data are often summarized using box and whisker plots (for example see Figure 4.5). Figure 4.2 provides an explanation of how to interpret the plots.

Figure 4.2 Box and Whisker Plots

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



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

4.2.2 Local Monitoring Programs

There are two programs local to the Pasquotank River basin that work to collect and analyze surface water quality data in the Pasquotank Basin. One is the Albemarle-Pamlico Citizens Monitoring Program and the other is the Surface Water Monitoring Program of Dare County. Each is generally described below.

Albemarle-Pamlico Citizens Water Quality Monitoring Program

The Albemarle-Pamlico Citizen's Water Quality Monitoring Program (APMP) is a volunteer estuary monitoring program begun in 1987 with funding from the Albemarle-Pamlico Estuarine Study. Approximately 65 volunteers monitor water quality from over 100 monitoring sites in the Albemarle-Pamlico Estuary located in southeastern Virginia and northeastern North Carolina. Housed at East Carolina University (ECU), the program has two basic goals: to promote stewardship of the region's water resources by encouraging public participation in volunteer monitoring, and to collect high quality scientific data to provide a baseline characterizing the condition of the estuary's water quality.

The APMP is a perfect example of how everyone concerned with water quality can benefit from volunteer monitoring. The program director, Patrick Stanforth, works closely with the Department of Environment Health and Natural Resources regional office providing data to the Division of Water Quality. The program is actively involved in education involving school children, scouting clubs, and camps in monitoring efforts. The data are also used by graduate and undergraduate students at ECU in class projects and the program utilizes several work-study students. In addition, there is coordination with local nonprofit organizations including the Pamlico Tar River Foundation, Pungo River Fisherman Association, Carteret Crossroads, and the North Carolina Coastal Federation. These are just a few examples of the people the APMP is involved with.

Water quality samples are collected weekly during the summer and twice monthly during the winter. The samples are taken at the same site, at approximately the same time of day, and on the same day of the week. This ensures that the data are easily compared and any changes (at the site) are quickly made apparent. The parameters monitored are: Air and water temperature, turbidity, water depth, salinity, dissolved oxygen, pH, rainfall and other observations. These are tested from a bucket of surface water collected at the site. Figure 4.3 illustrates the location of sampling sites in the Pasquotank River Basin.

Data are received monthly by the director from the volunteers. The data are then verified and entered in to a database. The data are stored on the database and it is available to anyone caring to use it.

Surface Water Monitoring Program of Dare County

Dare County has recently initiated a program to test the water quality of surface waters in its jurisdiction. The Dare County Water Testing and Management Program is a coordinated effort by the Dare County Commissioners and the Clean Water Advisory Committee to develop a comprehensive water quality testing and management program for the surface waters in and around Dare County. The initial state of the program began in October 1995 with the collection of samples at ten locations from Duck at the northern end of the county to Hatteras Village at the southern end. This monitoring program is designed to develop base line data on current water quality within specific drainage areas in the county and within the larger water bodies of the Pamlico, Albemarle and Currituck Sounds. On July 15, 1996 the monitoring program went from a volunteer pilot program to a full time testing department. The specific parameters currently being monitored include turbidity, pH, total phosphates, total dissolved phosphates, nitrate, nitrite, ammonia, chlorides, total coliform, E. coli, and Enterococcus which are analyzed in the Reverse Osmosis Water Plant Laboratory in Kill Devil Hills. Salinity, air and water temperature,

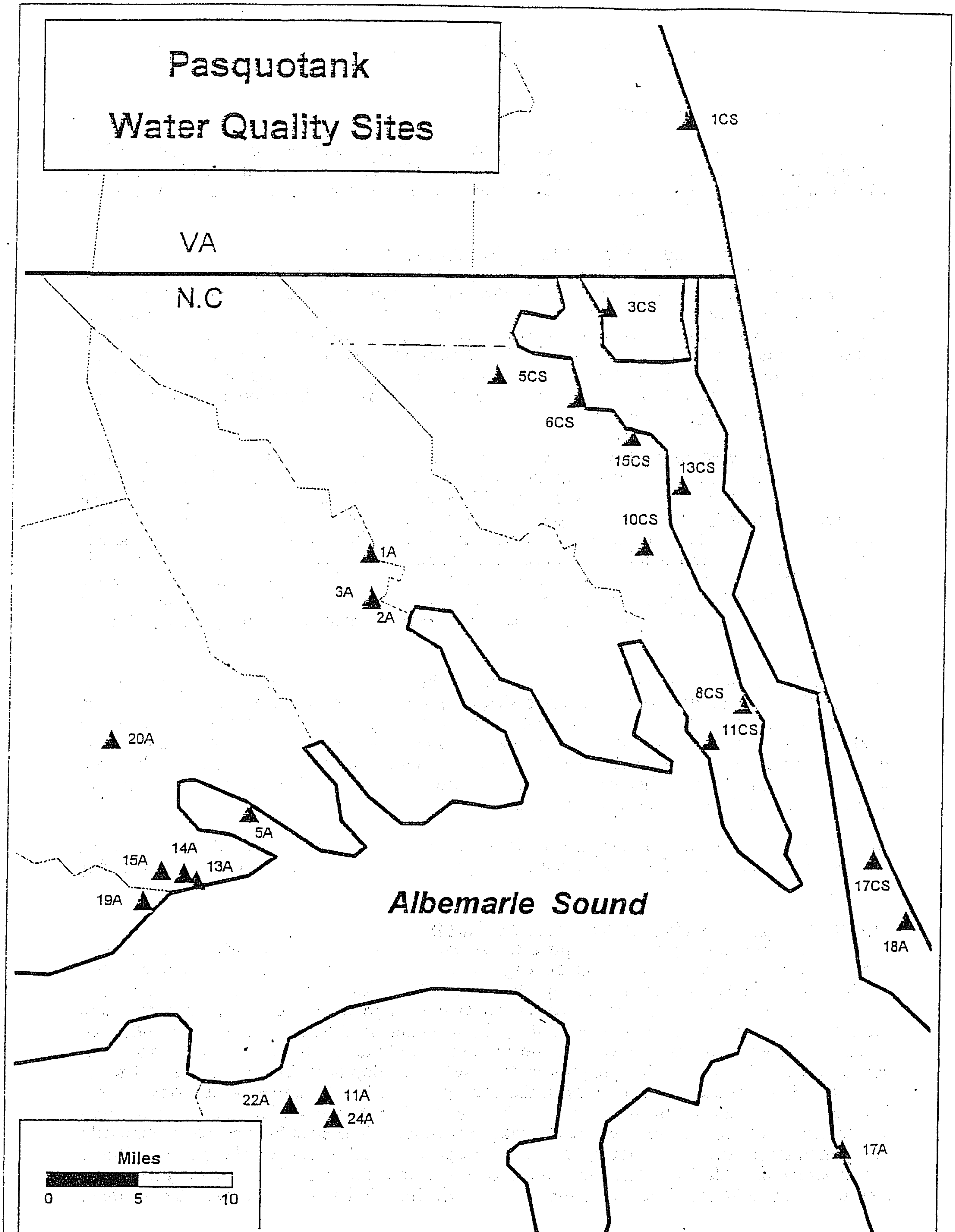


Figure 4.3. Map of APES Citizen Water Quality Monitoring Sampling Sites in the Pasquotank River Basin

dissolved oxygen and environmental observations are performed at the sample sites. There are currently 28 sample sites.

4.3 SUMMARY OF AMBIENT MONITORING DATA FOR THE PASQUOTANK RIVER BASIN COLLECTED BY DWQ

Ambient Monitoring System (AMS) stations for the basin are listed in Table 4.3 and shown on the map in Figure 4.4. North Carolina has 8 stations in the Pasquotank River Basin. Table 4.4 summarizes ,by parameter, data collected at ambient stations in the Pasquotank Basin where there are one or more excursions (or deviation) from the numerical water quality criteria. Each station includes the following information:

- parameter that exceeds the criterion
- total number of samples
- number of samples with less than the detection level recorded
- the number of samples for that parameter that represented an excursion from a water quality criterion

It should be noted that there are limitations to ambient water quality data. Because of the limited sampling frequency, the water quality sample may not be taken during a significant water quality event. It also should be noted that the criteria are presented as numerical and represent instantaneous measurements. The actual standard may include a narrative, such as turbidity, and, as in some metals criteria, may be based on extended exposure at or above the criteria to expect chronic toxicity of the most sensitive species of organism. Therefore the table is useful for relative comparisons between locations and screening areas where frequent excursions of individual or multiple parameters suggest waters that might be targeted for more detailed evaluations and/or specific management strategies. A more thorough evaluation can include review of temporal and spatial trends, association of concentrations to flow, degree of excursion from the criterion, or use of other analytical methods.

Table 4.5 shows totals from Table 4.4 as total samples, total excursions and percent excursions of total samples.

Table 4.3. Ambient Monitoring System Stations Within the Pasquotank Basin.

Primary No	STORETNo	Station Name	Subbasin
Pasquotank River Drainage			
02043862	M2750000	PASQUOTANK RIVER AT ELIZABETH CITY, NC	030150
02043882	M3500000	LITTLE RIVER AT US HWY 17 AT WOODVILLE NC	030152
02081179	M3900000	ALBEMARLE SOUND NEAR FROG ISLAND	030152
02043892	M5000000	PERQUIMANS RIVER AT SR 1336 AT HERTFORD NC	030152
02081172	M6100000	ALBEMARLE SOUND NEAR HARVEY POINT	030152
02081185	M6920000	KENDRICKS CREEK AT SR1300 AT MACKEYS NC	030153
02081166	M698000C	SCUPPERNONG RIVER ST SR 1105 NEAR COLUMBIA NC	030153
0208117840	M7175000	ALLIGATOR RIVER AT US 64 NEAR ALLIGATOR NC	030151

Table 4.4. Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria by Parameter. January 1990 to December 1994.

Station Number	Station Name	Parameter/Criterion	Samples All	Samples <Det	Samples Excur
02043882	LITTLE RIVER AT US HWY 17 AT WOODVILLE NC	Dissolved Oxygen (mg/l)[4]	32	0	22
02081185	KENDRICKS CREEK AT SR1300 AT MACKEYS NC	Dissolved Oxygen (mg/l)[4]	31	0	10
02081166	SCUPPERNONG RIVER ST SR 1105 NEAR COLUMBIA NC	Dissolved Oxygen (mg/l)[4]	32	0	23
02081185	KENDRICKS CREEK AT SR1300 AT MACKEYS NC	Nickel (µg/l)[8.3]	29	23	6
02043862	PASQUOTANK RIVER AT ELIZABETH CITY, NC	pH (SU)[6.8-8.5]	27	0	7
02043882	LITTLE RIVER AT US HWY 17 AT WOODVILLE NC	pH (SU)[6.0-9.0]	32	0	1
02081179	ALBEMARLE SOUND NEAR FROG ISLAND	pH (SU)[6.8-8.5]	108	0	16
02043892	PERQUIMANS RIVER AT SR 1336 AT HERTFORD NC	pH (SU)[6.8-8.5]	32	0	23
02081172	ALBEMARLE SOUND NEAR HARVEY POINT	pH (SU)[6.8-8.5]	117	0	6
02081185	KENDRICKS CREEK AT SR1300 AT MACKEYS NC	pH (SU)[6.8-8.5]	31	0	27
02081166	SCUPPERNONG RIVER ST SR 1105 NEAR COLUMBIA NC	pH (SU)[6.0-9.0]	32	0	7
02043882	LITTLE RIVER AT US HWY 17 AT WOODVILLE NC	Turbidity (NTU)[50]	31	0	1
02081185	KENDRICKS CREEK AT SR1300 AT MACKEYS NC	Turbidity (NTU)[25]	31	0	2

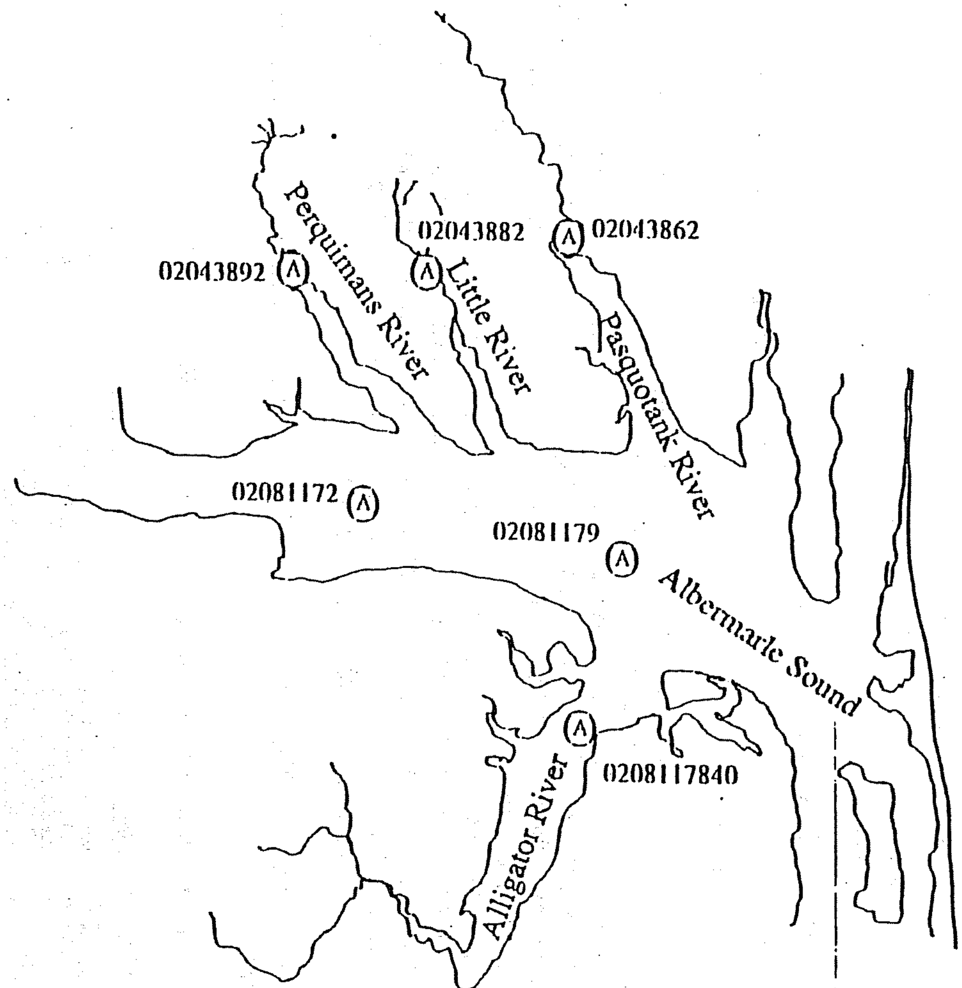


Figure 4.4. Location of Ambient Monitoring Stations in the Pasquotank River Basin

Table 4.5. Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria by Total Samples. January 1990 to December 1994.

Station Number	Station Name	Total	<Det	Samples Excursions	%Excursions
2043862	PASQUOTANK RIVER AT ELIZABETH CITY, NC	262	170	7	2.7
2043882	LITTLE RIVER AT US HWY 17 AT WOODVILLE NC	132	30	24	18.2
2043892	PERQUIMANS RIVER AT SR 1336 AT HERTFORD NC	132	31	23	17.4
2081166	SCUPPERNONG RIVER ST SR 1105 NEAR COLUMBIA NC	160	39	30	18.8
2081172	ALBEMARLE SOUND NEAR HARVEY POINT	648	183	6	0.9
208117840	ALLIGATOR RIVER AT US 64 NEAR ALLIGATOR NC	191	30	0	0.0
2081179	ALBEMARLE SOUND NEAR FROG ISLAND	530	104	16	3.0
2081185	KENDRICKS CREEK AT SR1300 AT MACKEYS NC	273	169	45	16.5
	Grand total	2328	756	151	6.5

An examination of the excursions from North Carolina criteria indicates only two parameters, dissolved oxygen and pH, with multiple excursions. The only other parameters with any excursions at all are turbidity with three and nickel with six. There are low concentrations of dissolved oxygen in the Little River and Kendrick's Creek and low pH concentrations in Little River, Kendricks Creek and Perquimans River. In the case of Little River and Kendricks Creek, low dissolved oxygen and pH indicate swamp water conditions and in fact, the Little River site is classified as swamp water.

When nutrient distributions are plotted, two sites show elevated levels of phosphorus and nitrogen relative to other sites. Figure 4.5 shows total phosphorus concentrations for ambient stations in the Pasquotank. The Little River site clearly has higher total phosphorus concentrations than other sites in the basin. When data for total nitrogen is presented graphically (Figure 4.6), Kendricks Creek is shown to exhibit higher concentrations than other sites for this parameter. However, when data for ammonia nitrogen (Figure 4.7) and total kjehdahl nitrogen (Figure 4.8) are plotted, both the Little River site and the Kendricks Creek site show elevated levels of these parameters.

Fecal Coliform Bacteria

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

Summary fecal coliform information is listed in Table 4.6. The primary screening tool used in establishing priority is the geometric mean. Sites with 10 or more fecal coliform samples within the last 5 years, that have a geometric mean exceeding 200 /100ml, are considered highest priority.

In the Pasquotank River, there were no stations with a geometric mean greater than 200/100ml. The only site with any sample above 200/100ml was the Little River site. This site, along with four others in the basin, have only been sampled for one year and no conclusion regarding fecal coliform conditions should be made using this small data set. Fecal coliform sampling was added to these sites in 1995 and will continue. As more data is generated, a clearer picture of bacterial conditions in these areas will become available.

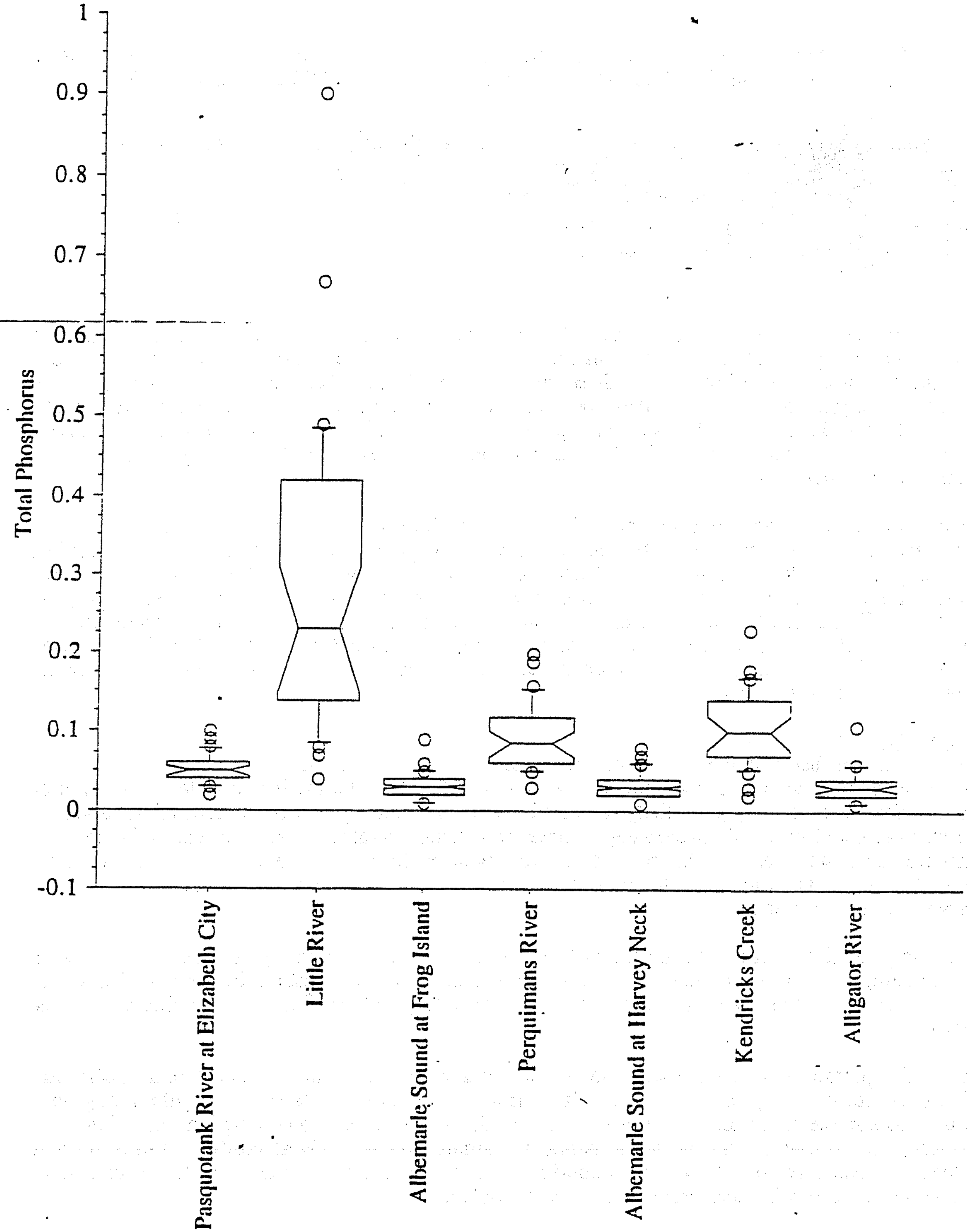


Figure 4.5. Pasquotank River Basin Ambient Monitoring Sites. Total Phosphorus (mg/l) data distribution - 1990 to 1995.

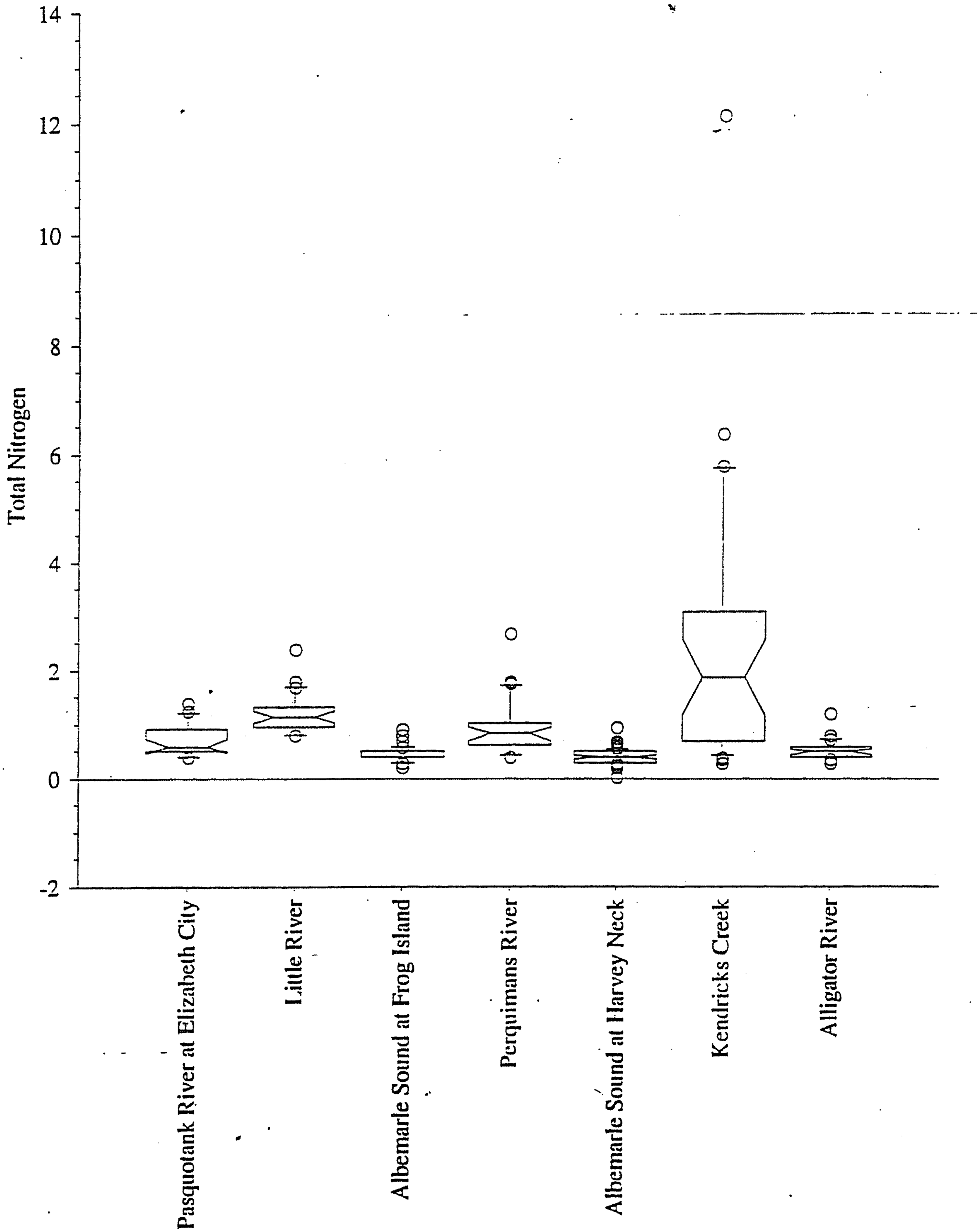


Figure 4.6. Pasquotank River Basin Ambient Monitoring Sites. Total Nitrogen (mg/l) data distribution - 1990 to 1995.

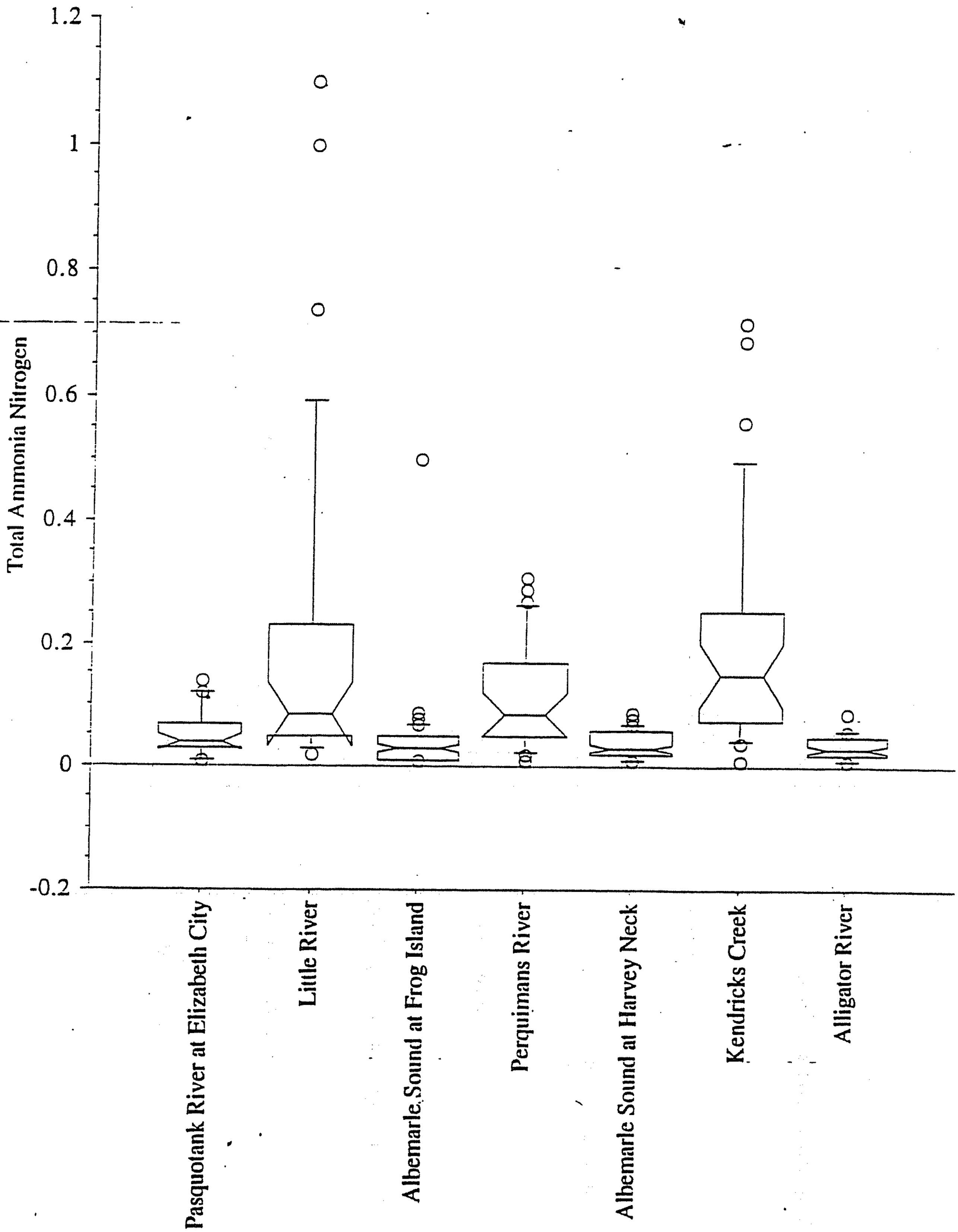


Figure 4.7. **Pasquotank River Basin Ambient Monitoring Sites. Total Ammonia Nitrogen (mg/l) data distribution - 1990 to 1995.**

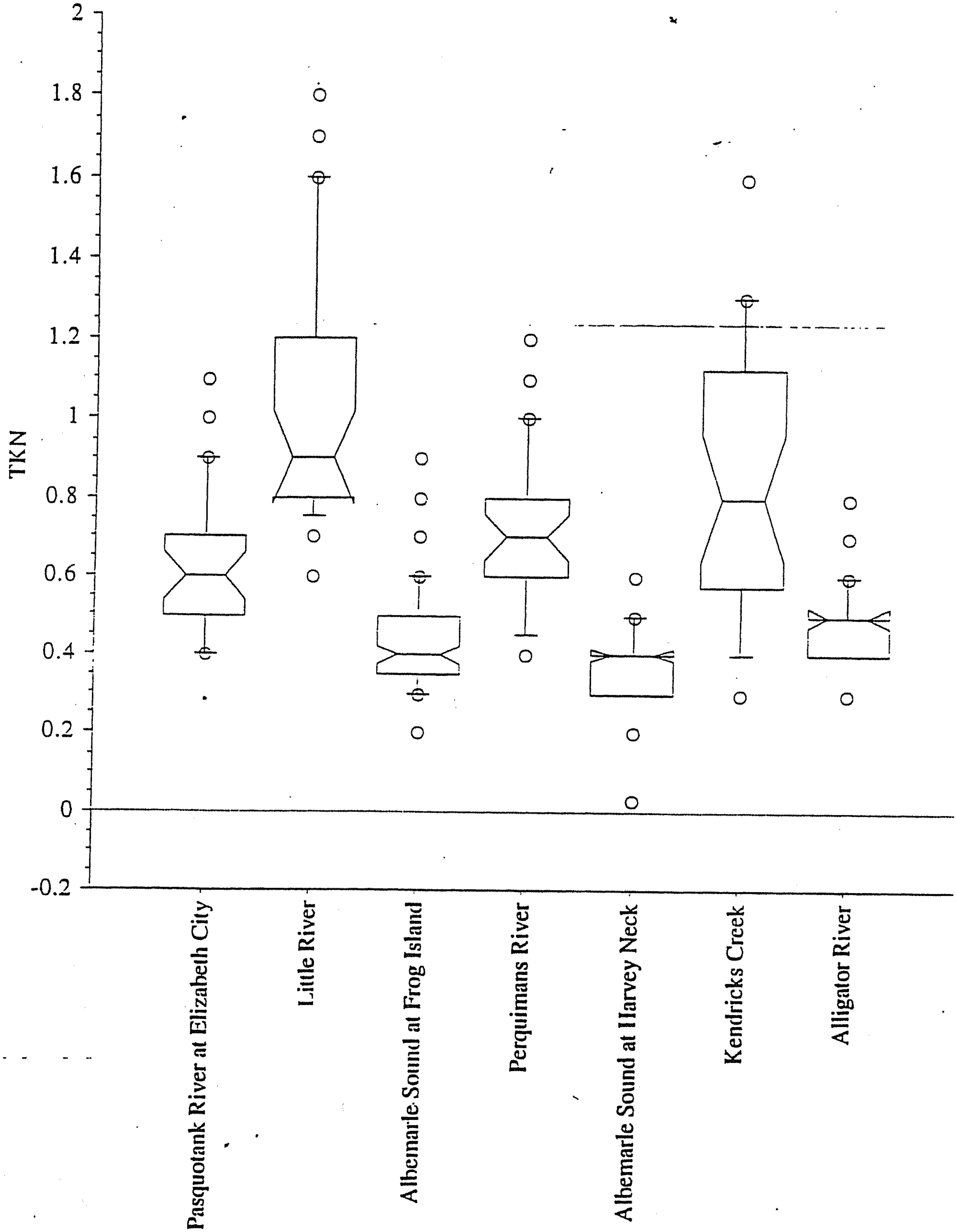


Figure 4.8. Pasquotank River Basin Ambient Monitoring Sites. Total Kjehdahl Nitrogen (mg/l) data distribution - 1990 to 1995.

Table 4.6. Fecal Coliform summary data for the Pasquotank River Basin. 1990 to 1995.

Site	Total Samples	Geometric Mean	Samples > 200/100ml	Percent >200/100ml	First Sample	Last Sample
Pasquotank Eliza. City	28	11.37	0	0.0	1/9/90	5/21/96
Little River	8	83.39	2	25.0	5/24/95	5/28/96
Alb. Sound at Frog Island	24	10.47	0	0.0	5/16/95	5/21/96
Perquimans River	8	19.96	0	0.0	5/24/95	5/28/96
Alb. Sund at Harvey Neck	102	10.83	0	0.0	1/23/90	5/21/96
Kendricks Creek	8	20.87	0	0.0	5/24/95	5/15/96
Scuppernong River	8	16.88	0	0.0	5/24/95	5/15/96
Alligator River	8	10.00	0	0.0	5/24/95	5/15/96

4.4 NARRATIVE WATER QUALITY SUMMARIES BY SUBBASIN

4.4.1 Subbasin 50 - Pasquotank River and Tributaries

<u>Description</u>
This subbasin consists of the Pasquotank River and its tributaries in Camden, Pasquotank and Gates counties. Land use in the area is mostly cropland or forest. A significant portion of waters in this subbasin are brackish estuarine, including Albemarle Sound and the Pasquotank River below Elizabeth City. Other towns in this subbasin, besides Elizabeth City, are Camden and South Mills, however most of the development is in Elizabeth City and to its south around the US Coast Guard Base. The one major discharger in this subbasin, Elizabeth City WWTP (2.5 MGD), discharges into the Pasquotank River. This facility has been permitted to expand to 4.5 MGD and the expansion is currently under construction. Figure 4.9 shows the location of DWQ's monitoring sites in this basin.

<u>Overview of Water Quality</u>
There are three ambient chemistry stations in this subbasin. These are in the Pasquotank River at the Railroad Bridge above Elizabeth City, at US 17 in Elizabeth City and at Buoy FL5SEC near Old Trap.

There are few indications of water quality problems in the Albemarle Sound in this subbasin. Nutrients are generally low and there are few signs of algae blooms. In the Pasquotank River, nutrients are elevated and blooms have been documented more often. Since nutrient levels are highest upstream of Elizabeth City and its WWTP, nonpoint sources, including agriculture, are thought to be the major sources of nutrients. The correlation between increased freshwater inputs and increased phosphorus concentrations also suggests runoff from nonpoint sources.

Benthos have been collected at three sites. These data indicate that water quality in the Pasquotank River near Elizabeth City appears stable. Fish have been collected for tissue analysis from the Pasquotank River at Elizabeth City. Monitoring results show only mercury as a significant metals contaminant with 16 of 61 (26%) samples containing mercury above human health criteria. Twelve of these 16 samples came from the Pasquotank River near Elizabeth City. Samples collected near Wade Point for dioxin analyses in 1989 and 1990 showed elevated levels, especially in white catfish. Other metals and organics results were non detectable or at levels below those of human health or ecological concern.

Two dischargers, Elizabeth City WWTP and the US Coast Guard, conduct toxicity tests in this subbasin. Self-monitoring reports show that these facilities have been in compliance with their permit since 1992.

Pasquotank River Basin
030150

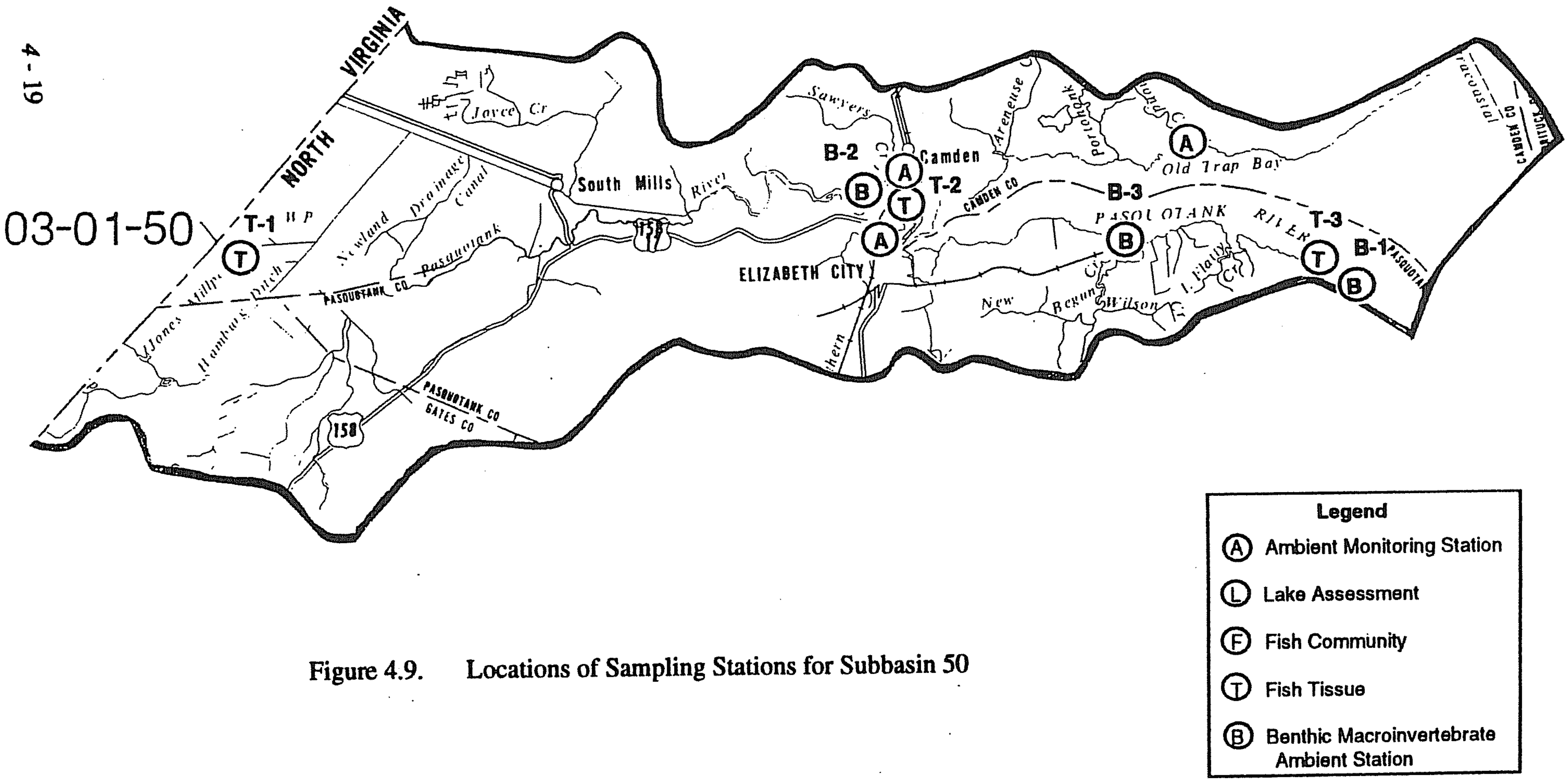


Figure 4.9. Locations of Sampling Stations for Subbasin 50

4.4.2 Subbasin 51 - Alligator River, Croatan Sound and a Portion of Albemarle Sound

Description

This subbasin consists of the Alligator River and its tributaries, Alligator (New) Lake, part of Albemarle Sound, Croatan Sound, Roanoke Island and part of Roanoke Sound in Dare County. Most waters in this subbasin are brackish estuarine, including Albemarle, Croatan and Roanoke Sounds and the Alligator River to the Intracoastal Waterway. Land use in the area is mostly forest including the Alligator River National Wildlife Refuge. Roanoke Island, with the cities of Manteo and Wanchese, is the most developed area in this subbasin. The two largest dischargers, in this subbasin, Manteo WWTP (0.6 MGD) and Wanchese Seafood (0.25 MGD), are located on the east side of Roanoke Island. Figure 4.10 illustrates the subbasin boundary and shows the location of the sampling sites in this area.

Overview of Water Quality

There are four ambient chemistry sites along the length of the Alligator River. The first station is at Cherry Ridge Landing between New Lake and the Intracoastal Waterway (ICWW). The second is at Newport News Point where the river turns north and widens. The third is the Catfish Point site near the mouth of the Frying Pan. The fourth is at US 64 near the mouth. The upper reaches of the Alligator River appear to have elevated nitrogen levels and low dissolved oxygen. While low pH values suggest that much of the oxygen problem is related to drainage from Hollow Ground Swamp, possible effects from agricultural runoff around New Lake cannot be ruled out. Oxygen levels increased and nitrogen levels declined by the time the river turns north. From Newport News Point to US 64, water quality appears to be stable and generally good. Chlorophyll-a levels slowly rise proceeding downstream, such that an occasional algae bloom has been documented at US 64.

The Alligator River upstream of US 64 and all of its natural tributaries (not canals, Alligator Lake or ICWW), have been classified as Outstanding Resource Waters. Two tributaries to Shallowbag Bay (upper Scarboro Creek and Doughs Creek) have been classified as High Quality Waters based on their designations by the Marine Fisheries Commission as primary nursery areas.

The salinity regime of the Albemarle Sound is an important factor in the establishment of phytoplankton communities. Median salinity values (since collecting began in 1982) averaged 2 parts per thousand (ppt). Shifts in algal species are evident moving from the freshwater tributaries which feed the Albemarle Sound to the open sound. Nuisance blue-green algae (Anabaena portoricensis, Anacystis cyanea) in the Chowan River and other tributaries such as the Pasquotank and Little Rivers cannot tolerate the slightly higher salinities of the Albemarle Sound.

Chlorophyll-a values are relatively low throughout the sound and there is little variation in chlorophyll between seasons despite the high densities of cyanophytes in summer. In the winter months diatoms are most likely to dominate algal biovolume and density estimates, whereas in the summer, typically small filamentous cyanophytes comprise the majority of algal biovolume and density. These blue-green algae are unusual in North Carolina estuaries, since they are more commonly found in piedmont reservoirs .

The Salty Dawg Marina in Shallowbag Bay was sampled in June 1990 as part of a state-wide marina study (DEM, 1990). Copper was found in the water column, in sediments and in oysters within the marina.

Benthos have been collected at eight sites within this subbasin. Somewhat degraded water quality was noted at three locations: Spencer Creek at the DOT ferry rehab facility, Shallowbag Bay near the Manteo WWTP outfall and in Wanchese Harbor.

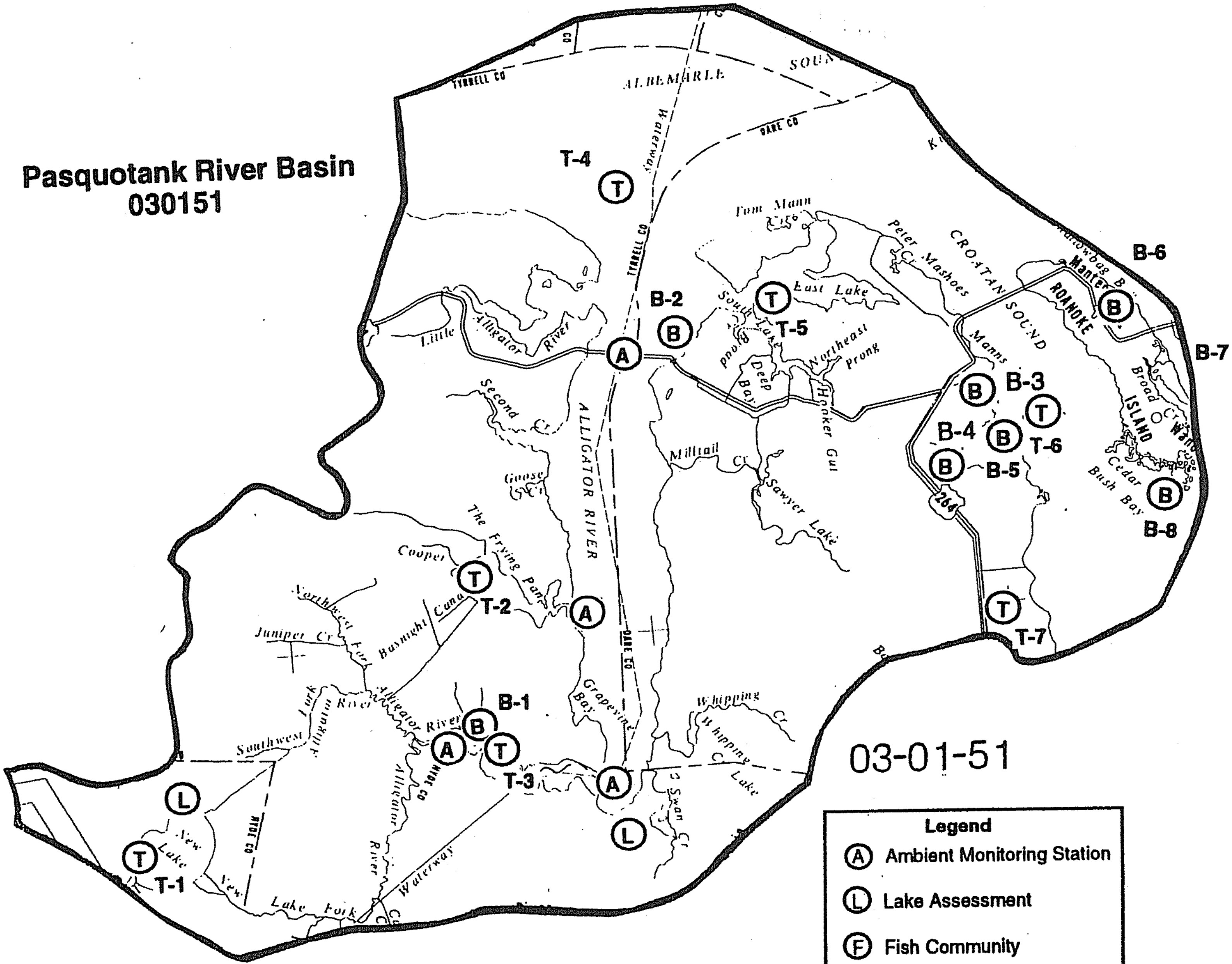


Figure 4.10. Locations of Sampling Stations for Subbasin 51

Shallowbag Bay was sampled to look for impacts from the Manteo WWTP discharge. Wanchese Harbor (Mill Cr) was sampled to look for effects from seafood processing and boat traffic in the harbor. Broad Creek was sampled as a reference for these two sites. The habitat at Shallowbag Bay and Broad Creek was primarily sand grading into a saltmarsh at shoreline. Habitat at Mill Creek was primarily bulkhead, with a small area of coarse sand and small rock.

Shallowbag Bay, at an undeveloped salt marsh 400 meters from the Manteo WWTP outfall, showed depressed taxa richness and lowered EBI. If this impact is due to the outfall, the discharge may be affecting nearly 1/3 of the bay. Nonpoint runoff may also be significantly impacting the entire bay.

Collecting in Wanchese Harbor (Mill Creek) was difficult since most of the area had been bulkheaded and dredged to 3m or more. As a result, only 18 taxa were collected here, half of what was collected in nearby Broad Creek. Despite this low taxa richness, there does not appear to be a significant decline in water quality in the harbor.

Fish have been collected for tissue analysis from two tributaries to the Alligator River: The Frying Pan and Boat Bay in the Alligator Wildlife Refuge. Mercury contamination at these sites was minimal with only 5 of 83 samples containing mercury above human health criteria. Other metals, dioxin, and organic contaminants were non detectable or below levels of concern.

There are two lakes in this subbasin that were sampled by DWQ: Alligator (New) Lake and Swan Creek Lake. Both lakes are classified as dystrophic due to the low pH and tannins in the water. Alligator Lake contains slightly elevated nutrients, possibly from local agriculture, which supports relatively high phytoplankton biovolumes for a dystrophic system. Swan Creek Lake appears to be unimpacted and is classified ORW. More specific information on these lakes is presented below.

Alligator Lake

Alligator Lake, also known as New Lake, is located in the coastal plain of North Carolina near Lake Mattamuskeet. The Lake has an average depth of less than three feet, a surface area over 5500 acres (2226 hectares) and a volume of 11.8 x 106m3. Because of the presence of the peat beds which contribute tannins and lower the pH of the water, Alligator Lake is dystrophic. This lake is classified C SW and supports secondary recreation such as fishing as well as providing a source of water for combating forest fires in the region. Alligator Lake was most recently sampled on August 23, 1989. Compared to most Carolina Bay Lakes, algal biovolume was high in Alligator Lake. Algal growth in other bay lakes tends to be limited by low nutrients, low light availability, and low pH. However, algal growth in Alligator Lake may have been enhanced by warm water temperature and plentiful nutrients in the water column. Algal biovolumes at the sampling sites approached, but did not exceed, levels associated with an algal bloom. A huge, unicellular, green algae , Staurastrum paradoxum cingulum, comprised 40% of the phytoplankton biovolume. This particular genus is typically found in acidic bodies of water. Another 30% and 20% of the biovolume was dominated by euglenophytes and diatoms, respectively.

Swan Creek Lake

Swan Creek Lake is located in the Alligator River National Wildlife Refuge. Marsh and forested areas surround the lake, which is just south of the Dare County Bombing Range (USAF). Swan Creek Lake has a mean depth of eight feet (2.5 meters), a surface area of 235 acres (95 hectares), and a volume of 0.2 $x10^6m^3$. This lake is recharged by precipitation and groundwater. No feeder stream is present, although some swamp water drains into the lake. The lake is dystrophic with naturally occurring low pH values and tea-colored or tannin stained water. Georgia Timberlands and the U.S. Fish and Wildlife Service jointly own the lake. Swan Creek Lake is classified C SW ORW. Swan Creek Lake was most recently sampled by DWQ on August 23, 1989.

4.4.3 Subbasin 52 - Perquimans River, Little River and Tributaries

Description

Pasquotank subbasin 52 consists of the northwestern edge of Albemarle Sound and the rivers that empty into it. The largest of these rivers are the Little River and the Perquimans River. The Perquimans River originates in the Great Dismal Swamp and flows south before emptying into Albemarle Sound. The largest town in this subbasin is Hertford. Land use within this subbasin is mainly agriculture with widespread use of canals draining wetlands. The NPS pollution potential from cropland in this subbasin is moderate to high, based on Natural Resource Conservation Service land use estimates. Figure 4.11 provides a map of the subbasin that includes the locations of DWQ's monitoring sites.

Overview of Water Quality

There are six permitted dischargers in subbasin 52, the largest of which is the Hertford WWTP (design flow = 0.4 MGD). Water quality in this subbasin is generally Fair based on benthic macroinvertebrate data. In the Perquimans River, duckweed growth is known to be problematic. The water quality problems encountered in this subbasin are thought to be due to agricultural nonpoint source runoff (NCDWQ 1988).

Fish community structure data were collected from one site in this subbasin on Burnt Mill Creek. A lower than expected NCIBI score (36) was attributed to a combination of several metrics which were scored as "1"--number of individuals (only 42 fish were collected), an absence of darters and intolerant species, and an abundance of omnivorous species such as the creek chubsucker, Erimyzon oblongus and the golden shiner, Notemigonus crysoleucas. Also, 3 of the 11 species were represented by only one individual per species. A scarcity of individuals and an absence of intolerant species and darters are indicative of habitat degradation such as siltation, and an abundance of omnivores is indicative of upstream sources of nutrient enrichment.

4.4.4 Subbasin 53 - Scuppernong River and Tributaries, and Phelps Lake

Description

The Scuppernong River, which drains to Albemarle Sound is the largest river system in Pasquotank subbasin 53. Landuse within this subbasin is mainly forested wetlands and agriculture, with widespread use of canals which drain wetlands. There are no large urban areas. Figure 4.12 provides a map of the subbasin with the location of sampling sites.

Overview of Water Quality

There are eight permitted dischargers in subbasin 53, the largest of which is the Columbia WWTP which is currently expanding to 0.3 MGD. The Scuppernong River and Kendricks Creek have received a bioclassification of Fair based on benthic macroinvertebrate data. The Scuppernong River is known to experience nuisance growths of duckweed. The water quality problems encountered in this subbasin are thought to be due to agricultural nonpoint source runoff (NCDWQ 1988). Based on NRCS landuse estimates of this area, NPS pollution potential from cropland is high and NPS pollution potential from forestland ranges from moderate to very low. There are also areas that have a high potential for farm animal NPS pollution (USDA NRCS 1995).

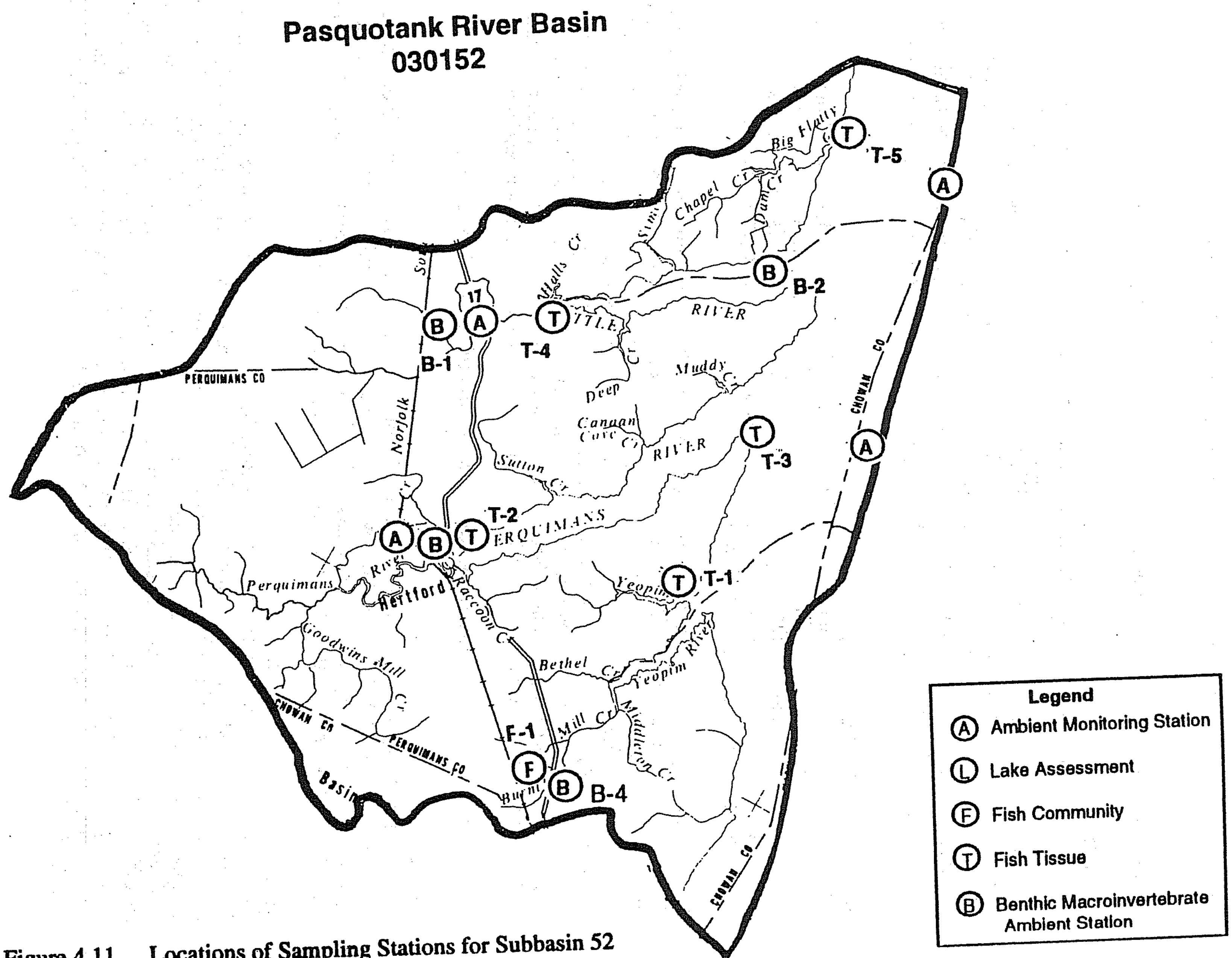


Figure 4.11. Locations of Sampling Stations for Subbasin 52

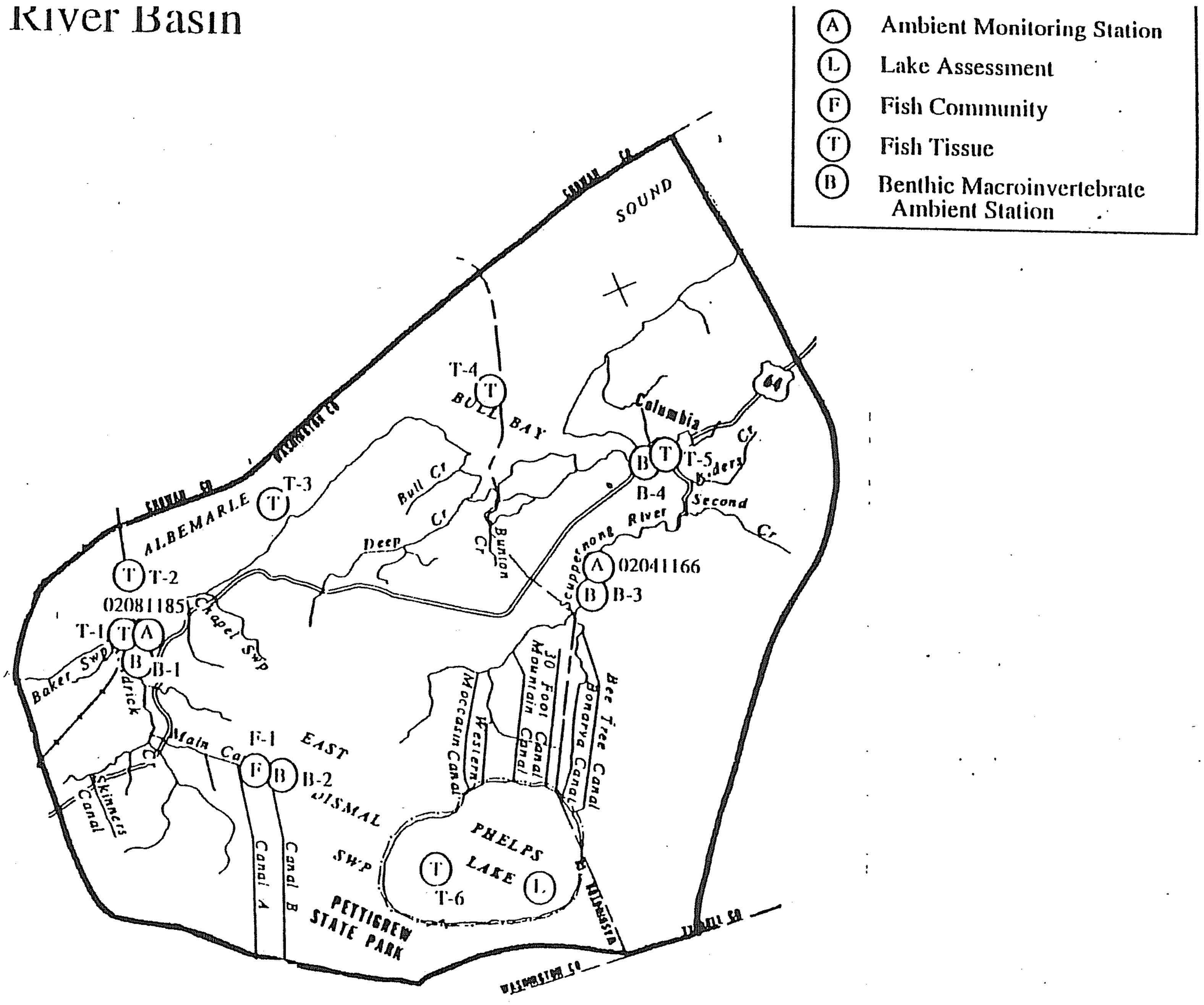


Figure 4.12. Locations of Sampling Stations for Subbasin 53

From 1990-1994, 76% of the water quality samples taken from the Scuppernong River had DO values that did not meet the state standard of 4 mg/l. Tissue samples from bowfin collected from the Scuppernong River, in 1995, were found to contain mercury levels above the criterion at which consumption advisories are posted.

Fish community structure data were collected from one site in this subbasin. This stream had fewer than expected number of individuals collected (i.e., only 86). Also, 6 of the 15 species that were collected were represented by only one individual per species. Thus, these 6 species had considerable leverage in scoring the metrics for the number of species of darters, the percentage of piscivores, and the number of intolerant species collected. Without their presence, the NCIBI score would have been lower reflecting even greater habitat degradation than what was observed.

Fish tissue samples were collected at six sites within the Pasquotank 53 subbasin. Significant mercury contamination was identified at Phelps Lake with over 50% of fish samples containing levels above human health standards. Mean mercury levels for bass and bowfin collected at Phelps were 1.16 ppm and 1.4 ppm respectively. Elevated mercury levels were also evident at Kendricks Creek where 11 of 35 samples contained concentrations above standards. Significant dioxin levels have been detected in fish collected from the western end of Albemarle Sound to

Bull Bay since 1990. Levels have gradually dropped in some species but remain above the NC criteria in others, especially catfish. Other metals and organics results were non detectable or at levels below those of human health or ecological concern.

Phelps Lake

Phelps Lake is a 16,600 acre (6,475 hectare) elliptical Carolina Bay Lake located in eastern Washington and Tyrrell Counties and is the second largest natural lake in the state. This lake lies on a vast peninsula between Albemarle Sound on the north and the Pamlico River on the south. This peninsula contains numerous low-lying swampy areas underlain by thick organic deposits and relatively well-drained areas with fertile mineral and organic soils. In the past, much of the region had been cleared of native vegetation, drained and put into large scale agricultural use (NRCD, 1980a). Phelps Lake rests on one of the highest elevations in the surrounding area with an altitude of 3.6 to 4.0 meters above mean sea level, resulting in outflow to the Scuppernong River during high water levels. There are no inflows from tributaries making Phelps Lake dependent upon rainfall for replenishment. The retention time is, therefore, extremely long and averages 1,161 days. As is typical of Carolina Bay Lakes, Phelps Lake is shallow with a mean depth of 1.4 meters (4.6 feet). The maximum depth is three meters (9.8 feet) at the center. Because of this shallow depth, Phelps Lake is wind mixed and rarely stratifies. The shape and bathymetry of the lake, which is bisected by a sand bar, suggests that the lake is actually two overlapping bays (Allen et al., 1979). The lake bottom is sandy except for the northern and eastern portions where silt, peat and organic matter accumulate (Lynch and Peacock, 1982).

Phelps Lake is owned by the State of North Carolina and is associated with the Pettigrew State Park. Phelps Lake currently contains excellent populations of largemouth bass (*Micropterus salmoides*) and pumpkinseed (*Lepomis gibbosus*). The lake is used primarily for recreational activities such as boating and fishing. It is also used as source of water to combat local peat fires. Phelps Lake provides habitat for the globally imperiled, endemic Waccamaw killifish (Fundulus waccamensis) (Shute, 1981) and for the leafless watermilfoil (Myriophyllum tenellum) (Lynch and Peacock, 1982), an aquatic macrophyte not previously found south of New Jersey. Phelps Lake is currently classified C Sw. Phelps Lake was most recently sampled on August 10, 1995. The NCTSI score was -4.5, indicating oligotrophic conditions. In 1995, Phelps Lake supported all of its designated uses.

Phelps Lake was sampled three times during the growing seasons of 1991 through 1992 as part of the reference lakes program. Reference lakes were intensively monitored during the growing season to determine if these lakes were representative of minimally impacted lakes by which other similar lakes in the same region could be compared. Samples were also collected in 1993 for consideration of reclassification to Outstanding Resource Water (ORW). Chemical and physical data collected during these years were consistent with that collected in previous years by DWQ. The TSI scores for Phelps Lake from 1991 through 1993 also remained consistently oligotrophic

Overall, water quality in Phelps Lake is excellent based on physical, chemical and biological monitoring results. Levels of dissolved oxygen and oxygen saturation readings are stable in Phelps Lake. Values of pH remain stable and are naturally in the acidic range because of underlying soils. Conductivity measurements are relatively low and are stable, reflecting a lack of impact from pollution. Turbidity values remain low and secchi transparency is high, demonstrating excellent water clarity. Nutrient concentrations and chlorophyll-a values are low, portraying a lack of enrichment or potential for nuisance algal growth. Chlorophyll-a concentrations, collected during summer sampling of Phelps Lake in 1993, averaged 4 µg/l and were well below the state standard of 40 µg/l. Concentrations of chlorophyll-a ranged from <1 to 7 µg/l.

4.4.5 Subbasin 54 - Currituck Sound and the North River

Description

This subbasin consists of Currituck Sound and the North River and its tributaries in Currituck and Camden counties. Land use in the area is mostly cropland, however development is increasing rapidly along US 158 and the Outer Banks. Most of the waters in this subbasin are brackish estuarine, including Currituck Sound and the North River. Many canals drain the Great Dismal Swamp primarily into the North River and the Northwest River. Currituck is the largest town in this subbasin; other small towns include Waterlily, Poplar Branch and Point Harbor on the mainland and Corolla on the Outer Banks. There are no major dischargers in this subbasin. Figure 4.13 provides a map of this subbasin showing the locations of the various monitoring stations.

Overview of Water Quality

There is one ambient chemistry site in this subbasin at the mouth of Currituck Sound. The major problem documented at this site was periodic algae blooms. All waters in this subbasin are classified as SC or C-Swamp with the exception of Tulls Creek, which is classified as B-Swamp.

DWQ has done an intensive analysis of nutrients in Currituck Sound. Results are presented in the following sub-section devoted to the sound.

Growths of vegetation in 1995 appeared to be more dense and abundant than in 1992 and 1993. This resurgence in submersed rooted vascular beds (SRV) in 1995 helps to explain increases in water clarity compared to previous years. Plants help to decrease turbidity by decreasing wave action and settling incoming sediments and vascular plants may shade algae, decreasing algal turbidity. SRV also provides vital nursery habitat for fish, shellfish and other animals. The five most common types of SRVs recorded in the Currituck Sound survey are Ruppia maritima (widgeon grass), Vallisneria americana (wild celery), Myriophyllum spicatum (Eurasian water milfoil), Najas guadalupensis (naiad or bushy pondweed) and Potamogeton pectinatus (sago pondweed). SRV is discussed in more detail in Chapter 2 of this basinwide plan.

Benthos have been sampled at seven locations within this subbasin. A good mix of submersed rooted vascular plants and salinity fluctuations that shift the benthic community from fresh water to estuarine in character make Currituck Sound one of the most diverse areas in the state for varying salinity regimes.

Pasquotank River Basin
030154

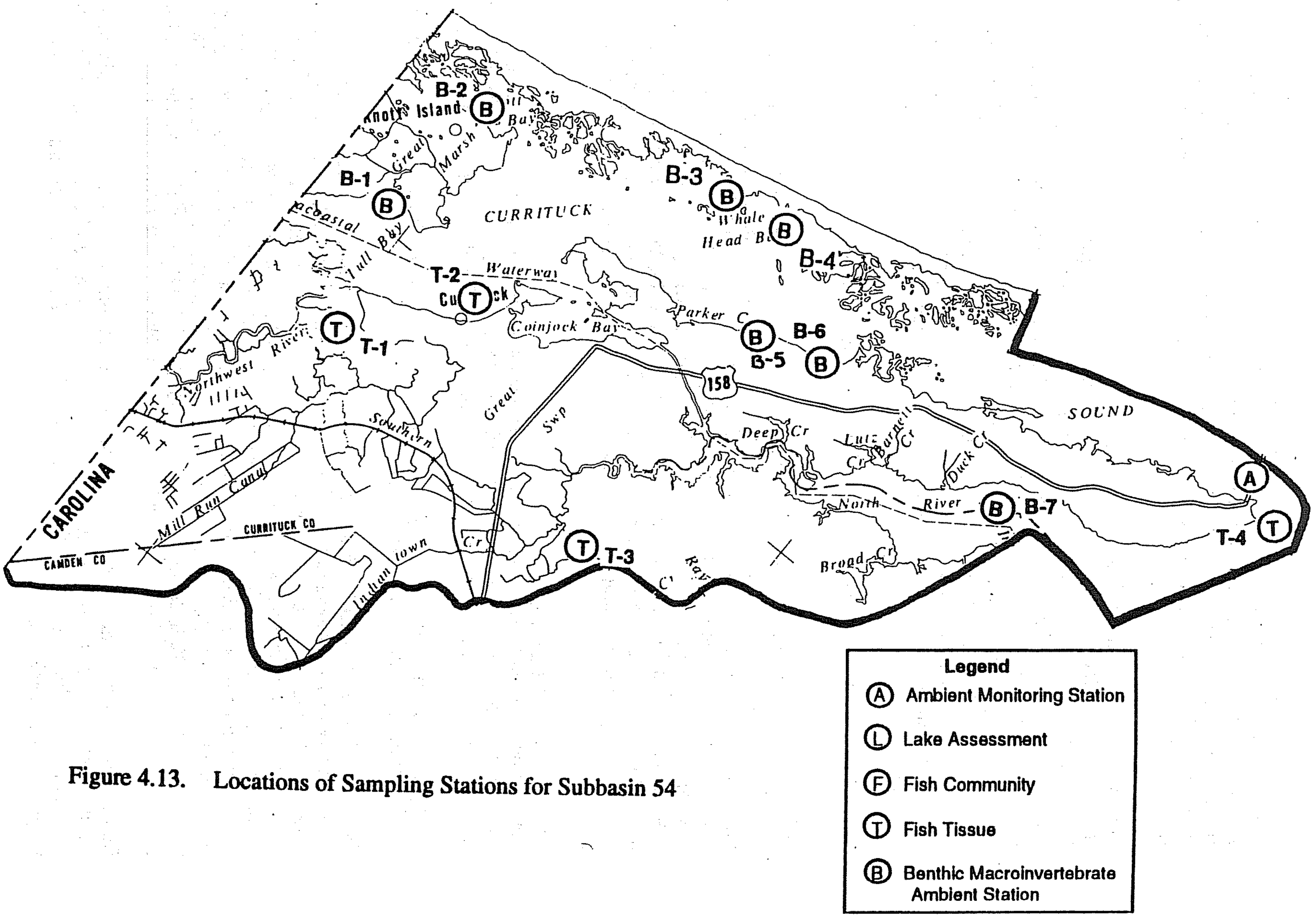


Figure 4.13. Locations of Sampling Stations for Subbasin 54

Fish tissue samples were collected on six occasions within the Pasquotank 54 subbasin. Mercury was detected at levels above the EPA screening value in 12 of 19 samples collected at Indian Town Creek in 1995 and in almost 1 sample in 6 from three surveys in Tulls Bay. Elevated mercury was most prevalent in bass and bowfin from the site. PCB concentrations exceeding the EPA screening values were detected in bass and carp from Tulls Bay and heptachlor epoxide concentrations exceeding the EPA screening values were detected in carp from the mouth of Currituck Sound.

Special Study of Currituck Sound

Currituck Sound is a shallow, fresh to brackish estuarine water body in the northeastern portion of the state whose circulation is influenced largely by wind movement. In the past, Currituck Sound was a viable bass fishery and waterfowl hunting ground. A large portion of the Currituck Sound is a vast marsh that serves as a critical part of the Atlantic Flyway for migratory waterfowl (Currituck Co. 1986). Thousands of wintering ducks, geese and swans contribute to the sound's reputation for waterfowl hunting. Currituck Sound was nominated for the designation of Outstanding Resource Waters (ORW) in 1990. Subsequently, a special study was conducted in 1992-1993 to assess water quality conditions and to determine if the sound qualified for the supplemental classification of ORW. Because of the presence of chronic widespread blue-green algal blooms, Currituck Sound failed to qualify for ORW at that time. Currituck Sound was again sampled monthly during the summer of 1995 as part of the basinwide assessment.

Throughout history, inlets from the ocean to Currituck Sound have been periodically carved by storms. In addition to severe storm overwash, current sources of salt water into the sound include the Albemarle Sound, Back Bay, North Landing River and the Intracoastal Waterway. Inputs of freshwater are provided by Tulls Creek and Jean Guite Creek. Salinities above several parts per thousand have caused problems in Currituck's once viable freshwater fishery. Populations of largemouth bass (Micropterus salmoides) and other primarily freshwater fish along with native freshwater macrophytes were greatly reduced with increasing salinities. These changes in salinity were caused both naturally and artificially. Severe droughts in the mid 1980's and pumping of saltwater into Back Bay contributed to increased salinities in the sound. A memorandum from the Environmental Protection Agency (EPA) and Albemarle Pamlico Estuarine Study (Dec 2, 1991) reports a potential problem, that of saltwater encroachment introduced by the link between the Lynhaven River to the Chesapeake Bay to the North Landing River. Currituck County received a grant in 1995 from the N.C. Division of Marine Fisheries to install gages to study the effects of saltwater movement from Canal #2 which feeds into the North Landing River.

Historically, salinities at the ambient station (02042955) near Point Harbor have reached as high as 9 or 10 ppt during the fall, when flows are lowest and saline waters are moving inward. Highest salinities in Currituck Sound are recorded at the ambient station near Point Harbor since it is closest to the inlet. However, Coinjock Bay sometimes has salinities higher than expected since salt from the North River is introduced via the Intracoastal Waterway. Lowest salinities occur in the spring when flows are highest. Salinities in the upper to middle portion of Currituck Sound in 1992-1993 were generally around 1 ppt. In 1995, salinity was approximately 3 ppt higher than in 1992 and 1993 at most stations. Higher salinities in 1995 were caused by a dry spring and summer which contributed to an increase in salinity. Rainfall records from April through September 1995 were reviewed and found that precipitation was 10.6 inches below normal. Higher levels of total solids in 1995 are attributed to the higher levels of salinity (dissolved solids) found in the sound.

Data from Currituck Sound demonstrate that nutrients are elevated in the upper portion of Currituck Sound, in the North Landing River near the state border, in the mouth of Tulls Bay and in Tulls Creek at SR 1222. A study conducted by DWQ (1994) showed that Tulls Creek exhibited high levels of nitrogen and phosphorus and that Tulls Creek is the largest contributor of nutrients to the sound. Therefore this watershed is of major concern. Consequently, the N.C. Cooperative Extension Service and the USDA Soil Conservation Service have proposed a stormwater management plan to reduce nutrient inputs in Tulls Creek. This plan involves the design and implementation of a storage system for stormwater runoff, so that nutrient inputs to surface waters can be minimized. Implementation of water control structures in a 400-500 acre agricultural area will insure that nutrient inputs will be reduced, as these structures have been documented to reduce nitrogen and phosphorus by 30 to 50% (Evans, et al. 1995).

Pulses of nutrients were also observed in Knotts Island Bay (Station 6 - close to Back Bay) and in Coinjock Bay near the Intracoastal Waterway (Station 10). Overall, nutrients decreased throughout the sound in a southerly direction (Figure 4.14). In 1992-1993 levels of nitrate/nitrite and orthophosphate (which are most readily available for phytoplankton) were extremely low with the exception of the top three stations. Nitrate/nitrite and orthophosphate in the top three stations ranged from <.01 to 0.56 mg/l and <.01 to 0.06 mg/l, respectively. In the lower seven stations both nitrate/nitrite and orthophosphate ranged from below the detection limit to 0.01 mg/l. In 1995 these nutrients were low throughout the sound and were mostly below the detection level which indicates uptake by phytoplankton.

A nitrogen to phosphorus ratio of 10:1 is a general concentration at which nutrients are in balance since algae typically utilize nitrogen and phosphorus at an average ratio of 10 parts nitrogen to 1 part phosphorus. Nutrient ratios of greater than 10:1 indicate water which is phosphorus limited while ratios of less than 10:1 are considered to be nitrogen limited. With the exception of two samples collected (Tulls Bay, Tulls Creek) in 1995, the entire sound was found to be phosphorus limited with TN:TP ratios ranging from 11:1 to 40:1. Data from previous years also demonstrated that Currituck Sound is phosphorus limited. This is to be expected since fresh waters are typically phosphorus limited while salt waters are generally nitrogen limited.

Blooms of blue-green algae (cyanophytes) are common throughout Currituck Sound and were found in 1992, 1993 and 1995. Eighty-seven percent of samples collected by DWQ during a study conducted in the growing season of 1992-1993 contained bloom densities of algae. In the absence of algal samples, chlorophyll-a is often used to assess algal growth. Although the state standard for chlorophyll-a is 40 µg/l, values much lower (20 µg/l) are often found during bloom conditions. Chlorophyll-a values in 1992 were particularly high for Currituck Sound. Of the 10 stations that were sampled for chlorophyll-a during 1992, 1993 and 1995, bloom conditions were frequently found in 1992 as demonstrated by chlorophyll-a values ranging from 10-48 µg/l and averaging 26 µg/l. Chlorophyll-a values at the same 10 stations in Currituck Sound averaged 8 µg/l in both 1993 and 1995. Very high densities of blue-green algae are often found with low accompanying values for chlorophyll-a. The small cyanophytes responsible for the blooms result in slightly discolored water and elevations in surface values of pH and dissolved oxygen. Phytoplankton of Currituck Sound are generally small filamentous or colonial, rather than the noxious surface blooming species that cause surface scums.

Moreover, the phytoplankton assemblage in Currituck Sound and in the Albemarle Sound are unique to the northeast region in North Carolina. Higher salinities in other estuaries such as the Neuse and Tar-Pamlico, prevent similar species composition. Common blue-green algae found in Currituck Sound include *Anabaenopsis raciborskii*, *Lyngbya circumcreta, L.* species A, *Phormidium angustissimum, Chroococcus spp, Dactylococcopsis sp,* and *Gomphosphaeria wichurae.*

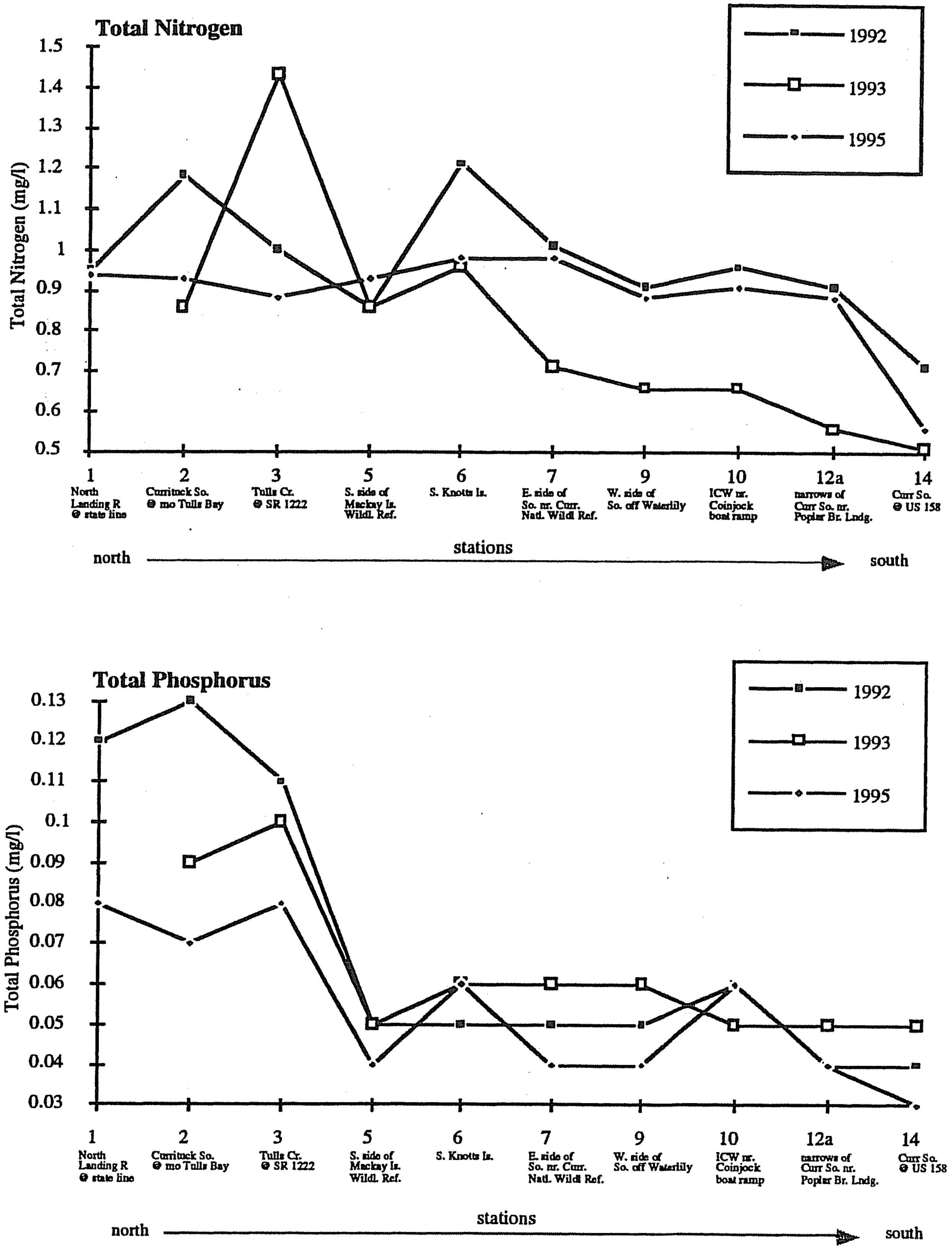


Figure 4.14. Mean Levels of Nutrients (Total Nitrogen and Total Phosphorus) in Currituck Sound

Other algal classes represented in these samples include cryptophytes (cryptomonads), chrysophytes (golden-brown algae), bacillariophytes (diatoms) and chlorophytes (green algae). While algal samples are dominated by cyanophytes in summer months through November, other algal classes are more prevalent in milder months such as February and June. Figure 4.15 illustrates algal dominance by density from 1989 through September 1995 at the ambient station near Point Harbor. There were no clear spatial or temporal patterns of blooms. Few algal samples were collected in the spring, however this season had the highest mean values for chlorophyll-a in Currituck Sound.

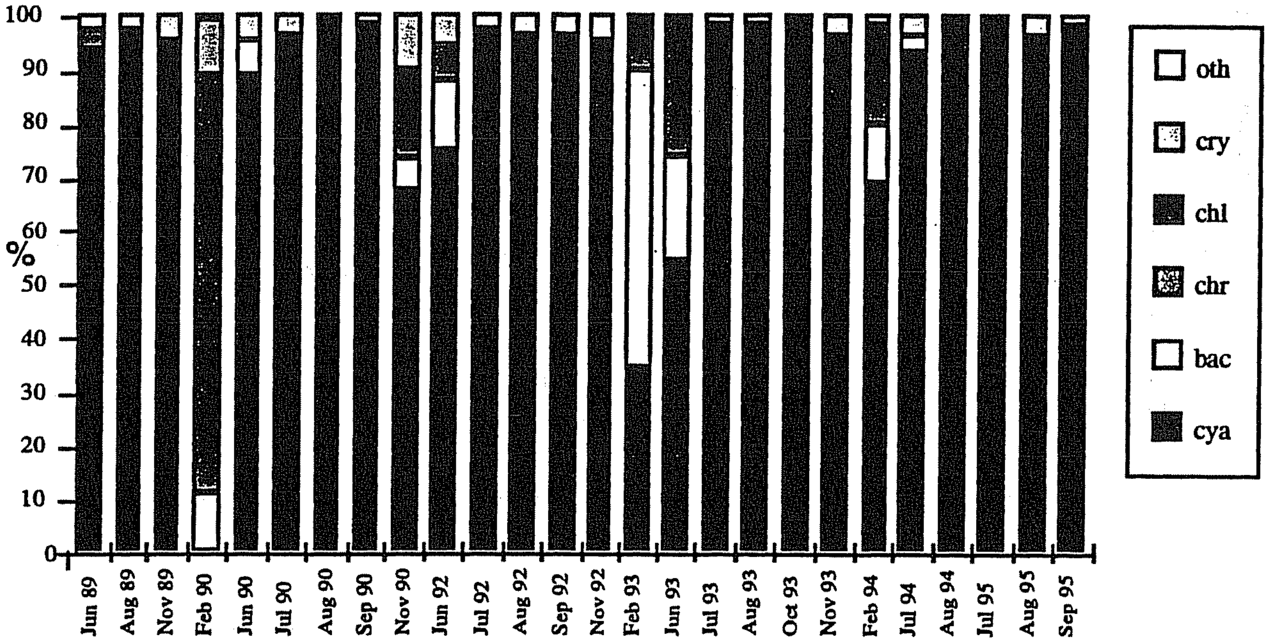


Figure 4.15. Percent Algal Dominance by Density in Currituck Sound at Station Near Point Harbor, 1989 - 1995

Some interesting differences in water chemistry are apparent between recent years. Water transparency in 1995 was slightly higher than in earlier years (1992-93) as demonstrated by higher Secchi values and lower mean turbidity measurements at most stations in 1995. A resurgence in submersed aquatic vegetation in 1995 helps to explain increases in water clarity. Plants help to decrease turbidity by decreasing wave action and settling incoming sediments and vascular plants may shade algae, decreasing algal turbidity.

Metal samples were collected from the water column monthly during the summer in 1995. Copper was above the action level (3 µg/l) 43% of the time and less than the detection level 30% of the time. Copper was found above the action level at least once at every station sampled in 1995. Zinc was found to be above the action level (86 µg/l) 20% of the time and less than the detection level 15% of the time. Aluminum, iron and magnesium were all detected in the water column each month, however, there are no action levels or state standards in salt waters for these elements. Iron, zinc and copper are naturally occurring and are released by weathering of rocks and soils as well as by point and non-point sources. These trace elements are necessary for plant growth but when found in larger than natural concentrations they can be toxic.

4.4.6 Subbasin 55 - Northeastern Pamlico Sound

Description

This subbasin consists of Pamlico Sound from Oregon Inlet to Hatteras Inlet and the Outer Banks in Dare County. It also includes Black Lake and Stumpy Point Bay. Land use in the area is largely undeveloped, since most of the subbasin lies within the Cape Hatteras National Seashore and Pea Island Wildlife Refuge. All waters in this subbasin are estuarine, with the exception of Black Lake. Hatteras is the largest town in this subbasin, with other, smaller, towns along NC 12: Avon, Buxton, Frisco, Rodanthe and Salvo. There are no major dischargers in this subbasin. The largest dischargers are Cape Hatteras Water Association (0.026 MGD), Kill Devil Hills (0.06 MGD) and the Villas Condominiums (0.06 MGD). Figure 4.16 illustrates the boundaries of this subbasin.

Overview of Water Quality

Water quality in this open water area appears to be generally high though there is a scarcity of information. All waters in this subbasin have been classified as SA except Black Lake which is classified C-Swamp.

Pamlico Sound was sampled in the Pea Island National Wildlife Refuge approximately 1/2 mile from land and 0.7 m deep. The muddy sand substrate had 100% cover of seagrass, mostly Halodule wrightii, with some Zostera marina. The high EBI and the presence of the bay scallop, Argopecten irradiens, is indicative of a very intolerant community and high water quality. The total number of taxa would probably have been even higher at this site if there had been other habitats (bare sand, oysters or a crab pot) available for sampling.

The Dare County desalination water treatment plant, which discharges to the Atlantic Ocean, regularly passes its toxicity tests.

4.4.7 Subbasin 56 - Roanoke Sound and Small Portions of Albemarle and Currituck Sounds

Description

This subbasin consists of the lower portion of Currituck Sound, outer Albemarle Sound, Kitty Hawk Bay and eastern Roanoke Sound in Dare County (see Figure 4.16 for a map of the area). Land use in the area is primarily residential and commercial along the outer banks including the towns of Duck, Kill Devil Hills and Nags Head. All waters in this subbasin are estuarine, with the exception of a few small lakes in the maritime forest of the Outer Banks. There are no permitted dischargers in this subbasin.

Overview of Water Quality

Waters in Roanoke Sound are classified SA, Albemarle Sound is classified SB and Currituck Sound and Kitty Hawk Bay are classified SC waters. The Division of Environmental Health's Shellfish Sanitation Branch has reported DMF closures to shellfishing in Kitty Hawk Bay, Buzzards Bay, Collington Creek and portions of Roanoke Sound due to elevated fecal coliform concentrations. Rangia clams are the only shellfish resource in most of this subbasin. Oyster production is good in Roanoke Sound.

Benthos have been collected at five locations in this subbasin. The mouth of Currituck Sound was found to support the most diverse and intolerant community in the state within its salinity range. Four small ponds in Buxton Woods appeared to suffer from stress due to low dissolved oxygen.

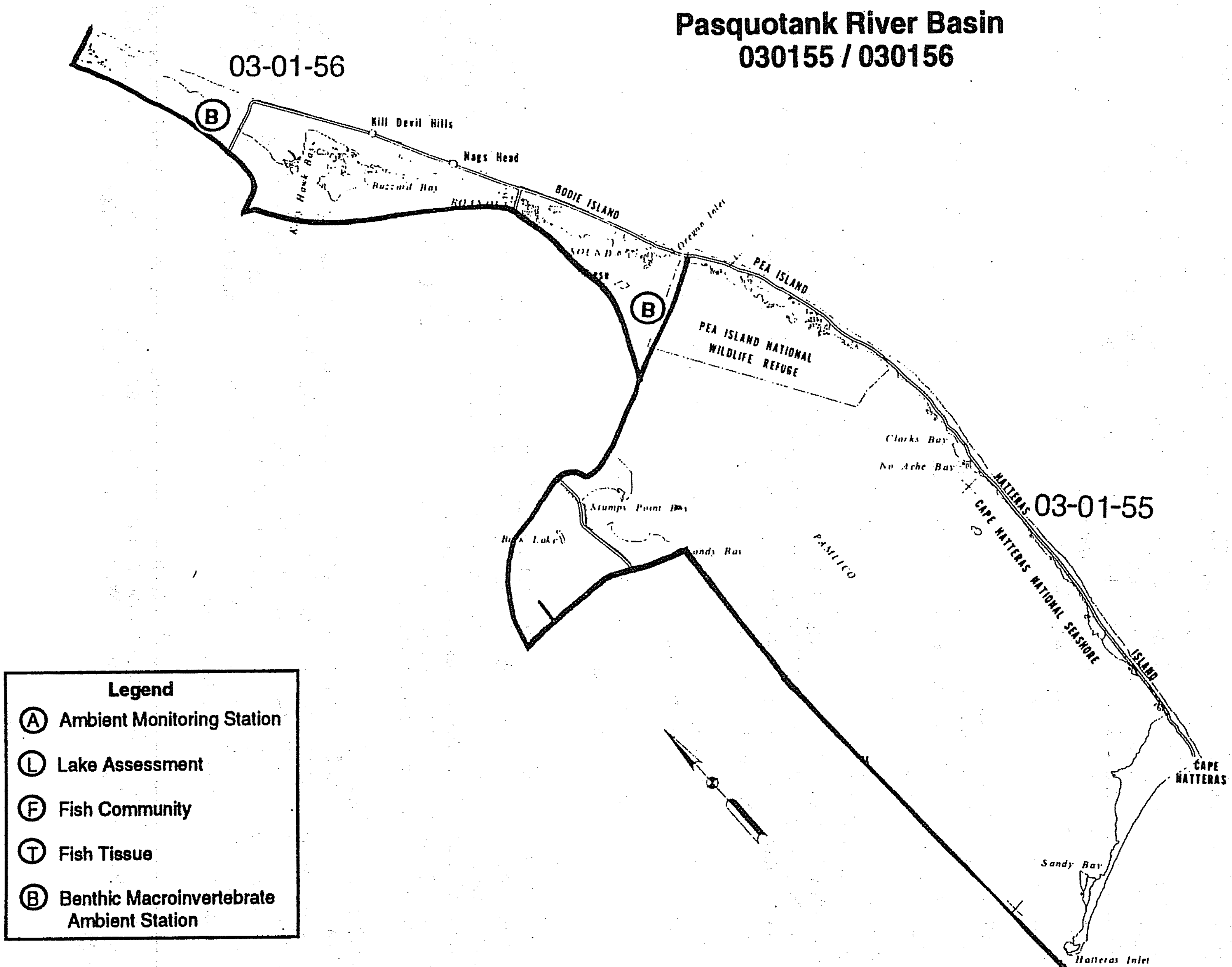


Figure 4.16. Locations of Sampling Stations for Subbasins 55 and 56

The only lakes in this subbasin are small, shallow lakes in the maritime forest on the Outer Banks. Water quality in the estuaries of this subbasin appears to be generally high. The lack of permitted dischargers and agriculture limit the potential impacts within this subbasin to urban runoff. The areas that have been closed to shellfishing are those areas that are undergoing high rates of development.

4.5 Phytoplankton in Albemarle Sound (Subbasins 50, 51, 52 and 53)

The Albemarle Sound is a fresh to brackish body of water in northeastern North Carolina. Salinities in the Albemarle Sound are low due to dilution from higher inflow of freshwater relative to the sound's volume. Likewise, the large inputs of freshwater from the Chowan and Roanoke rivers into the sound result in a short retention time. During times of low flow, saline waters encroach from the Pamlico Sound or Oregon Inlet. The salinity regime of the Albemarle Sound is an important factor in the establishment of phytoplankton communities. Median salinity values (since collecting began in 1982) ranged from 0 to 3 ppt while the sound as a whole averages 2 ppt.

Shifts in algal species are evident moving from the freshwater tributaries which feed the Albemarle Sound to the open sound. Nuisance blue-green algae (Anabaena portoricensis, Anacystis cyanea) in the Chowan River and other tributaries such as the Pasquotank and Little Rivers cannot tolerate slightly higher salinities of the Albemarle Sound. In addition, other physical factors such as increased turbulence, wind mixing and higher flushing rates suppress the buoyant growths of surface cyanophytes found in tributaries. During the growing season, phytoplankton of the Albemarle Sound are characterized as small, usually colonial or filamentous, non-scum forming blue-green algae (different than the nuisance type described above). These small blue-greens are more commonly found in piedmont reservoirs and are therefore anomalous since they are found in slightly brackish waters in the northeastern corner of the state (including Currituck Sound). These blue-green algae may cause slight discoloration in the water but are usually not as evident as large surface blooming algae. The larger forms of blue-green algae have been known to disurpt the aquatic food chain because they are not a suitable source of food for small aquatic animals which provide a food source for important fish species. This can lead to a decline the abundance of some fish species. It is not clear if or how the smaller blue-green algae that are found in the Albemarle Sound affect the food chain.

Chlorophyll-a values are relatively low throughout the sound and there is little variation in chlorophyll between seasons despite the high densities of cyanophytes in summer. In the winter months (November through February) diatoms (Cyclotella spp, Rhizosolenia spp.) and cryptophytes (Chroomonas amphioxea, C. minuta, Cryptomonas erosa) are most likely to dominate algal biovolume and density estimates. Throughout the summer months, typically small filamentous cyanophytes comprise the majority of algal biovolume and density. The filamentous species, Anabaenopsis raciborskii, Phormidium angustissimum, Lyngbya species A and colonial species, Chroococcus spp, Merismopedia tenuissima and Dactylococcopsis sp. are common dominants during warm weather. Density estimates are high relative to biovolume because of the small size of the dominant phytoplankton. Figure 4.17 depicts box and whisker plots of the algal biovolume and density in the sound at two ambient stations. Median density estimates for summer are elevated well beyond typical bloom conditions. Both stations in the Albemarle Sound (02081172, 02081179) contained similar species composition and similar algal biovolume and density estimates. Phytoplankton levels were higher in the summer during the growing season as would be expected.

Throughout the Albemarle and Currituck sounds, highest chlorophyll-a values occurred in Currituck Sound during the spring. Turbidity values also increased in an easterly direction where open waters and subsequent fetch increased mixing by wind. Highest median turbidity values occurred in the summer perhaps partially due to algal turbidity.

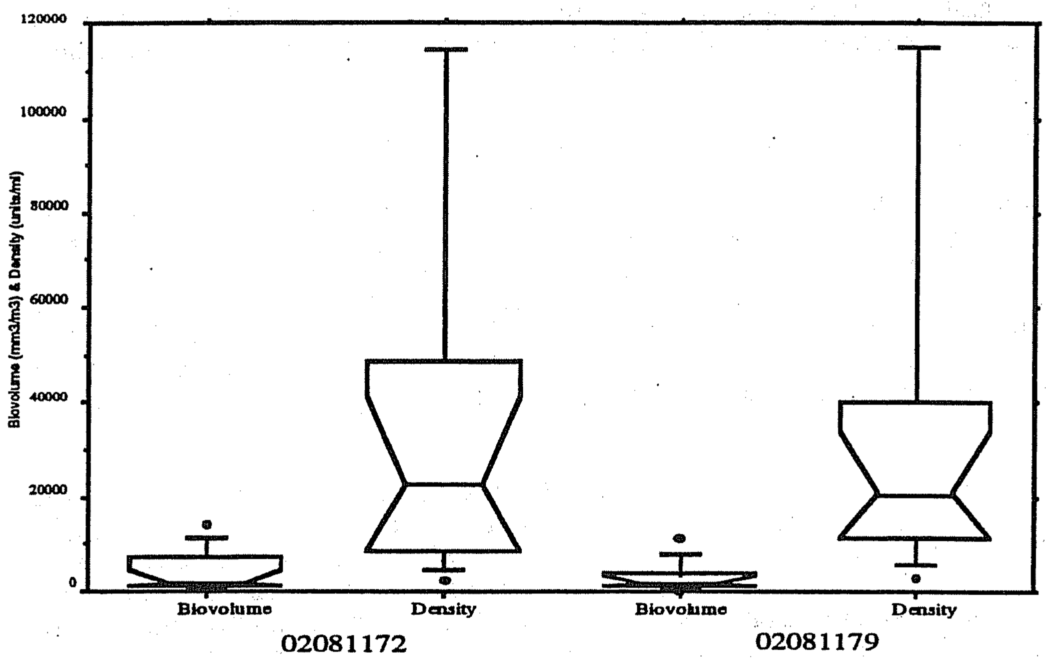


Figure 4.17. Algal biovolume and density in the Albemarle Sound during summer; 1991 - 1995

Overall nitrate/nitrite concentrations decreased from upstream to downstream from near Edenton in the western portion of the Albemarle Sound through Currituck Sound (02042955) indicating algal assimilation and dilution by brackish water. During summer and fall when flows were lowest, lowest levels of nitrate/nitrite were found throughout the Albemarle Sound. Mean organic nitrogen increased slightly moving eastward (or downstream) with Currituck Sound exhibiting the highest levels. Total phosphorus levels were fairly consistent throughout the sound and either decreased slightly from west to east or remained nearly the same. Levels of orthophosphate were fairly low throughout the sound.

4.6 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.6.1 Introduction to Use Support

Waters are classified according to their best intended uses. Determining how well a waterbody supports its designated uses (*use support* status) is another important method of interpreting water quality data and assessing water quality. Use support assessments for the Pasquotank River basin are presented in Section 4.5.

Surface waters (streams, lakes or estuaries) are rated as either *fully supporting* (S), *support-threatened* (ST), *partially supporting* (PS), or *not supporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and swimming) are fully supported, partially supported or are not supported. For instance, waters classified for fishing and water contact recreation (class C) are rated as fully supporting if data used to determine use support (such as chemical/physical data collected at ambient sites or benthic macroinvertebrate bioclassifications) did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as ST, PS or NS, depending on the degree of exceedence.

Streams rated as either partially supporting or nonsupporting are considered *impaired*. A waterbody is fully supporting but threatened (ST) for a particular designated use when it fully supports that use now, but may not in the future unless pollution prevention or control action is taken. Although these waters are currently supporting uses, they are treated as a separate category from waters fully supporting uses. Streams which had no data to determine their use support were listed as non-evaluated (NE).

For the purposes of this document, the term *impaired* refers to waters that are rated either partially supporting or not supporting their uses based on specific criteria discussed more fully below. There must be a specified degree of degradation before a stream is considered impaired. This differs from the word impacted, which can refer to any noticeable or measurable change in water quality, good or bad.

4.6.2 Interpretation of Data

The assessment of water quality presented below involved evaluation of available water quality data to determine a water body's use support rating. In addition, an effort was made to determine likely causes (e.g., sediment or nutrients) and sources (e.g., agriculture, urban runoff, point sources) of pollution for impaired waters. Data used in the use support assessments include biological data, chemical physical data, lakes assessment data, DEH shellfish sanitation surveys, and monitoring data. Although there is a general procedure for analyzing the data and determining a waterbody's use support rating, each stream segment is reviewed individually, and best professional judgment is applied during these determinations.

Interpretation of the use support ratings compiled by DWQ should be done with caution. The methodology used to determine the ratings must be understood, as should the purpose for which the ratings were generated. The intent of this use-support assessment was to gain an overall picture of the water quality, how well these waters support the uses for which they were classified, and the relative contribution made by different categories of pollution within the basin. In order to comply with guidance received from EPA to identify likely sources of pollution for all impaired stream mileage, DWQ used the data mentioned above.

The data are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Since the assessment methodology is geared toward general conclusions, it is important to not manipulate the data to support policy decisions beyond the accuracy of these data. For example, according to this report, nonpoint source pollution is thought to be the greatest source of water quality degradation. However, this does not mean that there should be no point source control measures. All categories of point and nonpoint source pollution have the potential to cause significant water quality degradation if proper controls and practices are not utilized.

The threat to water quality from all types of activities heightens the need for point and nonpoint source pollution control. It is important to consider any source (or potential source) of pollution in developing appropriate management and control strategies. The potential for further problems remains high as long as the activity in question continues carelessly. Because of this potential, neglecting one pollution source in an overall control strategy can mask the benefits achieved from controlling all other sources.

4.6.3 Assessment Methodology - Freshwater Bodies

Many types of information were used to determine use support assessments and to determine causes and sources of use support impairment. A use support data file is maintained for each of the 17 river basins. In these files stream segments are listed as individual records. All existing data pertaining to a stream segment (from the above list) is entered into it's record. In determining the use support rating for a stream segment, corresponding ratings are assigned to data values where this is appropriate. The following data and the corresponding use support ratings are used in the process: (note: The general methodology for using this data and translating the values to use support ratings corresponds closely to the 305(b) guidelines with some minor modifications.)

Biological Data

Benthic Macroinvertebrate Bioclassification

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S). The bioclassifications are translated to use support ratings as follows:

Bioclassification	Rating
Excellent	Supporting
Good	Supporting
Good-Fair	Support Threatened
Fair	Partially Supporting
Poor	Not Supporting

Fish Community Structure

The North Carolina Index of Biotic Integrity (NCIBI) is a method for assessing a streams biological integrity by examining the structure and health of its fish community. The index incorporates information about species richness and composition, trophic composition, fish abundance and fish condition. The index is translated to use support ratings as follows:

NCIBI	Rating
Excellent	Supporting
Good-Excellent	Supporting
Good	Supporting
Fair-Good	Support Threatened
Fair	Partially Supporting
Poor-Fair	Partially Supporting
Poor	Not Supporting
Very Poor - Poor	Not Supporting
Very Poor	Not Supporting

Phytoplankton and Algal Bloom Data

Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms" in which one or more species of alga may discolor the water or form visible mats on top of the water. blooms may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. An algal sample with a biovolume larger than 5,000 mm3/m3, density greater than 10,000 units/ml, or chlorophyll a concentration approaching or exceeding 40 micrograms per liter (the NC state standard) constitutes a bloom. A waterbody is rated ST if the biovolume, density and chlorophyll a concentrations are approaching bloom concentrations. If an algal bloom occurs, the waterbody is rated PS.

Chemical/Physical Data

Chemical/physical water quality data is collected through the Ambient Monitoring System as discussed in section 4.2.7. This data is downloaded from STORET to a desktop computer for analysis. Total number of samples and percent exceedences of the NC state standards are used for use support ratings. Percent exceedences correspond to use support ratings as follows:

Standards Violation	Rating
Criteria exceeded < 10%	Fully Supporting
Criteria exceeded 11-25%	Partially Supporting
Criteria exceeded >25%	Not Supporting

It is important to note that some waters may exhibit characteristics outside the appropriate standards due to natural conditions. These natural conditions do not constitute a violation of water quality standards.

Lakes Program Data

As discussed in section 4.2.3, assessments have been made for all publicly accessible lakes, lakes which supply domestic drinking water, and lakes where water quality problems have been observed.

Sources and Cause Data

In addition to the above data, existing information was entered for potential sources of pollution (point and nonpoint). It is important to note that not all impaired streams will have a potential source and/or cause listed for them. Staff and resources do not currently exist to collect this level of information. Much of this information is obtained through the cooperation of other agencies (federal, state and local), organizations, and citizens.

Point Source Data

Whole Effluent Toxicity Data
Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Streams that receive a discharge from a facility that have failed its whole effluent toxicity test may be rated ST (unless water quality data indicated otherwise), and have that facility listed as a potential source of impairment.

Daily Monitoring Reports
Streams which received a discharge from a facility significantly out of compliance with permit limits may be rated ST (unless water quality data indicated otherwise), and have that facility listed as a Point Source potential source of impairment.

Nonpoint Source Data

Information related to nonpoint source pollution (i.e., agricultural, urban and construction) was obtained from monitoring staff, other agencies (federal, state and local), 1988 nonpoint source workshops, land-use reviews, and workshops held at the beginning of each basin cycle.

Problem Parameters

Causes of use support impairment (problem parameters) such as sedimentation and low dissolved oxygen, were also identified for specific stream segments. For ambient water quality stations, those parameters which exceeded the water quality standard > 10% of the time for the review period were listed as a problem parameter. For segments without ambient stations, information from reports, other agencies, and monitoring staff were used if it was available.

Monitored vs. Evaluated

Assessments were made on either monitored (M) or evaluated (E) basis depending on the level of information that was used. Streams are rated on a monitored basis if the data is less than five years old. Streams are rated on an evaluated basis under the following conditions:

> If the only existing data for a stream is more than five years old, this data is used to rate the stream on an evaluated basis.
>
> If a stream is a tributary to a monitored (segment of a) stream rated fully supporting (S) or support threatened (ST), the tributary will receive the same rating on an evaluated basis. If a stream is a tributary to a monitored (segment of a) stream rated partially supporting (PS) or not supporting (NS), the stream is considered not evaluated (NE).

4.6.4 Assigning Use Support Ratings

At the beginning of each assessment, all data is reviewed by subbasin with the monitoring staff, and data is adjusted where necessary based on best professional judgment. Discrepancies between data sources are resolved during this phase of the process. For example, a stream may be sampled for both benthos and fish community structure, and the bioclassification may differ from the NCIBI (i.e. the bioclassification may be S while the NCIBI may be PS). To resolve this, the final rating may defer to one of the samples (resulting in S or PS), or, it may be a compromise between both of the samples (resulting in ST).

After reviewing the existing data, ratings are assigned to the streams. If one data source exists for the stream, the rating is assigned based on the translation of the data value as discussed above. If more than one source of data exists for a stream, the rating is assigned according to the following hierarchy:

> Benthic Bioclassification / Fish Community Structure
> Chemical/Physical Data
> Monitored Data > 5 years old
> Compliance / Toxicity Data

This is only a general guideline for assigning use support ratings and not meant to be restrictive. Each segment is reviewed individually and the resulting rating may vary from this process based on best professional judgment which takes into consideration site specific conditions.

After assigning ratings to streams with existing data, streams with no existing data were assessed. Streams that were direct or indirect tributaries to streams rated S or ST received the same rating (with an evaluated basis) if they had no known significant impacts, based on a review of the watershed characteristics and discharge information. Streams that were direct or indirect tributaries to streams rated PS or NS, or that had no data were assigned a Not Evaluated (NE) rating.

4.6.5 Assessment Methodology - Saltwater Bodies

Estuarine areas are assessed by the DEH shellfish management areas. The following data sources are used when assessing estuarine areas:

1. <u>DEH Sanitary Surveys</u> - The DEH is required to classify all shellfish growing areas as to their suitability for shellfish harvesting. Management areas are sampled and reviewed every

three years to determine their classification, identify problems, determine management strategies, etc., and this is published in the Sanitary Survey. Growing waters are classified as follows:

- Approved Area - an area determined suitable for the harvesting of shellfish for direct market purposes.
- Conditionally Approved Open - waters that are normally open to shellfish harvesting but are closed on a temporary basis in accordance with management plan criteria.
- Conditionally Approved Closed - waters that are normally closed to shellfish harvesting but are open on a temporary basis in accordance with management plan criteria.
- Restricted Area - an area from which shellfish may be harvested only by permit and subjected to an approved depuration process or relayed to an approved area.
- Prohibited Area - an area unsuitable for the harvesting of shellfish for direct market purposes.

2. Chemical / Physical Data - Water quality data collected from estuarine ambient monitoring stations. Parameters are evaluated based on the salt waterbody classification and corresponding water quality standards.

3. Phytoplankton and Algal Bloom Data - Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms: in which one or more species of algae may discolor the water or form visible mats on top of the water. Blooms may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. An algal sample with a biovolume larger than 5000 mm3/m3, density greater than 10,000 units/ml, or chlorophyll-a concentration approaching or exceeding 40 micrograms per liter (the NC state standard) constitutes a bloom.

Salt waterbodies are classified according to their best use. When assigning a use support rating, this classification is used with the above parameters as follows:

DEM Class.	DEH Shellfish Class.	Chemical/Physical	Phytoplankton
Fully Supporting			
SA	Approved	standard exceeded ≤ 10% of measurements	no blooms
S3 & SC	Does not apply	standard exceeded ≤ 10% of measurements	no blooms
Support Threatened			
SA	Conditionally Approved	no criteria	no blooms
SB & SC	Does not apply	no criteria	no blooms
Partially Supporting			
SA	Prohibited or Restricted	standard exceeded 11-25% of measurements	blooms
SB & SC	Does not apply	standard exceeded 11-25% of measurements	blooms
Not Supporting			
SA	Prohibited or Restricted	standard exceeded >25% of measurements	blooms
SB & SC	Does not apply	standard exceeded >25% of measurements	blooms

It is important to note that the DEH classifies <u>all</u> actual and potential growing areas (which includes all saltwater and brackish water areas) as to their suitability for shellfish harvesting but different DEM use classifications may be assigned to separate segments within a DEH management area. The DEH classifications and management strategies are only applicable to those areas that DEM has assigned the use classification of SA. This will result in a difference of acreage between DEH areas classified as prohibited or restricted, and DEM waterbodies rated PS. For example, if DEH classifies a 20 acre waterbody as prohibited, but only 10 acres have a DEM use classification of SA, only those 10 acre classified as SA will be rated as partially supporting their uses. DEM areas classified as SB and SC are rated using chemical/physical data and phytoplankton data.

4.6.6 Revisions to Methodology Since 1992 - 93 305(b) Report

Methodology for determining use support has been revised. In the 1992-1993 305(b) Report, evaluated information from older reports and workshops were included in the use support process. Streams rated using this information were considered to be rated on an evaluated basis. In the current use support process, this older, evaluated information has been discarded, and streams are now rated using only monitored information (including current and older monitoring data). Streams are rated on a monitored basis if the data is less than five years old. Streams are rated on an evaluated basis under the following conditions:

If the only existing data for a stream is more than five years old, this data is used to rate the stream on an evaluated basis.

> If a stream is a tributary to a monitored segment of a stream rated fully supporting (S) or support threatened (ST), the tributary will receive the same rating on an evaluated basis. If a stream is a tributary to a monitored segment rated partially supporting (PS) or not supporting (NS), the stream is considered not evaluated (NE).

These changes resulted in a reduction in streams rated on an evaluated basis.

The basinwide process allows for concentrating more resources on individual basins during the monitoring phase. Therefore, more streams were monitored, and more information was available to use in the use support process.

Fish consumption advisories are no longer used in determining the use support rating. They are now shown on a separate map, and discussed in Chapter 3. This will more clearly show what types of advisories are in effect, and where they are occurring.

4.7 USE SUPPORT RATINGS FOR THE PASQUOTANK RIVER BASIN

Use Support ratings for all monitored and evaluated surface waters in the basin are presented on color-coded maps in Figure 4.18. The following sections describe the assignment of ratings to both the fresh and salt waters in the basin.

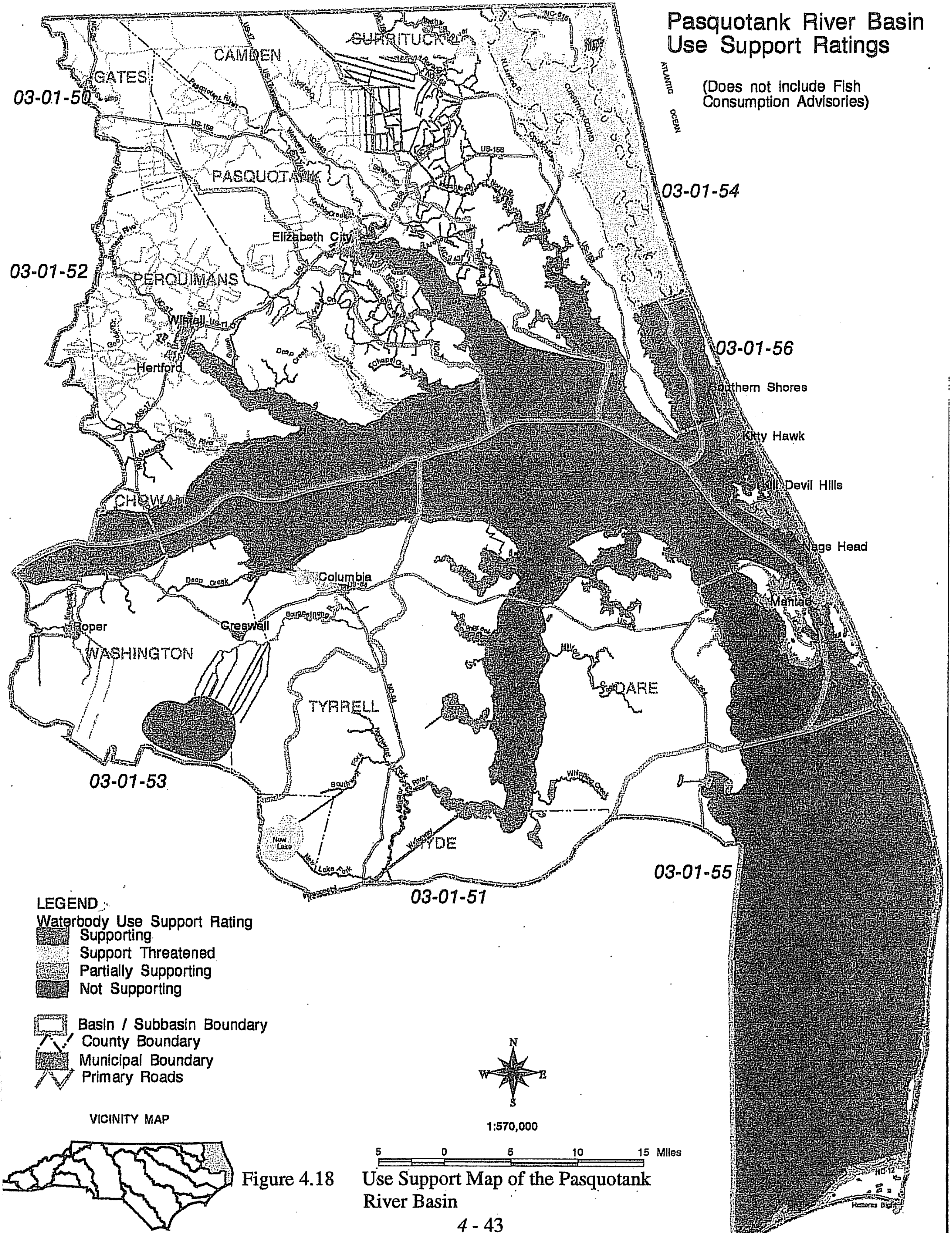


Figure 4.18 Use Support Map of the Pasquotank River Basin

4.7.1 Freshwater Streams and Rivers

Of the 479 miles of freshwater streams and rivers in the Pasquotank basin, use support ratings were determined for 85% or 413 miles with the following breakdown: 41% were rated fully supporting, 34% support-threatened, 9% partially supporting, 1% not supporting and 14% not evaluated. These use support values are different from the values in the 1992-1993 305(b) Report. The total waters supporting their uses appear to have increased, while those that are impaired appear to have decreased. While the water quality may have improved since the 1992-1993 305(b) report, the changes in values may also be due to reasons discussed in section 4.4.6.

Table 4.7 (next page) provides information on streams and stream segments that were monitored. Streams with data that was collected during the time period of 1991 through 1995 are considered to be monitored. This includes bioclassification and collection date for macrobenthic invertebrate samples, fish community structure samples, ambient monitoring station information, problem parameters such as sediment, potential sources of pollution (point or nonpoint), and the overall use support rating. All remaining streams in the basin were rated on an evaluated basis, or, if no data exists, were considered not evaluated. Table 4.8 presents the overall use support determinations by subbasin.

Table 4.8. Use Support Status for Freshwater Streams (Miles) (1991-1995)

Subbasin	S	ST	PS	NS	NE	Total Miles
030150	22.7	109.2	0	0	0	131.9
030151	86.1	3.7	0	0	1.4	91.2
030152	7.3	36.5	11.8	6.7	5.7	68
030153	27.4	14.1	33.4	0	59.3	134.2
030154	52	1.7	0	0	0	53.7
Total	195.5	165.2	45.2	6.7	66.4	479
Percentage	41	34	9	1	14	

<u>Impaired Waters</u>

In determining sources of pollution for impaired waters, observation from field staff, information from the 1988 nonpoint source workshops, and discharger daily monitoring reports were used. This does not provide a complete explanation for all potential sources of pollution in the basin. Recently, multi-agency teams have been assigned to address nonpoint source pollution in each of the river basins. As the different agencies work together within these teams, they will eventually provide more complete information on the nonpoint sources affecting the impaired waters.

As discussed in the Methodology section, some waters exceed the water quality standards due to natural conditions. Many of the streams and rivers in the Pasquotank River Basin drain swamp land. (For example, many of the streams in subbasins 030150, 030152 and 030154 drain the Dismal Swamp.) Low dissolved oxygen and low pH are characteristic of these systems, and exceedences of these parameters occurred at many of the ambient stations. Additional data (if it existed) and best professional judgment were used to determine when these exceedences were due to natural or unnatural conditions.

In subbasin 30152, the Little River (11.8 stream miles) was rated partially supporting. The impairment is thought to be from agriculture and animal operations. Burnt Mill Creek was sampled as part of a special study comparing the benthic macroinvertebrate and fish faunas of NC coastal plain streams. Although the biological criteria for this method have not yet been

Table 4.7. Use Support Status for Freshwater Streams in the Pasquotank River Basin

Station Number	Station Location	Classification	Index Number	Miles	Chem. Rating 90-94	<---Biological Rating---> 1991	1992	1993	1994	1995	Fish	OVERALL RATING Prob. Param.	Use Support	Major Source
30150														
2043862	Pasq. R US 158, Pasq	C Sw	30-3-(5.5)	23.8	NS					Good-Fair (Est)		pH	ST	NP
30151														
	Alligator R, nr Gum Neck, SR 1316, Tyrell	C Sw ORW	30-16-(1)	19.3		ORW '90				NR			S	
30152														
2043882	Little River at Woodville, US Hwy 17	C Sw	30-5-(1)	11.8	NS							DO	PS	NP
2043892	Perquimans R, US 17, Perquimans	C Sw	30-6-(1)	17.1	NS					Good-Fair		pH	ST	NP
	Burnt Mill Cr, NC 37, Chowan	C Sw	30-8-1	3.5						Swamp-NR			NS	NP
30153														
2081185	Kendrick Cr nr Mackeys, Washington	C Sw	30-9-(1)	13.2	NS							DO, pH	PS	NP,P
	Main Canal, SR 1126, Washington	C Sw	30-9-4	5.0						Swamp-NR			PS	NP
2081166	Scuppernong River near Columbia NC Peat, SR-1105	C Sw	30-14-4-(1)	15.2	NS					Fair		DO,pH	PS	NP,P

established, the benthic and fish communities and their habitat all showed evidence of severe impairment. Burnt Mill Creek and the Middleton Creek tributary were both rated not supporting based on this information. The impairment is thought to be from agriculture and animal operations.

In subbasin 30153, Kendrick Creek, Main Canal and the Scuppernong River from its source down to NC 64 (a total of 33.4 stream miles) were all rated partially supporting. Sources of impairment are thought to be agriculture and animal operations. In addition, the Creswell WWTP which discharges to the Scuppernong River, may be contributing to the impairment.

4.7.2 Salt (Estuarine) Waters

Use support determinations were made for all of the 868,800 acres of saltwater in the Pasquotank Basin. This includes DEH management areas H1 through H6, I1 through I10, I12, and I14 through I16. Approximately 91.6% of the saltwaters were rated as fully supporting, 7.7% were rated support threatened and the remaining .7% were rated partially supporting. Table 4.9 lists the use support determinations by the DEH area. Figure 4.19 illustrates the location of the DEH area boundaries.

The majority of the management areas H1 through H6 are classified by DWQ as SA waters. In areas H1 through H5, a total of 4,062 acres were classified as prohibited by the DEH, which resulted in a partially supporting rating. The major cause of the closures was due to elevated levels of fecal coliform bacteria. The majority of the impairment is caused by nonpoint sources such as urban runoff, septic tanks and marinas.

The majority of the I DEH management areas have no commercial shellfish resource and are classified SC and SB by DWQ. In area I2, approximately 800 acres outside of Buzzard Bay is classified as SA by DWQ, and prohibited by DEH. This resulted in a partially supporting rating. The cause of the closures was elevated fecal coliform bacteria, and the sources are believed to be septic tanks and urban runoff.

In area I6, approximately 1,125 acres of the upper portion of the Little River was rated partially supporting, while the lower portion of it (5,625 acres) was rated support threatened. the major cause of impairment was low dissolved oxygen, while the source was thought to be agriculture.

In area I16 mild algal blooms were documented in 1992, 1993, and 1995 in the upper portion of the Currituck Sound. Although the Currituck Sound currently supports its uses, the algal blooms resulted in a support threatened rating for 58,500 acres.

4.7.3 Lakes

Subbasin 030151

Alligator Lake, located in Hyde County, is currently classified as C SW and has a surface area of 5,500 acres. It was sampled in August 1989 and found to be supporting its designated uses.

Swan Lake is located in the Alligator River National Wildlife Refuge in Hyde County, is classified as C SW ORW, and has a surface area of 235 acres. It was sampled in August 1989 and found to be supporting its designated uses.

Table 4.9. Use Support Status for Estuarine Waters in the Pasquotank River Basin

Area Name	Total Acres	DEH AREA	Overall Use Support: Support	Support Threatened	Partial Support	Non-Support	Major Causes: Fecal	DO	Chla	Metals	Major Sources: Point	Nonpoint	Source Descriptions
Roanoke Sound	20,500	H1	18,550	0	1,950	0	1,950				500	1,450	WWTP, urban runoff, septic tanks, marinas
Croatan Sound	42,500	H2	41,609	0	891	0	891					891	urban runoff, septic tanks, marinas
Stumpy Sound	5,500	H3	5,235	0	265	0	265					265	septic tanks
Hatteras	5,800	H4	5,175	0	625	0	625					625	urban runoff, septic tanks, marinas
Outer Banks	66,800	H5	66,469	0	331	0	331					331	urban runoff, septic tanks, marinas
Open	246,800	H6	246,800	0	0	0							
North River	25,000	I1	25,000	0	0	0							
Eastern Albemarle Sound	55,000	I2	54,200	0	800	0	800					800	septic tanks, urban runoff
Scuppernong River	28,500	I3	26,220	2,280	0	0							
Alligator River	36,000	I4	36,000	0	0	0							
Pasquotank River	21,000	I5	21,000	0	0	0							
Little River	7,500	I6	750	5,625	1,125	0		1,125				1,125	ag,swamp
Perquimans River	12,000	I7	12,000	0	0	0							
Yeopim River	6,500	I8	5,850	650	0	0							
Sandy Point	8,400	I9	8,400	0	0	0							
Leonard's Point	17,000	I10	17,000	0	0	0							
Plymouth	16,000	I12	16,000	0	0	0							
Western Albemarle Sound	44,000	I14	44,000	0	0	0							
Middle Albemarle Sound	114,000	I15	114,000	0	0	0							
Currituck Sound	90,000	I16	31,500	58,500	0	0							
Totals	868,800		795,758	67,055	5,987	0	4,862	1,125	0	0	500	5,487	
Percentages			91.6	7.7	0.7	0.0	81.21	18.79	0.00	0.00	8.4	91.6	
Pasquotank River Total	868,800		795,758	67,055	5,987	0	4,862	1,125	0	0	500	5,487	
%	100.0		91.6	7.7	0.7	0.0	81.2	18.8	0.0	0.0	8	92	

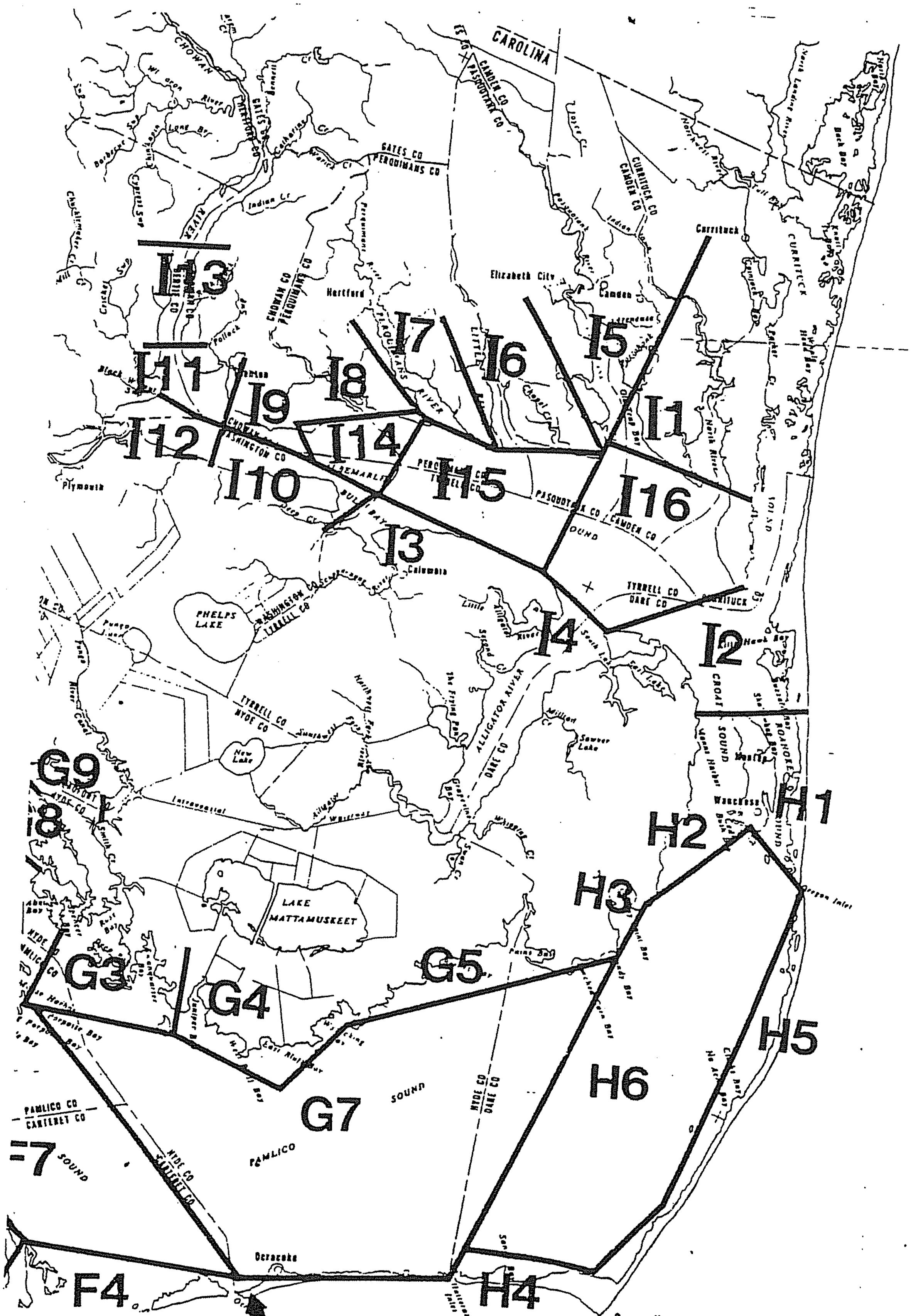


Figure 4.19. Map of DEH Shellfish Growing Areas in the Pasquotank River Basin

Subbasin 030153

Phelps Lake is located in Washington and Tyrrell Counties, is currently classified as C Sw, and has a surface area of 16,600 acres. It was sampled in August 1995 and found to be supporting its designated uses.

It should be noted that the lake is under a fish consumption advisory for mercury. As described in section 4.6.6, this advisory does not influence the use support designation. The consumption advisory is described in detail in section 3.2.2 of Chapter 3.

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CHAPTER 5

EXISTING WATER QUALITY PROGRAMS AND PROGRAM INITIATIVES IN THE BASIN

5.1 INTRODUCTION

This chapter summarizes the point and nonpoint source control programs available for addressing water quality problems in the Pasquotank River Basin and a number of important initiatives being implemented by federal, state, local and private interests. **Section 5.2** summarizes the state and federal legislative authorities developed to protect water quality. **Section 5.3** presents the water quality standards and classifications program. **Sections 5.4 and 5.5**, respectively, present existing point and nonpoint source pollution control programs. A more complete description of these programs can be found in Appendix VI. Application of these programs to specific water quality problems and water bodies is presented in Chapter 6. **Section 5.6** presents water quality program initiatives that have been implemented within the basin. **Section 5.7** discusses integration of point and nonpoint source control management strategies and introduces the concept of *total maximum daily loads* (TMDLs). **Section 5.8** provides information on potential sources of funding for both point and nonpoint water quality protection programs.

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

Authorities for some of the programs and responsibilities carried out by the Water Quality Section are derived from a number of federal and state legislative mandates outlined below. The major federal authorities (Section 5.2.1) for the state's water quality program are found in sections of the Clean Water Act (CWA). State authorities listed in Section 5.2.2 are from state statutes.

5.2.1 Federal Authorities for NC's Water Quality Program

- **The Clean Water Act Section 301** - Prohibits the discharge of pollutants into surface waters unless permitted by EPA.
- **The Clean Water Act Section 303(c)** - States are responsible for reviewing, establishing and revising water quality standards for all surface waters.
- **The Clean Water Act 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.
- **The Clean Water Act Section 305(b)** - Each state is required to submit a biennial report to the EPA describing the status of surface waters in that state.
- **The Clean Water Act Section 319** - Each state is required to develop and implement a nonpoint source pollution management program.
- **The Clean Water Act Section 402** - Establishes the National Pollutant Discharge Elimination System (NPDES) permitting program. Allows for delegation of permitting authority to qualifying states (includes North Carolina).
- **The Clean Water Act Section 404/401** - Section 404 regulates the discharge of fill materials into navigable waters and adjoining wetlands 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.

5.2.2 State Authorities for NC's Water Quality Program

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

5.3 Surface Water Classifications and Standards

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

The Water Quality Standards program in North Carolina has evolved over time and has been modified to be consistent with the Federal Clean Water Act and its amendments. Water quality classifications and standards have also been modified to promote protection of surface water supply watersheds, high quality waters and the protection of unique and special pristine waters with outstanding resource values. Classifications and standards have been broadly interpreted to provide protection of uses from both point and nonpoint source pollution.

Some of the classifications, particularly for HQW, ORW and WS waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. Special HQW protection management strategies are presented in 15A NCAC 2B.0201(d), which is included in its entirety in Appendix I under Antidegradation Policy. These measures are intended to prevent degradation of water quality below present levels from both point and nonpoint sources. HQW requirements for new wastewater facilities and for existing facilities which expand beyond their currently permitted loadings address oxygen-consuming wastes, total suspended solids, disinfection, emergency requirements, volume, nutrients (in nutrient sensitive waters) and toxic substances. For oxygen-consuming wastes, for example, effluent limitations for new or expanding facilities are as follows: BOD_5 = 5 mg/l; NH_3-N = 2 mg/l; DO = 6 mg/l (except for those expanding discharges which expand with no increase in permitted pollutant loading).

For nonpoint source pollution, development activities which require an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or local erosion and sedimentation control program approved in accordance with 15A NCAC 4B .0218, and which drain to and are within one mile of High Quality Waters will be required to control runoff from the one-inch design storm using either a low density or high density option described in the rules.

The requirements for ORW waters are more stringent than those for HQWs. Special protection measures that apply to North Carolina ORWs are set forth in 15A NCAC 2B .0216 (most of which is included in Appendix I). At a minimum, no new discharges or expansions of existing discharges are permitted, and stormwater controls for most development needing an Erosion and Sedimentation Control Plan are required.

The requirements for WS waters vary significantly from WS-I to WS-V. The WS-I classification carries the most stringent requirements for dischargers and surrounding land use activities while WS-V carries the least.

5.4 NORTH CAROLINA'S POINT SOURCE CONTROL PROGRAM

North Carolina does not allow point source discharges without a permit. Discharge permits are issued under the authority of North Carolina General Statute (NCGS) 143.215.1 and the National Pollutant Discharge Elimination System (NPDES) program. The NPDES program was delegated to North Carolina from the US Environmental Protection Agency. These permits serve as both state and federal permits. North Carolina has a comprehensive NPDES program which includes the permitting of both wastewater and stormwater discharges. Information on permitted NPDES dischargers within the Pasquotank River basin can be found in Section 3.3.

NPDES permits are issued in two categories; individual or general. Individual permits are issued to a specific facility, contain site specific requirements, and incorporate recommendations from the basinwide water quality management plan. Individual NPDES permits are typically issued for a five year cycle with all permits in a river basin expiring at the same time. This permitting strategy allows for comprehensive review of individual dischargers within the basin and implementation of recommendations contained in the basinwide water quality management plan. New discharge permits issued during an interim period are given a shorter permit cycle so that expiration coincides with the basin cycle. Individual permits in the Pasquotank River basin are scheduled for expiration and renewal in February and March of 1998.

General permits are developed for specific types of industries. Each general permit contains requirements that are appropriate for a typical facility within a specific industrial classification. Facilities that are considered atypical or have a history of water quality problems are required to obtain an individual permit. Because general permits are specific to a type of industrial activity and are issued statewide they do not contain basin specific measures. A general permit is typically issued for a five year cycle, which expires statewide on the same date. All general permits have a permit number that begins with "NCG".

5.4.1 NPDES Permits for Wastewater Discharges

Under the NPDES wastewater permitting program, each NPDES discharger is assigned either *major* or *minor* status. For municipalities, all dischargers with a flow of greater than 1 million gallons per day (MGD) are classified as major.

All new wastewater discharge permit applications must include an engineering proposal which includes a description of the origin, type, and flow of wastewater, a summary of waste treatment and disposal options, and a narrative description of the proposed treatment works and why the proposed system and point of discharge were selected. The summary must contain sufficient detail to assure that the most environmentally sound alternative was selected from the reasonably cost effective options. An assessment report describing the impact on waters in the area must be submitted for all applications of new discharges in excess of 500,000 gallons per day or 10 million gallons per day of cooling water or any other proposed discharge of 1 million gallons per day or more.

Under the NPDES program, wastewater treatment systems must be operated by a certified operator. Training and certification of operators is conducted by the DWQ. It is the goal of the program to provide competent and conscientious professionals that will protect both the environment and public health.

The amount or loading of specific pollutants that are allowed to be discharged into surface waters are defined in the NPDES permit and are called *effluent limits*. Point source discharges generally have the most impact on a stream during low flow conditions when the percentage of treated effluent within the stream is greatest. Effluent limits are generally set to protect the stream during these 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. Computer modeling may be used to determine the fate and transport of pollutants, reduction goals for contaminants, and to derive effluent limits for NPDES permits. A wasteload allocation is performed to ensure the effluent limits are set at levels that can be safely assimilated by the receiving stream.

Most dischargers are required to periodically sample their treated effluent. This process is called self-monitoring. Larger and more complex dischargers are also required to sample both upstream and downstream of the discharge point. NPDES facilities are required to monitor for all pollutants for which they have permit limits as well as other pollutants which may be present in their wastewater. Sampling results are submitted to DWQ each month for compliance evaluations. If limits are not being met, various legal actions may be taken against the discharger to ensure future compliance.

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, wastewater treatment facilities with industrial sources may have to monitor for chemical specific toxicants and/or whole effluent toxicity, and all dischargers with design flows greater than 50,000 gallons per day (GPD) monitor for total phosphorus and total nitrogen. Minimum NPDES wastewater monitoring requirements are provided in 15A NCAC 2B .0500.

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

A pretreatment program is aimed at protecting municipal wastewater treatment plants and the environment from the adverse impacts that may occur when hazardous or toxic wastes are discharged into a public system. This program requires that businesses and other entities that use or produce toxic wastes pretreat their wastes prior to discharging into a public wastewater system.

5.4.2 NPDES Permits for Stormwater Discharges

As currently defined by the NPDES program, stormwater point source discharges originate from two distinct sources; municipalities and selected industrial facilities. Subject municipalities are defined as those incorporated areas that encompass a population of 100,000 or more. Subject industrial activities are those where stormwater discharges directly related to manufacturing, processing or raw materials storage areas occur. A complete definition of "stormwater discharge associated with industrial activity" including a comprehensive listing of subject industries can be found in 40 CFR 122.26. The types of industrial activities that are subject to stormwater permitting are typically defined by Standard Industrial Classification (SIC) codes. SIC codes have been developed by the federal Office of Management and Budget to define industries in accordance with the composition and structure of the economy.

There are currently 19 general stormwater permits available for specific types of industrial activities across the state. As previously explained, the general permits define stormwater controls and monitoring for a typical facility within a specific industrial classification. General stormwater permits incorporate requirements determined to be appropriate based upon an analysis of available analytical monitoring data, input from industry and associations, site visits, and review of federal and other documents providing guidance on specific types of industries, pollutants, and stormwater discharges.

The North Carolina Department of Transportation (DOT) is subject to the NPDES stormwater permitting program. The permit, when issued, will cover stormwater runoff from DOT's non-administrative activities throughout the state including the state roadway network, construction, vehicle maintenance, and materials storage facilities. The draft permit is currently scheduled to be sent to public notice in 1998.

Stormwater permits may specify monitoring and reporting requirements for both quantitative and qualitative assessment of the stormwater discharge as well as operational inspections of the entire facility. The specific pollutant parameters for which sampling must be performed are based upon the types of materials used and produced in the manufacturing processes and the potential for contamination of the stormwater runoff at a typical facility.

All NPDES stormwater permits require the development and implementation of a Stormwater Pollution Prevention Plan (SPPP). The SPPP requires the permitted facility to develop a comprehensive stormwater management plan. This plan is the basis for evaluating the pollution potential of the site and implementing best management practices (BMPs) to reduce pollutants in runoff from the site.

All stormwater permits specify qualitative monitoring of each stormwater outfall for the purposes of evaluating the effectiveness of the Stormwater Pollution Prevention Plan and assessing new sources of stormwater pollution. Qualitative monitoring parameters include color, odor, clarity, floating and suspended solids, foam, oil sheen, and other obvious indicators of stormwater pollution.

Stormwater permits may provide for the use of cut-off concentrations in order to minimize the required analytical monitoring for facilities which are not significant contributors to stormwater pollution. These cut-off concentrations are not intended to be effluent limits (as used in wastewater permitting), but provide guidelines for determining which facilities are major contributors to stormwater pollution and need further monitoring. The arithmetic mean of all monitoring data collected during the term of the permit must be calculated for each parameter and compared to the permitted cut-off concentration. If the mean is below the cut-off concentration, then the facility may discontinue analytical monitoring for that parameter until the final year of the permit unless changes occur at the facility. This approach prevents facilities from using the cut-off concentrations as target concentrations for evaluating the effectiveness of the Stormwater Pollution Prevention Plan while also ensuring that problem facilities continue to collect analytical data on their discharges.

5.5 NONPOINT SOURCE CONTROL PROGRAMS

Nonpoint source pollution occurs when rainfall or snowmelt runs off the ground or impervious surfaces like buildings and roads and drains into waterways. Some of the most common nonpoint source pollutants and their causes are presented in Chapter 3.

The two approaches that are used to address nonpoint source pollution are prevention and engineered controls. Some of the methods of pollution prevention include optimum site planning, use of natural drainage systems rather than curb and gutter, nutrient management plans, public/farmer education, storm drain stenciling, and hazardous waste collection sites. It is generally more cost-effective to prevent and minimize pollution than to build engineered controls. For example, developers who are subject to stormwater requirements often choose to build low density developments rather than bearing the expense of building engineered BMPs. Engineered BMPs also have on-going expenses associated with long-term operation and maintenance.

Engineered BMPs generally work by capturing, retaining, and treating runoff before it leaves an area. Some commonly used types of BMPs include stormwater wetlands, wet detention ponds, water control structures, bioretention areas, and infiltration basins. Often higher levels of pollutant removal can be achieved by using a combination of different control systems. The main advantage of engineered controls is that they can treat runoff from high density developments.

The current trend is toward a more comprehensive "systems approach" to managing nonpoint source pollution. This involves using an integrated system of preventive and control practices to accomplish nonpoint pollution reduction goals. This approach emphasizes site planning, protecting important natural areas such as wetlands, and finding the most cost-effective engineered controls for high density areas. Programs which are currently using the systems approach include the animal waste regulations and the regulations for coastal stormwater management and water supply watersheds. In general, the goals of the nonpoint source management program include the following:

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

Table 5.1 lists a number of federal and state programs that address nonpoint source pollution. These programs are listed by category based on the type of activity. A complete program description can be found in Appendix VI for nonpoint source control programs. Refer to Table 5.2 for a brief description of each program and the contact persons within the basin for each program.

Table 5.1 List of Nonpoint Source Programs

PROGRAM	LOCAL	STATE	FEDERAL
AGRICULTURE:			
Agriculture Cost Share Program	SWCD	SWCC, DSWC	
N.C. Pesticide Law of 1971		NCDA	
Pesticide Disposal Program		NCDA	
Animal Waste Management	SWCD	DWQ,DSWC, CES	NRCS
Laboratory Testing Services		NCDA	
Watershed Protection (PL-566)			NRCS
1985 ,1990 and 1995 Farm Bills			USDA
- Conservation Reserve Program			
- Conservation Compliance			
- Sodbuster			
- Swampbuster			
- Conservation Easement			
- Wetland Reserve			
- Water Quality Incentive Program			
URBAN			
Coastal Stormwater Program		DWQ	
ORW, HQW, NSW Management Strategies		DWQ	
Water Supply Watershed Protection Program	city, county	DWQ	
Stormwater Control Program	city, county	DWQ	EPA
CONSTRUCTION			
Sedimentation and Erosion Control	ordinance	DLR, DOT	
Coastal Area Management Act	ordinance	DCM	
Coastal Stormwater Program		DWQ	
ON-SITE WASTEWATER DISPOSAL			
Sanitary Sewage Systems Program	county	DEH	
SOLID WASTE DISPOSAL			
Resource Conservation and Recovery Act			EPA
Solid Waste Management Act of 1989	city, county	DSWM	
FORESTRY			
Forest Practice Guidelines		DFR	
National Forest Management Act			USDA-FS
Forest Stewardship Program		DFR	
MINING			
Mining Act of 1971			DLR
HYDROLOGIC MODIFICATION			
Clean Water Act (Section 404)		DCM, DWQ	COE
Rivers and Harbors Act of 1899			COE
Dam Safety Permit		DLR	
WETLANDS:			
Clean Water Act (Sections 401 and 404)		DWQ	COE
Wetland Reserve Program			USDA

COE: US Army Corps of Engineers
DWQ: Division of Water Quality
DFR: Division of Forest Resource
DSW: Division of Soil and Water
USDA: US Department of Agriculture
DCM: Division of Coastal Management
DLR: Division of Land Resources
DOT: Department of Transportation
DSWM: Division of Solid Waste Mgt.
USDA-FA: US Department of Agriculture-Forestry Service
NCDA: NC Department of Agriculture
NRCS: Natural Resources Conservation Service
SWCC: Soil and Water Cons. Commission
SWCD: Soil and Water Conservation District

Table 5.2 Pasquotank River Basin Nonpoint Source Contacts

Agriculture

USDA Natural Resources Conservation Service:

Formerly the Soil Conservation Service; provides technical specialist for certifying waste management plans; certified trainers for swine applicators training sessions works with landowners on private lands to conserve natural resources helping farmers and ranchers develop conservation systems uniquely suited to their land and individual ways of doing business; provides assistance to rural and urban communities to reduce erosion, conserve and protect water, and solve other resource problems; conducts site evaluations and soil surveys; administers the Wetlands Reserve Program; offers planning assistance for local landowners for installing best management practices; offers technical assistance for the determination of wetlands on agricultural lands.

Camden County	R. Dwane Hinson	(919)482-4127	414 West Queen St., Edenton, NC27932
Chowan County	R. Dwane Hinson	(919)482-4127	414 West Queen St., Edenton, NC27932
Currituck County	R. Dwane Hinson	(919)482-4127	414 West Queen St., Edenton, NC27932
Dare County	Sandra W. Merritt	(919)441-1345	2601 N. Croatan Hwy, Kill Devil Hill, NC27949
Gates County	W. Paul Boone	(919)358-7846	P.O. Box 265, Winton, NC27986-0265
Hyde County	Neil Alligood	(919)926-4361	P.O. Box 264, Swan Quarter, NC27885
Pasquotank County	R. Dwane Hinson	(919)482-4127	414 West Queen St., Edenton, NC27932
Perquiman County	R. Dwane Hinson	(919)482-4127	414 West Queen St., Edenton, NC27932
Tyrrell County	Sandra W. Merritt	(919)441-1345	2601 N. Croatan Hwy, Kill Devil Hill, NC27949
Washington County	Rafus W. Croom	(919)793-4561	128 East Water St. Suite202, Plymouth, NC27845

Soil & Water Conservation Districts:

The local Soil and Water Conservation District Boards function under the administration of the North Carolina Soil and Water Conservation Commission (SWCC). The districts are responsible for administer the Agricultural Cost Share Program, 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

Camden County	Randolph Keaton	(919)771-5400	188 Old Swamp Rd., South Mills, NC27976
Chowan County	W. Earl White	(919)482-2659	RR 2 Box 379, Edenton, NC 27932
Currituck County	Manly M. West	(919)232-2706	Rt. 2, Box 139, Moyock, NC27958
Dare County	Carol Lyons	(919)261-2769	219-A West Tateway Rd., Kitty Hawk, NC27949
Gates County	R. E. Miller, Jr.	(919)357-1013	P.O. Box 42, Gatesville, NC 27938
Hyde County	David Oneal	(919)926-5721	Rt.1, Box 209, Swan Quarter, NC27885
Pasquotank County	Tom Burn	(919)264-3129	301 Lane Dr., Elizabeth City, NC27909
Perquiman County	Elmer Lassiter	(919)297-2640	Rt.1, Box 319, Belvidere, NC 27919
Tyrrell County	Roy Smith	(919)796-3891	Rt.1, Box 219, Columbia, NC27925
Washington County	Allen Gerald	(919)793-3826	Rt.1, Box 285, Plymouth, NC27962

Division of Soil and Water Conservation:

Provides administrative and technical assistance to the Soil & Water Conservation Districts in areas pertaining to soil science and engineering; distributes Wetlands Inventory maps for a small fee. Administers the Agriculture Cost Share Program (ACSP).

Central Office	Donna Moffitt (ACSP)	(919)715-6108	512 N. Salisbury St. Raleigh NC 27626

Table 5.2 Pasquotank River Basin Nonpoint Source Contacts, continued

Agriculture

NCDA Regional Agronomists:

Provides technical specialists for certifying waste management plans. Provides certified trainers for animal waste applicators training sessions. Tracks, monitors, and accounts for use of nutrients on agricultural lands. Identifies and evaluates the use of nutrient management plans.

Central Office	Tom Ellis	(919)733-7125	Box 27647 Raleigh, NC 27611
Regional Office	Charlie Tyson	(919)443-4404	Rt. 3, Box 254B, Nashville, NC 27856

Education

NC Cooperative Extension Service:

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

Camden County	Freddie O'Neal	(919)338-0171	P.O. Box 129, Camden, NC27921
Chowan County	J. Michael Williams	(919)482-8431	P.O. Box 1030, Edention, NC 27932
Currituck County	Rodney Sawyer	(919)232-2261	P.O. Box 10, Currituck, NC27932
Dare County	Ann Ward	(919)473-1101	Adm. Bldg., Manteo, NC27954
Gates County	Wayne Nixon	(919)357-1400	Co. Agri. Bldg., Gateville, NC 27938
Hyde County	Mac Gibbs, Jr.	(919)926-3201	P.O. Box 219, Swan Quarter, NC27885
Pasquotank County	Don Baker	(919)338-3954	P.O. Box 1608, Elizabeth City, NC27909
Perquiman County	Lewis W. Smith	(919)426-5428	Cp. Office Bldg., Hertford, NC27944
Tyrrell County	Richard Rhodes	(919)796-1581	Agr. Bldg., Box 208, Columbia, NC27962
Washington County	Frank Winslow	(919)793-2163	P.O. Box 70, Plymouth, NC27962

Forestry

Division of Forest Resources:

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

Central Office	Moreland Gueth	(919)733-2162 ext. 255	P.O. Box 29581 Raleigh, NC 27626-0581

Fish and Wildlife Resources

Division of Marine Fisheries

The North Carolina Division of Marine Fisheries (DMF) is responsible for stewardship of the state's marine and estuarine resources. The DMF's jurisdiction encompasses all coastal waters and extends to 3 miles offshore. Agency policies are established by the 17-member Marine Fisheries Commission and the Secretary of the Department of Environment, Health and Natural Resources.

Central Office	Pasquale Wojciechowski	(919)726-7021	P.O. Box 769, Morehead City, NC 28557
Elizabeth City Office	Sara Winslow	(919)264-3911	1367 US HWY 17, Elizabeth City, NC 27909

Table 5.2 Pasquotank River Basin Nonpoint Source Contacts, continued

Fish and Wildlife Resources

Wildlife Resources Commission:

To manage, restore, develop, cultivate, conserve, protect, and regulate the wildlife resources of the State, and to administer the laws relating to game, game and freshwater fishes, and other wildlife resources enacted by the General Assembly to the end that there may be provided a sound, constructive, comprehensive, continuing, and economical game, game fish, and wildlife program.

Central Office	Frank McBride	(919)528-9886	P.O. Box 118 Northside, NC 27564

General Water Quality

DWQ Water Quality Section:

Control of water pollution from point sources such as municipal and industrial wastewater discharges, and from nonpoint sources that originate from agricultural drainage, urban runoff, land clearing, construction, mining, forestry, septic tanks and land application of waste; issues permits for both discharging and on-site wastewater treatment systems, conducts compliance inspections, operates an ambient water quality monitoring program, and performs a wide variety of special studies on activities affecting water quality; administers the 319 projects statewide.

Central Office	Beth McGee	(919)733-5083	DWQ - Planning Branch, P.O. Box 29535 Raleigh NC 27626
Washington Region	Roger Thorpe	(919)946-6481	943 Washington Sqare Mall, Washington, NC 27889

U.S. Army Corps of Engineers:

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

Wilmington District	W.C. Long II	(910)251-4745	P.O. Box 1890, Wilmington, NC 28402-1890

DWQ Groundwater Section:

Groundwater classifications and standards, enforcement of groundwater quality protection standards and cleanup requirements, review of permits for wastes discharged to groundwater, issuance of well construction permits, underground injection control, administration of the underground storage tank (UST) program (including the UST Trust Funds), well head protection program development, and ambient groundwater monitoring.

Central Office	Carl Bailey	(919)733-3221	P.O. Box 29578 Raleigh, NC 27626-0578
Washington Region	Willie Hardison	(919)946-6481	943 Washington Square Mall, Washington, NC 27889

Table 5.2 Pasquotank River Basin Nonpoint Source Contacts, continued

General Water Quality

DEHNR Division of Coastal Management:

Responsible for carrying out the provisions of the North Carolina Coastal Area Management Act (CAMA); processes major development permits, review all dredge and fill permit applications, and determines consistency of state and federal grants and projects with the North Carolina Coastal Management Program; prepares guidelines for a local land use planning program in twenty coastal counties; administers grants to local government for planning, permitting and beach access programs; and acquires and manages coastal and estuarine reserves as natural areas for research, education and preservation.

Central Office	Lori Sutter	(919)733-2293	P.O. Box 27687, Raleigh, NC 27611-7687
Washington Office	Jane Daughtridge	(919)946-6481	943 Washington Square Mall, Washington,NC 27889
Elizabeth City Office	John Thayer	(919)264-3901	1367 US Hwy. 17, Elizabeth City, NC 27909

Construction/Mining

DEHNR Division of Land Resources:

Conducts land surveys and studies, produces maps, and protects the state's land and mineral resources. Administers the NC Sedimentation and Erosion Control Program.

Central Office	Mel Nevills	(919)733-4574	512 N. Salisbury St. Raleigh NC 27626
Washington Region Office	Richard Peed	(919)946-6481	943 Washington Square Mall., Washington, NC 27889

Solid Waste

DEH Solid Waste Management:

Management of solid waste in a way that protects public health and the environment. The District includes three sections and one program -- Hazardous Waste, Solid Waste, Superfund, and the Resident Inspectors program.

Raleigh Regional Office	Ben Bams	(919)571-4700	P.O. Box 27687, Raleigh, NC 27609
Washington Regional Office	Chuck Boyette	(919)946-6481 ext. 307	943 Washington Square Mall, Washington, NC 27889

Table 5.2 Pasquotank River Basin Nonpoint Source Contacts, continued

On-Site Wastewater Treatment

Division of Environmental Health:

Safeguards life, promotes human health, and protects the environment through the practice of modern environmental health science, the use of technology, rules, public education, and above all, dedication to the public trust.
Services include:

- Training of and delegation of authority to local environmental health specialists concerning on-site wastewater
- Engineering review of plans and specifications for wastewater systems 3,000 gallons or larger and industrial process wastewater systems designed to discharge below the ground surface
- Technical assistance to local health departments, other state agencies, and industry on soil suitability and other site considerations for on-site wastewater systems.

Central Office - DEH	Steve Steinbeck	(919)715-3273	2728 Capital Blvd. Raleigh, NC 27604
Camden County	Ralph Hollowell	(919)338-4490	P.O. Box 306, Elizabeth City, NC27909
Chowan County	Walker Rayburn, Jr.	(919)482-6019	P.O. Box 808, Edenton, NC 27932
Currituck County	Joe Hobbs	(919)232-2271	P.O. Box 26, Currituck, NC 27929
Dare County	Mavin F. (Fred) Parker	(919)441-2143	P.O. Box 26, Manteo, NC 27954
Gates County	Daniel R. McDougald	(919)358-7833	P.O. Box 246, Winton, NC 27986
Hyde County	Hubert H. Watson	(919)926-3561	P.O. Box 100, Swan Quarter, NC 27885
Pasquotank County	Ralph Hollowell	(919)338-4490	P.O. Box 306, Elizabeth City, NC27909
Perquiman County	Timothy S. Peoples	(919)426-2111	103 Charles St., Hertford, NC27944
Tyrrell County	Robert Martin	(919)792-7811	P.O. Box 546, Williamston, NC 27892
Washington County	Ronnie Cooper	(919)793-3023	Rt. 2, Box 78-R, Plymouth, NC 27962

Note: The DWQ, DLR, and The Division of Solid Waste Management Washington Regional Offices serve Bertie, Chowan, Currituck, Camden, Dare, Gates, Hertford, Hyde, Pasquotank, Perquimans, Tyrrell, and Washington counties.

The Division of Coastal Management (DCM) Elizabeth City Field Office serves Currituck, Camden, Chowan, Gates, Pasquotank, Perquimans, and Dare counties.

The DCM Washington Field Office serves Bertie, Hertford, Hyde, Tyrrell, and Washington ounties.

Section 319

Clean Water Act Section 319(h) grant moneys are made available to the states on an annual basis by EPA. Agencies in the state that deal with NPS problems submit proposals to DWQ each year for use of these funds in various projects. Projects that have been funded in the past include BMP demonstrations, watershed water quality monitoring and improvement projects, data management, educational activities, modeling, stream restoration efforts, riparian buffer establishment, and others.

Use Restoration Waters

The North Carolina Division of Water Quality is currently developing the Use Restoration Waters (URW) program to restore surface waters to their designated uses. If adopted, this program would allow the state to work with local governments, businesses, and residents to develop management strategies appropriate for the area. In order to be effective, the URW program would include a mix of mandatory and voluntary programs. The voluntary and mandatory programs would be coordinated on a watershed-specific basis by DWQ and a group of stakeholders who have an interest in the impaired waterbody and associated watershed. In addition, the URW program would attempt to develop cooperative relationships among these agencies so that overlapping efforts can be consolidated and targeted to restore designated water body uses.

5.6 PROGRAM INITIATIVES IN THE PASQUOTANK RIVER BASIN

Through the development of this plan, efforts were made to identify efforts that have been undertaken within the basin to protect water quality. The following discussion focuses on program initiatives that have been implemented or are underway within the Pasquotank River basin. These initiatives demonstrate a tremendous effort to protect surface waters in the basin. There may be other initiatives underway in the basin which we are not yet aware of. Table 5.3 presents a summary of the agency or organizations that have program initiatives in the basin.

Table 5.3 Program Initiatives in the Pasquotank River Basin

Level of Agency	Name of Agency	Type of Initiative
Federal and State	National Estuary Program - APES Study; DWQ	See Page 5-15
Federal	US Department of Agriculture - National Resource Conservation Service	See Page 5-15
State	NC Division of Soil and Water Conservation	administer the *NC Agriculture Cost Share Program for Nonpoint Source Pollution Control (NCACSP)*
State	NC Division of Environmental Health	See Page 5-17
State	NC Department of Agriculture	See Page 5-16
State	Cooperative Extension Service	See Page 5-15
State	NC Division of Land Resources	Sedimentation Pollution Control Act
State	NC Division of Coastal Management	CAMA Land Use Plans
State	NC Division of Forest Resources	Forest Practice Guidelines and Various Projects
Local Govt. and Citizen Groups	Currituck County	Educational Projects
Local Govt. and Citizen Groups	Elizabeth City	Upgraded its Waste Water Treatment Plant
Local Govt. and Citizen Groups	Town of Kitty Hawk	Coordinates Albemarie-Pamlico Citizen Water Quality Monitoring Program
Academic	North Carolina State University	Modeling nitrogen loading in the Lower Coastal Plain

5.6.1 National Estuary Program - Albemarle-Pamlico Estuarine Study (APES)

Inclusion of North Carolina in the US EPA's National Estuary Program (NEP) carried with it the responsibility of protecting the local, state and national interest in maintaining the ecological integrity of this country's second largest estuarine system, the Albemarle-Pamlico.

Important components of NEP membership are the consideration of water quality, fisheries resources, land and water habitats, and the interaction of humans with the natural resources of the estuarine system. This focus shaped the research and public involvement phases of the Albemarle Pamlico Estuarine Study. This holistic approach to ecological management was employed when writing the Comprehensive Conservation and Management Plan (CCMP) and was further reflected in the basinwide strategy of water quality management, initiated by the Division of Water Quality. This strategy permeates the various component plans that make up the CCMP.

The CCMP is the product of collaborative, consensus-building effort involving numerous federal, state, and local agencies, interest groups, organizations, and individuals. The Management Conference which guided the Study, was composed of approximately 95 members who were divided into four committees: The Policy Committee, Technical Committee and two Citizens' Advisory Committees (one for the Albemarle area and one for the Pamlico). The members comprising these committees represented a variety of interests: government agencies, university researchers and the public. The committees were responsible for identifying problems in the estuarine system, generating research where gaps in knowledge existed, increasing public awareness of environmental issues, and identifying solutions to address those issues. As a result of their efforts, more is known about the Albemarle-Pamlico estuary than ever before.

The CCMP contains five general management plans to address regional concerns: The Water Quality Plan, Vital Habitats Plan, Fisheries Plan, Stewardship Plan and the Implementation Plan. Each plan contains a goal statement, objectives, strategies, management actions and critical steps necessary in attaining the recommended outcome. Potential economic costs and other considerations are also described. Appendix IV presents the implementation status of the components of the Water Quality Plan.

5.6.2 Federal Initiatives

US Department of Agriculture, Natural Resource Conservation Service (NRCS):

- Assist farmers in obtaining Agriculture Cost Share funds for no-till farming practices.
- Organizes Environmental Field Days at local schools.
- Improves drainage management for agricultural lands.

5.6.3 State Agency Initiatives

Cooperative Extension Service:

- Assists Blacklands Farm Manager's Association to organize field tour every summer. Water quality related topics covered in the tour include nitrogen management, water control structure, alternative septic systems, precision farming, integrated pest management (IPM) and no-till farming.
- Assists Blacklands Farm Manager's Association to conduct a conference to present research results on various water quality areas.
- Organizes Northeast Field Day for summer 95 and 96. Various BMP demonstrations were among activities of the field day.
- Provides technical and educational assistance to winter educational meetings with farmers organized by county agents.
- Participates in Tyrrell County elementary school environmental education field day.
- Conducts ongoing IPM programs for farmers in Northeastern NC to reduce pesticide and fertilizer use, promote good stewardship of agricultural chemicals.
- Conducts Master Gardener training in IPM for Master Gardeners to use when they work with their home-owner and home garden clientele.
- Organizes annual Consultant's Roundtable to present up-to-date research information on IPM to area crop consultants to use when they work with their clientele.
- Trains area crop scouts in scouting procedures consistent with IPM principles.
- Educates the non-farm general public about IPM and pesticide safety through newspaper articles, radio programs, educational programs for civic groups, etc.

- Designed a display board (what is IPM?) for use at meetings, workshops, and other public display opportunities.
- Assists in conducting Commercial Pesticide Rectification training classes for holders of commercial pesticide licenses-focusing on IPM principles and applications.
- Assists in training of Certified Waste Management System operators.
- Participates in Environmental Field Days organized by NRCS at local schools.
- Conducting Tulls Creek Project. The focus of this Currituck County project is to design, implement, and evaluate a routing and storage system for retaining stormwater runoff and to prevent off-site movement of residual nutrients, particularly nitrogen and phosphorus, to nearby surface water.

<u>North Carolina State University:</u>

- Conducting Modeling Cumulative Impacts of Land Use and Management Practices on Nitrogen Loading in Lower Coastal Plain Watershed. This project, funded by Section 319 grant, focuses on developing and applying watershed scale models to evaluate the effects of land use and management practices on the nitrogen loading of watersheds in the lower coastal plain. Watershed scale models will be developed and extensively tested using data collected from a heavily instrumented site near Washington County, NC.

<u>NC Department of Agriculture:</u>

- Provides soil testing service to farmers, homeowners and turf managers. This ensures that agronomic productivity is maximized while at the same time reducing indiscriminate nutrient applications. Recommendations are both site and crop specific.
- Provides nematode management strategies to farmers, homeowners and turf managers. The strategies include crop rotation, resistant crop varieties and the use of nematicides. Plant parasitic nematodes have to be managed in order to maintain the productivity of crops in eastern North Carolina.
- Provides plant analysis service to farmers. This service provides the opportunity for farmers to monitor the nutritional status of growing crops. This provides farmers with the necessary information to select and apply only those nutrients that are needed.
- Various types of waste materials including industrial waste and livestock waste are analyzed and evaluated for their agronomic value. With this information, the waste is seen and utilized as a source instead of a liability.
- Eight regional agronomists provide on-site assistance to help growers implement management recommendations in a cost-effective and environmentally sound manner.

<u>NC Division of Environmental Health:</u>

- Conducts annual onsite sewage conference to update engineers and state agents (environmental health specialists in health departments) on latest technology to abate pollution from septic tank system.
- Reviews two health department septic tank programs per year for quality assurance.
- Provides an annual 3 day Advanced Soils or Advanced Septic Tank Systems Course to health department agents.
- Conducts complete shoreline surveys of septic tank systems every 3 years and updates them yearly. Failing systems are referred to health department for corrective action.
- Monitors Fecal coliform level since 1968.

NC Division of Land Resources:
The NC Division of Land Resources (DLR) is responsible for administering the Sedimentation Pollution Control Act of 1973 (SPCA). Since the inception of the SPCA, the Sedimentation control Commission has funded extensive workshops and educational programs aimed at children throughout the state. During fiscal year 1996, the DLR conducted workshops and symposiums, funded research and intern programs, reprinted manuals and developed video modules and produced newsletters on a budget of over $270,000 for the entire state. The DLR has the following materials available.

- ◊ Erosion and Sediment Control Field Manual
- ◊ Erosion and Sediment Control Practices: Video Modules
- ◊ Erosion and Sediment Control "Inspector's Guide"
- ◊ Erosion and Sediment Control Planning and Design Manual
- ◊ "Erosion Patrol" Package for Grade 3

The DLR is also implementing various measures for protecting water quality statewide. These measures include:

- Coordinates the targeting and tracking of BMPs implementation in the basin.
- Conducts two workshops for public, regulated community and local governments on sediment reductions achievable through the requirements of the Sedimentation and Erosion Control Act.
- Enforces existing sediment related rules and evaluate need for additional mandatory measures.

NC Division of Coastal Management
The Coastal Area Management Act (CAMA), passed in 1974, requires the development of land use plans by each of the 20 coastal counties that fall within the coastal area. These plans must be consistent with state guidelines and address a wide range of issues, including resource protection and conservation, hazards mitigation, economic development and public participation. Land use plans must be updated every five years. 1995 revisions to the land use planning guidelines strengthened the connection between land use planning and surface water quality. Future land use plan updates must consider water quality use classifications, watershed planning and problems identified in basinwide plans. There are nine counties in the Pasquotank basin that are affected by CAMA. These are Camden, Chowan, Currituck, Dare, Gates, Pasquotank, Perquimans, Tyrrell and Washington.

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

NC Division of Soil and Water:
The NC Division of Soil and Water Conservation administers the *NC Agriculture Cost Share Program for Nonpoint Source Pollution Control (NCACSP)*. This program provides incentives to farmers to install best management practices (BMPs) by offering to pay up to 75% of the average cost of approved BMPs. The NC Agriculture Cost Share Program funding totals for the Pasquotank River basin from 1985 through 1995 is $391,254. Farmers in the basin have spent up to $130,418 in matching funds for cost share money. The cost share figures include a wide array of BMPs including conservation tillage, sod based rotation, diversions, critical area planting, crop conversion to grass, trees, spring development, stock trails, land application of waste, livestock exclusion, waste management.

NC Division of Forest Resources:

The DFR is implementing various measures for protecting water quality statewide. These measures began with the creation of voluntary *Forest Practice Guidelines (FPGs) Related to Water Quality.* The measures were voluntary applied best management practices, which had no enforcement power by any agency. In 1989, the SPCA was amended to require compliance with nine performance standards in order to remain exempt from the SPCA's permitting requirements. These nine standards are the *Forest Practice Guidelines Related to Water Quality (FPGs)* whose compliance is accomplished through the use of BMPs. The *Forestry Best Management Practices Manual* was published in September, 1989, to guide forestry operations in protecting water quality. The manual and the FPGs are available for any DFR office at no charge.

The FPG requirements include:

◊ establishment of a Streamside Management Zone,

◊ prohibition of debris entering streams,

◊ access and skid trail stream crossing protection measures,

◊ access road entrance restriction,

◊ prohibition of waste entering streams,

◊ waterbodies, and groundwater,

◊ pesticide and fertilizer application restrictions, and

◊ rehabilitation of project site requirements.

Some additional measures implemented in the basin by the DFR include:

- Administering the FPGs through site visits during the course of routine field work to prepare Forestry Management Plans for landowners, when logging is observed, and as a follow up to citizen complaints.
- Conducting logger training in water quality/FPG issues through the ProLogger Program, field days and static display to logger trade show
- Conducting Atlantic White Cedar Project. The objective of this project is to restore Atlantic White Cedar in 640 acres of prior converted wetlands with peaty soils to achieve nonpoint source reductions of mercury and nitrogen in surface waters which drains into the Pungo River.

5.6.4 Local Government and Citizen Initiatives

Currituck County:

- Provides soil testing and analysis service and information on precision farming.
- Conducts nutrient management, pesticide management and master gardener training programs.

Dare County

- monitor surface waters at 28 sites across the county
- conducted several symposia and forum meetings for public information by The League of Women Voters of Dare County
- hosted a water quality and quantity conference by the Outer Banks Community Foundation and other organizations including USDA Natural Resources Conservation Service, National Park Service, NC Aquarium, Jockey's Ridge State Park, Dare County Health Department, Dare County Public School, Town of Nags Head, Town of Kill Devil Hills, Pea Island National Wildlife Refuge, Nags Head Woods, Ocracoke Preservation Society, Roanoke Island Historical Society, North Carolina Coastal Reserve, Chicamacomico Historical Association.

Elizabeth City:

- Upgraded its waste water treatment plant

Town of Kitty Hawk:

- Coordinates Albemarle-Pamlico Citizen Water Quality Monitoring Program
- Samples water in Kitty Hawk Bay since 1989 for dissolved oxygen, pH, salinity and turbidity

5.7 Integrating Point And Nonpoint Source Pollution Control 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 is 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.

Total Maximum Daily Loads

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

Under the TMDL approach, waterbodies that do not meet water quality standards are identified. States establish priorities for action, and then determine reductions in pollutant loads or other actions needed to meet water quality goals. The approach is flexible and promotes a watershed approach driven by local needs and States priorities. The overall goal in establishing the TMDL is to establish the management actions on point and nonpoint sources of pollution necessary for a waterbody to meet water quality standards.

As DWQ improves its abilities to quantify and predict the impacts of point and nonpoint source pollution, the basinwide approach will make more innovative management strategies possible.

Other Possible Strategies

- *Agency banking* refers to the concept of holding assimilative capacity in reserve by DEM 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 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 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. Local authorities, regulated industries, landowners, and other interested parties are encouraged to provide ideas to develop these strategies. By accommodating, to the degree possible, local needs and preferences, the probability of the plan's long-term success will be increased.

5.8 POTENTIAL SOURCES OF FUNDING FOR WATER QUALITY PROJECTS

There are numerous sources of funding for all types of water quality projects. The sources of funding include federal and state agencies, nonprofits, and private funding. Funds may be loans, cost-shares, or grants. Section 319(h) grants are discussed in some detail in Section 5.8.1. Other funding sources are listed in Section 5.8.2.

If a local government, environmental group, university researcher, or other individual or agency wants to find funding to address a local water quality problem, it is well worth the time to prepare a thorough but concise proposal and submit it to applicable funding agencies. The list of goals for Section 319(h) proposals can be used as a guideline for other funding agencies. Even if a project is not funded, persistence may be beneficial when funding agencies observe several consecutive proposals from the same group.

5.8.1 Section 319(h) Grants

EPA offers the state Clean Water Act Section 319(h) grant moneys on an annual basis. These grants must be used to fund projects that address nonpoint source pollution issues. Some projects which DWQ has funded with this money in the past include BMP demonstrations, watershed water quality improvements, data management, educational programs, modeling, stream restoration, and riparian buffer establishment. Agencies, environmental groups, university researchers, and others in the state that have expertise in nonpoint source pollution problems are invited to submit Section 319(h) proposals to DWQ.

DWQ established a Workgroup process in 1995 for prioritizing and selecting projects from the pool of cost-share proposals and includes this list in its annual application to EPA. The Workgroup consists of representatives from the state and federal agencies that deal with NPS issues, including agricultural, silvicultural, on-site wastewater, mining, solid waste and resource protection.

DWQ staff first reviews proposals for minimum 319 eligibility criteria such as:

- Does it support the state NPS Management Program milestones?
- Does the project address targeted, high priority watersheds (See Table 5.4)?
- Is there sufficient nonfederal cost-share match available (40% of project costs)?
- Is the project period adequate?
- Are measurable outputs identified?
- Is monitoring required? Is there a QA/QC plan for monitoring?
- If GIS is used, is it compatible with those of the state?
- Is there a commitment for educational activities and a final report?

Workgroup members separately review and rank each proposal which meets the minimum 319 eligibility criteria. In their review, members consider such factors as: technical soundness; likelihood of achieving water quality results; degree of balance lent to the statewide NPS Program in terms of project type; and competence/reliability of contracting agency. They then convene to discuss individual projects' merits, to pool all rankings and to arrive at final rankings for the projects. The Workgroup seeks a balance between geographic regions of the state and types of projects. All proposals that rank above the funding target are included in the annual grant application to EPA, with DWQ reserving the right to make final changes to the list. Actual funding depends on approval from EPA and yearly Congressional appropriations.

Table 5.4 Nonpoint Source (NPS) 319 Priority Ratings for Coastal Waters

<u>High priority waters</u>:
• monitored waters that have an overall use support rating of non-supporting,

- monitored waters that have a use support rating of partially supporting but have a high predicted loading for one or more pollutants,
- highly valued resource waters as documented by special studies
  - High Quality Waters (HQW)
  - Outstanding Resource Waters (ORW)
  - Water Supply I, Water Supply II, Critical areas of WS-II, WS-III or WS-IV
  - Shellfish Waters (Class SA) having a significant shellfish resource and moderate bacteriological problems, as identified by the Division of Environmental Health, in which harvesting is prohibited or restricted
  - Shellfish Waters (Class SA) that drains to ORW and in which shellfish harvesting is prohibited or restricted
  - Shellfish Waters (Class SA) in which harvesting is conditionally approved by DEH and a significant shellfish resource exists

Medium priority waters:

- monitored waters that have an overall use support rating of partially supporting,

Low priority waters:

- Shellfish Waters (Class SA) in which harvesting is prohibited or restricted but which are not considered to have a significant shellfish resource
- All other waters not considered high or medium priority

To obtain more information about applying for a Section 319(h) grant, contact:

Linda Hargrove, DWQ - Planning Branch
P.O. Box 29535, Raleigh, NC 27626-0535
(919) 733-5083 ext. 352

5.8.2 Other Sources of Funding

Besides Section 319(h) funding, there are numerous sources of funding for all types of water quality projects. The sources of funding include federal and state agencies, nonprofit, and private funding. Funds may be loans, cost-shares, or grants.

If a local government, environmental group, university researcher, or other individual or agency wants to find funding to address a local water quality problem, it is well worth the time to prepare a thorough but concise proposal and submit it to applicable funding agencies. The list of goals for Section 319(h) proposals can be used as a guideline for other funding agencies. Even if a project is not funded, persistence may be beneficial when funding agencies observe several consecutive proposals from the same group.

Tables 5.5 and Appendix VI provide summaries of the agencies that are potential sources of funds for point sources of pollution. Table 5.6 and Appendix VI provide summaries of the agencies that are potential funding sources for nonpoint sources of pollution.

In addition to these sources, the Clean Water Trust Fund will be another source of funding for both point and nonpoint sources of pollution. The 1996 General Assembly earmarked 6.5% annually of the year end General Fund credit balance to help finance projects that address water pollution problems and focus on upgrading surface waters, eliminating pollution and protecting and preserving unpolluted surface waters. Contact Norma Ware at (919) 733-6854 and refer to Appendix VI for more details on this program.

Table 5.5 Funding Agencies for Assistance With Point Sources

Source	Agency and Name of Funding Source
Federal	U.S. Rural Utilities Service: Water and Wastewater Loan and Grant Program Rural Business and Cooperative Service: Rural Business Enterprise Grants Appalachian Regional Commission: Supplements to Other Federal Grants in Aid U.S. Economic Development Administration: Public Works and Development Facilities Grant Program
State	NC Division of Water Quality: Construction Grants and Loans Program NC Division of Community Assistance: Small Cities Community Development Block Grant NC Commerce Finance Center: Industrial Development Fund
Private	Rural Economic Development Center, Inc.: Supplemental and Capacity Grants Program

Table 5.6 Funding Agencies for Assistance with Nonpoint Sources

Type of Assistance	Agency and Name of Funding Source
Agriculture	NC Agriculture Cost Share Program for NPS Pollution Control (NCACSP) Environmental Quality Incentives Program (EQIP) Conservation Reserve Program (CRP) Wetland Reserve Program (WRP) Small Watershed Program, PL-566 Conservation Easement Soil and Water Conservation Loan Program
Education	GTE Foundation Toyota TAPESTRY Grants National Environmental Education and Training Foundation (NEETF)
Water Quality Planning	Section 205(j) Water Quality Planning Grants
Stream Restoration	NC Division of Water Resources Stream Repair Funding
Forestry	Forestry Stewardship Incentive Program Forestry Incentives Program
Land Conservation	National Wetland Priority Conservation Plan NC Conservation Tax Credit Program Federal Wild and Scenic Rivers Program Emergency Wetlands Resources Act of 1986

CHAPTER 6

MAJOR BASINWIDE WATER QUALITY CONCERNS AND RECOMMENDED MANAGEMENT STRATEGIES

6.1 INTRODUCTION

One of the major concerns for water quality in this basin includes rapid growth in the coastal area. In addition, there are more localized water quality problems in areas such as the Little River and Scuppernong River likely due to agricultural contributions of nonpoint source pollution. Solving these problems and protecting the surface water quality of the basin in the face of continued growth and development will be a major challenge.

The long range mission of basinwide management is to provide a means of addressing the complex problem of planning for increased development and economic growth while protecting and/or restoring the quality and intended uses of the Pasquotank River basin's surface waters. Growth and other priority issues are discussed in Section 6.2, below. In striving towards its mission, DWQ's highest priority near-term goals are as follows:

- <u>**To identify and restore impaired waters in the basin**</u>. Section 6.3 discusses impaired and threatened waters and how these waters are prioritized for restoration and protection. Priority Issues and Recommended Management Strategies are presented for each subbasin in Section 6.4.
- <u>**To identify and protect high value resource waters and biological communities of special importance**</u>. Section 6.5 discusses management strategies for protecting the HQW/ORW's in the basin.
- <u>**To manage the causes and sources of pollution to ensure the protection of those waters currently supporting their uses while allowing for reasonable economic growth.**</u> Major water quality issues addressed under this topic in Section 6.6 include sedimentation, nutrients, urban stormwater runoff, fecal coliform bacteria, toxic substances and oxygen-consuming wastes.

6.2 MAJOR WATER QUALITY CONCERNS AND PRIORITY ISSUES

6.2.1 Coastal Growth Management

The Need for Coastal Growth Management

The coastal zone is a popular place, attracting visitors and permanent residents, alike. Over 50% of today's US population lives along the coast, and most of future growth is predicted to occur in coastal areas (NOAA, 1993). The situation in North Carolina and in the Pasquotank River Basin is no different. Over the last decade, the coastal growth rate has been nearly twice that of the state (NC CFC, 1994). North Carolina's coastal population grew by nearly 200,000 and growth rates for most coastal counties will exceed 20% by the turn of the century (Culliton et al., 1990, NC CFC). Growth on Roanoke Island and the Dare County portion of the Outer Banks has far outpaced the remainder of the basin as discussed in Chapter 2.

Unfortunately, continued growth exerts a variety of environmental impacts on coastal ecosystems. Examples include wastewater disposal, stormwater runoff, habitat disruption, and demands on natural resources such as water supply needs, marina construction and fishery resources (Center for Watershed Protection, 1995).

The economies of many coastal North Carolina communities are strongly dependent upon a high quality environment. Visitors and residents alike expect to be able to catch and consume local seafood, swim and boat without threats to health and safety and enjoy scenic surroundings. If such expectations are not met, tourism industries will decline and coastal economies may suffer. Commercial fisherman and others whose livelihoods depend upon a clean environment can be harmed as well. Unfortunately, evidence, such as the closure of shellfish waters dues to fecal coliform bacteria contamination, is showing that such effects are beginning (Center for Watershed Protection, 1995).

Coastal residents sometimes find it easier to blame water quality problems on upland sources. Contrary to this belief, the greatest pollution control per unit effort can be achieved by concentrating on coastal sources (Phillips, 1991).

Growth Management Needed at the Local Level

Growth management--defined here as local planning and development review requirements designed to maintain or improve water quality (Center for Watershed Protection, 1995)--has often been unpopular among local governments for a variety of reasons. While it is important to acknowledge this, we must also acknowledge that further improvements in state programs, while necessary, are by themselves unlikely to prevent further deterioration of coastal water quality. Increasingly, local governments in areas such as the Chesapeake Bay and Puget Sound watersheds have recognized that a more proactive approach is essential to protect their coastal resources. Seventy percent of the local governments in the 12 county Puget Sound region, for example, have adopted some form of a stormwater management plan (Dohrmann, 1995).

The Comprehensive Conservation and Management Plan (CCMP), which was prepared by the NC Department of Environment, Health and Natural Resources (NC EHNR) as part of the Albemarle-Pamlico Estuarine Study (NC EHNR, 1994) echoes the need for local government planning in addressing coastal growth. In discussing the growth issue, it acknowledges that several types of planning are already required at the local level. Coastal counties are required to prepare land use plans under requirements of the federal Coastal Zone Management Act and amendments. At the state level, this program is administered by the NC Division of Coastal Management (DCM). Local governments that provide public water service must prepare water supply plans through a program administered by the NC Division of Water Resources. However, the CCMP goes on to state that "While these requirements result in environmental planning for many parts of the region, many local communities -- as well as local natural resources -- would benefit from expanded comprehensive planning aimed at meeting both environmental and economic goals." (NC EHNR, 1994). The document goes on to recommend that the state provide resources to local governments to assist in proactive, voluntary planning initiatives - especially in the area of geographic information systems (GIS). Some state GIS efforts are discussed below.

Some Recommendations/Resources for Addressing Coastal Growth

Over the past several years DWQ, DCM and other agencies have been involved in a number of projects to encourage and assist local governments in carrying out wastewater planning and growth management activities. One of these projects was the development of the *Blueprint to Protect Coastal Water Quality: A Guide to Successful Growth Management in the Coastal Region of North Carolina* (Center For Watershed Protection, 1995). This was developed as part of a federal grant project sponsored by the Division of Water Quality and carried out by the Neuse River Council of Governments. Local governments should consider the application of growth management techniques outlined in the "Blueprint" document. It provides practical concepts and tools that can be implemented at the local level to protect coastal water quality. Copies are available free of charge from the DWQ's central office in Raleigh.

The following two tables summarize key features of the document. Table 6.1 lists growth management elements that are discussed in detail in *Blueprint*. Each element can be tailored to both rural and developed areas and to inland, soundside and barrier island locations. Table 6.2 lists 22 growth management tools also presented in *Blueprint*. These tools range from on-the-ground best management practices, such as modifying parking areas in order to reduce impervious surface areas, to establishing regional wastewater and/or stormwater authorities.

Table 6.1 Growth Management Elements Applicable to the North Carolina Coast

1. Use Watershed-based Land Use Planning
2. Protect Sensitive Natural Areas
3. Establish Buffer Network
4. Minimize Impervious Cover in Site Design
5. Limit Erosion During Construction
6. Treat Stormwater
7. Maintain Coastal Growth Measures

Table 6.2 Growth Management Tools

1. Overlay Zoning	8. Septic System Siting Criteria	16. Septic System Inspection and Maintenance
2. Greenbelts	9. Shoreline and Wetlands Buffers	17. Septic System Alternatives
3. Transfer of Development Rights	10. Cluster Zoning	18. Regional CAMA Planning
4. Watershed Impervious Limits	11. Modification of Street Standards	19. Wastewater Authority
5. Marina Siting and Design	12. Modification of parking Areas	20. Stormwater Authority
6. Sensitive Habitat Protection Ordinance	13. Site Clearing Standards	21. Wastewater/Stormwater Authority
7. Forest Conservation	14. Stormwater Treatment	22. Water Quality Authority
	15. Marina Pumpout	

In addition to the Blue Print document, the Division of Water Quality, in cooperation with the Center of Geographic Information and Analysis (CGIA) recently held a series of three one-day workshops for local governments on GIS. The workshops were funded through a federal CCMP implementation grant from the EPA. One of the workshops was held in the Pasquotank Basin in Plymouth.

The NC Division of Coastal Management has also been providing extensive GIS information to local governments to aid in development of local land use plans. These plans must be consistent with state guidelines and address a wide range of issues, including resource protection and conservation, hazards mitigation, economic development and public participation. 1995 revisions to the land use planning guidelines strengthened the connection between land use planning and surface water quality. Future land use plan updates must consider water quality use classifications, watershed planning and problems identified in basinwide plans.

6.2.2 Working with the NPS Team to Control NPS Pollution

Pollution from nonpoint sources is identified as the major contributor to water quality impairment in the river systems of the Pasquotank River Basin. It will be important during this basinwide planning cycle to actively work with the NPS team to better identify nonpoint source pollution contributions and to improve conditions where feasible. It is recognized that in some cases the information that DWQ has on the probable contributions from land uses such as agriculture are dated and sketchy. Accomplishments in managing runoff from agriculture and animal operations that have occurred during the last five years or so (such as Conservation Management Plans in compliance with the Farm Bill, or improved management of waste from animal operations in compliance with new regulations) are not reflected in this information. It is important for the progress that has been made in BMP implementation to be identified and acknowledged. Team members can assist in consolidating this information. However, agriculture and animal operations remain prominent in the landscape of the river basin and it will be important to work toward further gains in this area in order to protect water quality.

As is evident in section 6.3.1 which identifies the impaired waters in the basin, and section 6.4.1 which contains water quality issues and recommendations by subbasin, agriculture and animal operations are believed to be the primary contributor to impairment of water quality in the basin. Addressing these problems is best accomplished by a knowledgeable team of local professionals and stakeholders - the NPS team. Therefore, the primary recommendation for impaired waters in the Pasquotank basin is to work with this team to prioritize areas for restoration and target available resources of the team participants toward them. The NPS team is further discussed section 6.2.4 and in Chapter 7.

6.2.3 Priority Issues and Recommended Actions Identified by Workshop Participants

Two public workshops were conducted in the Pasquotank River basin on the afternoon of July 25, and the morning of July 26, 1996 and were attended by over 50 participants. DWQ staff presented general descriptions of the state's water quality program and basinwide planning as well as specific information on the basin. Participants were asked to identify what they saw as the priority water quality issues for the Pasquotank River basin. DWQ examined the comments received at the workshop and grouped them into seven broad categories.

These seven categories (listed below) and associated specific comments are presented in Table 6.3 along with reference to sections of this basinwide management where applicable.

- resource issues,
- cooperation and coordination between States, state agencies, and local governments,
- nonpoint source pollution,
- growth/development issues,
- regulatory issues,
- education and
- site-specific concerns.

While each identified issue may not be directly responded to in the plan, an effort has been made to consider these issues within the framework of the basinwide approach. Where there has been some discussion about the category or specific comments within the plan, the table provides this reference.

Table 6.3. Priority Water Quality Issues Identified by Workshop Participants and Reference Sections in the Pasquotank River Basinwide Water Quality Management Plan

General Category	Specific Comments	Reference Section(s)
Resource Issues	- wetlands - need to protect fishery spawning and nursery areas - closed shellfish areas - bass habitat - submerged rooted vegetation	2.6.5, 2.6.1, 2.6.2, 3.2.5, 6.5.1
Cooperation and Coordination between States, State Agencies and Local Governments	- better interstate communication - get more DWQ people out of Raleigh - cooperation between DEH and county health departments - make sure there is collaboration between APES CCMP and DWQ - coordination between two EPA regions that oversee VA and NC	6.2.2, 6.2.5, Appendix IV
Nonpoint Source Pollution	- nutrient loading - animal waste - septic tanks - sedimentation - hydrodynamics/flow modification - saltwater intrusion - need more buffers - runoff from agriculture - golf courses - impacts from boating - runoff from bridges	3.2.4, 3.2.5, 3.4, Appendix V, Appendix VI
Growth/Development Issues	- coastal development - population growth - loss of habitat - need cost/benefit analyses for various types of development - secondary impacts from VA Beach growth - cluster new development in less sensitive areas	3.2.5, 6.2.1
Regulatory Issues	- alternative funding sources for land preservation (i.e. impact fees) - need more zoning and land-use planning - need EISs for new or expanded animal operations - have to compensate people for loss of land due to implementation of buffers - equitable enforcement	5.7, 6.2.1
Education	- more outreach - better education of county commissioners on environmental issues - educate everyone and they will voluntarily protect water quality - get public to care	
Site - Specific Concerns	- secondary impacts of bridge to be built across Currituck Sound - expansion of Highway 17 - hog farms in Camden County	6.2.1, 6.4.5, Appendix VI

6.2.4 Priority Issues and Recommended Actions Identified by the Nonpoint Source (NPS) Team Members

DWQ has begun setting up nonpoint source teams in each of the state's 17 major river basins. These teams will have representatives from agriculture, urban stormwater, construction, mining, on-site wastewater disposal, forestry, solid waste, wetlands, groundwater, natural resource agencies, local governments, special interest groups and citizens. These teams will provide descriptions of current NPS management activities within a basin, conduct assessments of NPS controls in targeted watersheds, prioritize impaired waters for development and implementation (including funding) of restoration strategies and NPS issues for remedial action. The team will develop five-year action plans to reflect these priorities.

At their first meeting in 1996, the Pasquotank basin NPS Team members described their vision of priority issues and comments for water quality problems in the basin. A summary of these issues and comments are presented in Table 6.4. Issues and comments presented by the NPS team members will be incorporated into the five-year action plan being developed by the team. DWQ will continue to work with the NPS team to clarify the water quality issues of the Pasquotank River basin and formulate implementable strategies to deal with these issues.

Table 6.4. Priority NPS Issues Identified by the Pasquotank Basin NPS Team

Category	Comments
Agriculture	We need to expand the use of BMPs. More education programs are needed for nonpoint source controls. Nutrient issue is still a big concern in the basin. There are needs to promote the concept of total watershed management.
Development	Increased development is contributing to problems with sedimentation and wastewater discharge. Water table is decreasing in many areas in the basin. Need to consider secondary impact from Virginia Beach growth.
Golf Courses	Fertilizer and pesticide use may be impacting water quality.
Other	Inlets for estuary access are not well maintained. Designated spawning nursery areas needed to be protected.
General Approach	We need to target our resources to the areas we identify as the largest priority. Our action plan should focus on prevention. The action plan we create should include incentives for "good actors." We should utilize existing resources/programs for education.

Pollution from nonpoint sources is identified as a major contributor to water quality impairment in the Pasquotank River Basin. It will be important during this basinwide planning cycle to actively work with the NPS team to better identify nonpoint source pollution contributions and to improve conditions where feasible. It is recognized that in some cases the information that DWQ has on the probable contributions from land uses such as agriculture is dated and sketchy. Accomplishments in managing runoff from agriculture and animal operations that have occurred during the last five years or so (such as Conservation Management Plans in compliance with the Farm Bill, or improved management of waste from animal operations in compliance with new regulations) are not reflected in this information. It is important for the progress that has been made in BMP implementation to be identified and acknowledged. Team members can assist in consolidating this information. However, agriculture and animal operations remain prominent in the landscape of the river basin and it will be important to work toward further gains in this area in order to protect water quality.

6.2.5 Priority Issues and Recommended Actions Identified by the Albemarle Pamlico Estuarine Study Comprehensive Conservation and Management Plan (CCMP)

The Pasquotank River Basin is part of a broader region defined as the Albemarle-Pamlico Estuary which has been included in EPA's National Estuary Program. The Albemarle-Pamlico Estuarine Study (APES) investigated the region intensively and produced the Comprehensive Conservation and Management Plan (CCMP). Within the CCMP, there are several recommendations made with regard to water quality issues, including the implementation of a basinwide approach to water quality management which this plan represents. The goal of the Water Quality Plan section of the CCMP is to "restore, maintain or enhance water quality in the Albemarle-Pamlico region so that it is fit for fish wildlife and recreation". (NC EHNR, 1994) Within the Water Quality Plan there are five broad objectives that are listed and briefly described below. A description of the status of the implementation of the APES CCMP is contained in Chapter 5 of this document. A detailed status report is reproduced in Appendix IV.

<u>Objective A: Implement a Comprehensive Approach to Water Quality Management</u>

<u>Objective B: Reduce Sediments, Nutrients and Toxicants from Nonpoint Sources</u>

<u>Objective C: Reduce Pollution from Point Sources, such as Wastewater Treatment Facilities and Industry</u>

<u>Objective D: Reduce the Risk of Toxic Contamination to Aquatic Life and Human Health</u>

<u>Objective E: Evaluate Indicators of Environmental Stress in the Estuary and Develop New Techniques to Better Assess Water Quality Degradation</u>

6.2.6 NC Coastal Future's Committee

In celebration of NC's unique coastal resources, Governor James B. Hunt, Jr. declared 1994 the "Year of the Coast" and created the Coastal Futures Committee. This committee was a group of 15 appointed members charged with studying current management efforts and drafting recommendations for future action (NC CFC, 1994). Recommendations on strengthening land use planning, protecting water quality and public trust rights, preserving the region's natural heritage, encouraging sound economic development and promoting environmental education were made. The following are some of the more significant recommendations related to water quality issues (from NC CFC, 1994):

- CAMA planning should be amended to consider issues affecting entire regions, such as basinwide water quality protection;
- the state should increase efforts to protect water quality by strengthening comprehensive planning throughout entire river basins and by strengthening efforts that focus on local sources of pollution within coastal counties; these efforts should include developing improved water quality standards and guidelines designed to restore and adequately protect fragile areas such as shellfish beds and fish nurseries from shoreline development and other sources of water quality degradation;
- local land use plans should consider the cumulative and secondary impacts of growth on communities and on water quality;
- environmental laws concerning pollution from nonpoint sources, such as runoff from cities and farms should be strengthened and more strictly enforced; and,
- the proposed supplemental URW (Use Restoration Waters) classification should be implemented.

6.2.7 Blue Ribbon Oyster Committee

The NC Blue Ribbon Advisory Council on Oysters (NCBRACO) issued its final Report on Studies and Recommendations in October 1995. In the report the Council "reaches the inescapable conclusion that oyster harvests have declined sufficiently in North Carolina to justify bold new action and to require initiation of that action immediately. ... Because of the economic, cultural, and environmental value of healthy oyster populations, the council judges the perpetuation of this decline in an important component of our coastal heritage to be unacceptable to the citizens of our state." It cites a number of reasons for this decline including outbreaks of oyster diseases (mostly weather driven), physical degradation of oyster reefs, overharvest and to "substantial deterioration of coastal water quality". Both the Albemarle-Pamlico Estuarine Study and Governor Hunt's Coastal Futures Committee, which preceded the council, have also recognized the importance of protecting and restoring shellfish waters.

The Council's report, along with a report from the Council's Public Bottom Production Committee, makes a series of specific water quality recommendations (NC Blue Ribbon Advisory Council on Oysters, 1995). The objective of these recommendations is to "restore and protect coastal water quality to create an environment suitable for oysters that are safe for human consumption. These recommendations include, but are not limited to:

- institution of regulatory mechanisms for control of NPS runoff, particularly fecal coliform bacteria and nutrients,
- mandatory 100 foot buffers along all SA waters,
- reducing the allowable built-upon area for low density development,
- promote and fund research on oyster reefs that documents their positive impact on water quality
- urge the Marine Fisheries and Environmental Management Commissions to work together to establish and implement a "Use Restoration Waters" classification in order to restore closed shellfish beds,
- DEHNR should "augment its basinwide management plans to include mechanisms for controlling both point and nonpoint source nutrient additions" and "develop and fund a coastal water quality monitoring system capable of measuring oxygen levels in bottom waters in historically important shellfish grounds."
- work with the NCDOT to reverse past road construction activity that has adversely affected oyster beds through restrictions on normal water flow

6.3 IDENTIFICATION AND RESTORATION OF IMPAIRED WATERS

6.3.1 What Are the Impaired Waters?

Impaired waters are those waters identified in Chapter 4 as partially supporting or not supporting their designated uses. Table 6.5 and 6.6 present impaired waterbodies in the freshwater and saltwater portions of Pasquotank River basin (respectively), the source of impairment, NPS Priority rating (see Section 6.3.3) and summary of recommended management strategy. See Chapter 4 for explanation of use support ratings.

6.3.2 What are the "Threatened Waters"?

Some waters have notable water quality problems but the impact of the problem is not severe enough to cause the stream to be considered impaired under the state use-support designation described in Chapter 4. These waters are rated Support-Threatened. In the Pasquotank River basin, portions of the Scuppernong, Little, Yeopim and Perquimans Rivers are considered threatened. Good-Fair biological ratings and periodic algal blooms likely due to nonpoint source pollution are the primary conditions resulting in the threatened status. In addition, part of Currituck Sound is threatened due to mild algal blooms. Sources and causes of pollution that are resulting in these waters' threatened status should be identified. An evaluation of management strategies will determine if the sources and causes can be reduced, eliminated or reversed before further negative impact occurs.

Table 6.5. Impaired freshwaters in the Pasquotank River Basin.

Waterbody (subbasin)	Use Support Rating	Probable Source of Impairment	Recommended Management Strategy	Chapter 6 Reference Section
Little River (030152)	PS	agriculture, animal operations	Agricultural activities are thought to be contributing to water quality impairment. The NPS team should consider targeting this area.	6.4.3
Burnt Mill Creek (030152)	NS	agriculture, animal operations	Benthic and fish community data indicate severe impairment in this stream. Agricultural activities are suspected to be causing the impairment. It should be a high priority of the NPS team to determine the activities causing impairment and to improve water quality in this stream.	6.4.3
Kendrick Creek (030153)	PS	agriculture, animal operations	Biological data indicate that water quality is fair. Agriculture is thought to be contributing to impairment. The NPS team should consider targeting this area.	6.4.4
Main Canal (030153)	PS	agriculture, animal operations	Fish community data indicate that water quality is depressed. The NPS team should consider this area for targeting their efforts.	6.4.4
Scuppernong River (030153)	PS	agriculture, animal operations, WWTP	Biological and ambient chemistry data indicate that water quality is depressed. Both point and nonpoint sources of pollution are thought to be contributing to the problem. The NPS team should consider targeting this area and DWQ will investigate the potential of impairment from the WWTP.	6.4.4

PS = Partially Supporting NS = Not Supporting

Table 6.6. Impaired estuarine waters in the Pasquotank River Basin.

Waterbody (subbasin)	Use Support Rating	Probable Source of Impairment	Recommended Management Strategy	Chapter 6 Reference Section
Roanoke Sound	PS	urban runoff, septic tanks, marinas	These are shellfish waters that have been prohibited by DEH for harvesting. It should be determined whether or not a significant shellfish resource exists before prioritization for remediation occurs.	6.4.7
Croatan Sound and a portion of eastern Albemarle Sound	PS	urban runoff, septic tanks, marinas	same as above	6.4.2
Hatteras, waters next to Outer Banks, and Stumpy Point Bay	PS	urban runoff, septic tanks, marinas	same as above (most of these areas are small, automatic closures around marinas and treatment plant outfalls)	6.4.6
Shallowbag Bay	PS	WWTP, septic tanks, urban runoff	Manteo has upgraded their WWTP; NPS contributions to impairment should be investigated.	6.4.2
Little River	PS	agriculture, swamp waters	Low dissolved oxygen levels are the cause for this river's impairment. Agricultural activities combined with swamp conditions are thought to be reasons for impairment. The NPS team should consider targeting this area.	6.4.3

6.3.3 How are Waters Prioritized for Restoration or Protection?

Priority Waters for Nonpoint Source (NPS) Management Strategies

DWQ has developed criteria for assisting in the selection of NPS-impaired waters for prioritization by the NPS Team. The NPS Team will use both primary and additional criteria to select the priority NPS-impaired waterbodies. An NPS-impaired waterbody that meets the primary criteria and one or more of the additional criteria is a good candidate for prioritization by the NPS Team.

The primary criteria are (in order of importance):

- Highly-valued resource waters, such as High Quality Waters and Water Supplies I-IV, that have a demonstrated pollution problem.
- Monitored waters that have an overall use support rating of non-supporting.
- Monitored waters that have a use support rating of partially supporting but have a high predicted loading for one or more pollutants.
- Tributaries of highly-values resource waters.

The additional criteria for selecting the priority NPS-impaired waterbodies are:

- Waters that pose a potential threat to human health,
- Waters that are important for ecological reasons not reflected in their classification and use support ratings (such as endangered species, unique habitats, or significant biological resources),
- Waters that are highly eroded or have other evidence of serious erosion problems that are not reflected in the use support ratings,
- Waters that have experienced a recent, rapid decline in water quality, and
- Waters that have identifiable pollution sources and a high likelihood of successful restoration.

Waters that meet the above criteria form a list of potential candidtates for targeting by the NPS team. A summary of these potential priority waterbodies in the Pasquotank basin are presented in Table 6.7.

Table 6.7. Potential NPS Priority Waterbodies in the Pasquotank River Basin

Waterbody:	Burnt Mill Creek
Subbasin:	030152
Use Classification:	C, Sw
Notable Features:	swamp
Use Rating:	Nonsupporting
Length Affected:	3.5 miles
Problem Parameters:	Unknown, rating based on biological data
Waterbody:	Kendrick Creek, including tributary (Main Canal)
Subbasin:	030153
Use Classification:	C, Sw
Notable Features:	swamp, drains to Partially Supporting waters
Use Rating:	Partially Supporting
Length Affected:	18.2 miles
Problem Parameters:	DO, pH
Waterbody:	Scuppernong River
Subbasin:	030153
Use Classification:	C, Sw
Notable Features:	drains to Partially Supporting waters
Use Rating:	Partially Supporting
Length Affected:	15.2 miles
Problem Parameters:	DO, pH
Waterbody:	Little River
Subbasin:	030152
Use Classification:	C, Sw
Notable Features:	drains to Partially Supporting waters
Use Rating:	Partially Supporting
Length Affected:	11.8 miles
Problem Parameters:	DO

Abbreviations:
C = Class C Waters, waters protected for secondary recreation, including wading, boating, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class C.
Sw = Swamp Waters, supplemental classification intended to recognize those waters that generally have naturally occurring very low velocities, low pH and low dissolved oxygen.
DO = dissolved oxygen

<u>Section 319 of the Clean Water Act (CWA) NPS Priority</u>

Clean Water Act Section 319(h) grant monies are made available to the states on an annual basis by EPA. Agencies in the state that deal with NPS problems submit proposals to DWQ each year for use of these funds in various projects. Projects are prioritized as either High, Medium or Low based on criteria presented in Table 5.4 of Chapter 5.

<u>Section 303(d) of the Clean Water Act (CWA)</u>

States are required to develop a list of waters not meeting water quality standards or which have impaired uses (Partially Supporting or Not Supporting) under Section 303(d) of the Clean Water Act. Waters may be excluded from the list if existing control strategies are expected to achieve the standards or uses. Control strategies may be both point or nonpoint programs. Waterbodies which are listed must be prioritized and a management strategy or Total Maximum Daily Load (TMDL) must be developed.

Use support ratings for the 303(d) list are based on monitoring data collected in the last five years. Further information on the 303(d) program and a complete list of 303(d) waters in the Pasquotank River basin can be found in Appendix VIII. The list includes use support ratings, major causes and sources of impairment, descriptions of potential sources of pollution and the stream priority rating.

6.4 PRIORITY ISSUES AND RECOMMENDED MANAGEMENT STRATEGIES BY SUBBASIN

6.4.1 Pasquotank River and Tributaries (Subbasin 50)

Overview

This subbasin includes the Pasquotank River and its tributaries.

Issues and Recommended Management Strategies

In this subbasin, the upper, freshwater portion of the Pasquotank River is considered to be support-threatened. Many waters within the watershed for this river drain swamp land, including the Dismal Swamp. Exceedences of standards for pH and dissolved oxygen have been seen, but some of these are attributed to natural conditions of the swamp waters. Infrequent algal blooms are known to occur in the river, but nutrient levels decrease by the time water reaches the Albemarle Sound. Regional Office staff have indicated that duckweed can be a problem in the upper portion of this river.

DWQ will continue to monitor conditions in this subbasin. If problems worsen, investigative actions will need to be conducted in the upper watershed to determine the causes and sources of the problems and devise site-specific corrective actions.

6.4.2 Alligator River, Croatan Sound and a Portion of Albemarle Sound (Subbasin 51)

Overview

This subbasin includes the Alligator River and its tributaries, as well as portions of the Albemarle, Croatan and Roanoke Sounds. Most waters are brackish estuarine.

Issues and Recommended Management Strategies

Croatan Sound and Eastern Albemarle Sound
Portions of the Croatan Sound and eastern Albemarle Sound (adjacent to Croatan) that are classified for shellfishing (Class SA) are prohibited to shellfish harvesting due to high fecal coliform concentrations that are thought to be the result of urban runoff, septic tanks and marinas. As a result, this area received a use support rating of partially supporting and is considered impaired. The NPS team should consider investigating whether or not there is a shellfish resource there that could be harvested if actions were taken to lower fecal coliform levels.

Shallowbag Bay
This bay along the Roanoke Sound side of Roanoke Island is considered impaired. Historically, the discharge from the Town of Manteo wastewater treatment plant (WWTP) has been considered one of the potential sources of impairment. In summer of 1993 the Town of Manteo constructed a new WWTP to accomodate an increased volume of discharge and improve treatment to advanced tertiary levels. In addition to replacing the existing, problematic WWTP, the new facility eliminated the discharges from Pirates Cove (also known as Roanoke Properties) and the town's rotary distribution system and resulted in significantly improved treatment of those waste streams. Despite the increase in the hydraulic volume of the discharge, the upgrade resulted in an overall reduction in loading for BOD5 and ammonia, and the fecal coliform limit for the new facility was lowered from 200 (colonies)/100 ml to 14/100 ml. Requirement in the new NPDES permit for the expanded discharge also included extensive instream monitoring at several locations in order to evaluate potential impacts in and around the Bay.

Evaluation of compliance data for the Manteo WWTP indicates that the facility consistently meets the stringent coliform limit. Therefore, it is unlikely that the discharge is making a measurable contribution to fecal coliform levels in Shallowbag Bay, which have been recently recorded as high as 2000-4000 /100 ml. Evaluation of the instream data collected by the facility has indicated that fecal coliform levels in the Bay are subject to wide fluctuations , with a tendency for low and high levels to coincide to periods of dry and wet weather, respectively. Trends of this nature would indicate that coliform levels in the bay are predominantly influenced by nonpoint sources, such as urban runoff and poor or failing septic systems. There is a need to investigate the nonpoint source contributions to impairment and to take appropriate action to address identified problems.

Two tributaries to Shallowbag Bay (upper Scarboro and Doughs Creeks) have been classified as High Quality Waters (HQWs) based on their designation by the Division of Marine Fisheries as primary nursery areas. There is no information to suggest that they are not currently supporting their uses. Reference section 6.5.2 for management strategies applied to HQWs.

Alligator River
The Alligator River has been designated as an Outstanding Resource Water and is considered to be fully supporting its uses. DWQ will continue to monitor this river to detect any changes in water quality that would need to be addressed. Reference section 6.5.2 for management strategies applied to ORWs.

6.4.3 Perquimans River, Little River and Tributaries (Subbasin 52)

Overview

This subbasin consists of the Perquimans and Little Rivers (including tributaries) and a portion of the Albemarle Sound where these rivers empty into it. It also includes the smaller Yeopim River and its tributaries.

Issues and Recommended Management Strategies

Little River
Both the freshwater and estuarine portions of the Little River have been rated as partially supporting (impaired) due to depressed dissolved oxygen. Other portions of the river are rated support-threatened and supporting. Swamp conditions combined with runoff from agricultural activities, including animal operations, are thought to be contributing to the impairment. This river is on the priority target list for attention by the NPS team. The team will consider this area for targeting of their efforts.

Perquimans River
The Perquimans River is a large, slow-moving system that has experienced a slight decrease in aquatic diversity between 1990 and 1995 (possibly indicating a decline in water quality), although its Good-Fair biological rating did not change. This rating has resulted in a use support designation of support-threatened for the freshwater portion of the river. Regional Office staff have indicated that duckweed can be a problem in this river. DWQ will continue to monitor this river for any further changes in water quality.

Yeopim River
A portion of the Yeopim River is considered support-threatened. Regional Office staff have indicated that fish kills have occurred in the river and there is a significant amount of agriculture in the watershed.

The only creek in the whole Pasquotank River basin that has received a use support designation of not-supporting is Burnt Mill Creek which drains to the Yeopim River. Benthic macroinvertebrate and fish community data show evidence of severe water quality impairment in this creek. Contributors to this impairment are thought to be agriculture and animal operations. The NPS team should make this area a high priority for the targeting of its efforts due to the severity of impairment. DWQ will continue to monitor conditions in the creek for any improvements that may result from new regulations requiring the permitting of animal operations (which may be contributing to the impairment).

6.4.4 Scuppernong River and Tributaries, and Lake Phelps (Subbasin 53)

Overview

This subbasin includes the Scuppernong River drainage, Kendrick Creek, the portion of the Albemarle Sound into which those waters drain, and Lake Phelps.

Issues and Recommended Management Strategies

Scuppernong River
The upper Scuppernong River is considered partially-supporting its uses (indicating impairment). This river is thought to be impacted by agriculture and animal operations. This river is a priority water body for nonpoint source concerns, and the NPS team will consider targeting their efforts to this area. This river also receives wastewater from the Creswell treatment plant which may also be contributing to the impairment.

Kendrick Creek
Kendrick Creek and one of its tributaries, Main Canal, are impaired (partially supporting their uses). Agriculture and animal operations are thought to be causing the problems with water quality. This creek is a priority water body for nonpoint source concerns, and the NPS team will consider targeting their efforts to this area.

Lake Phelps
Lake Phelps is an oligotrophic Carolina Bay lake that is considered to be fully supporting its uses. As discussed in Chapter 3, this lake is currently covered by a limited fish consumption advisory for mercury. The source of the mercury contamination in fish tissue is not yet well understood. However, Lake Phelps (along with Lake Waccamaw in the Lumber River Basin) is currently the subject of an intensive study by the Division of Air Quality to characterize mercury contributions from atmospheric sources. The lake has been nominated for consideration for designation as Outstanding Resource Waters (ORW) because of its high water quality and unique natural resources. Because the criteria for qualification as an ORW are very rigorous (see Appendix I for ORW language) and including the requirement that there be "no significant impacts from pollution", it is necessary for the mercury issue to be better understood before a determination on the ORW nomination can be made.

6.4.5 Currituck Sound and the North River (Subbasin 54)

Overview

This subbasin encompasses Currituck Sound and its tributaries, as well as the North River which flows into the eastern Albemarle Sound. The North River is fully supporting its uses.

Issues and Recommended Management Strategies

Currituck Sound
Currituck Sound is a unique ecosystem that experiences a variety of water quality influences. Part of the sound is considered support-threatened due to the occurrence of mild algal blooms (described in Chapter 4). The remainder of the sound is fully supporting its uses. DWQ will continue to monitor the character, frequency and duration of the blooms to determine whether or not they are becoming more severe. The NPS team should consider any actions that could be taken to reduce the amount of nutrients entering the sound.

Currituck has also experienced significant fluctuations in salinity due to hydrological modifications made to the overall system. The fluctuations have influenced important natural resources in the sound including bass populations and the extent and type of submerged rooted vegetation in the area. Controlling or reducing salinity inputs to Currituck Sound is a difficult proposition. At present, several potential sources of salt intrusion into the sound have been identified, but knowledge of the overall significance of each source and how they interact in the sound's cumulative salinity balance is limited. For instance, a recent U.S. Geological Survey (Bales and Skrobialowski, 1994) indicated that up to 30,000-40,000 tons of salt per year may be transported south into Currituck Sound via Canal Number Two, but it is not currently known whether or not that contribution is significant to the entire system. Another USGS-DWR study is currently underway with the objective of quantifying major fluxes of salt and water in and out of the sound (Bales, 1996). DWQ concurs with the need for this study. A better understanding of the salt and flow balance in Currituck Sound may lead to future efforts to change or effectively manage salinity levels.

Future Growth
The barrier island adjacent to Currituck Sound is likely to experience high growth rates in the future. The NC Department of Transportation (DOT) is proposing to build a bridge across the sound (NC DOT, 1996) to provide access from the northern mainland to the northern Outer Banks. Other plans for road improvements are in place to achieve this goal as well. A comprehensive Environmental Impact Statement (EIS) that considers the secondary and cumulative impacts of the new bridge project should become available in 1997 (NC DOT, personal communication, 1996).

Local governments should begin planning for this now in order to protect natural resources and accommodate economic development at the same time. Section 6.2.1 of this Chapter summarizes the main points of a document entitled *Blueprint to Protect Coastal Water Quality: A Guide to Successful Growth Management in the Coastal Region of North Carolina* (Center For Watershed Protection, 1995). Copies of this document are available from DWQ upon request (919/733-5083, ext. 573). Local planning will be critical to minimizing negative environmental impacts from coastal growth in this region.

6.4.6 Northeastern Pamlico Sound (Subbasin 55)

Overview

This subbasin contains waters of the Pamlico Sound adjacent to Cape Hatteras National Seashore.

Issues and Recommended Management Strategies

<u>Pamlico Sound</u>
Water quality in the open water area is high and the entire area is classified for shellfishing. However, there are small pockets adjacent to land areas that have been closed to harvesting (Stumpy Point Bay, Hatteras, Outer Banks) due to unacceptably high coliform bacteria levels believed to be coming from urban runoff, septic tanks and marinas. Many of these closures are also "automatic" closures that area applied around marinas and wastewater treatment plant outfalls to protect the public from possible fecal coliform contamination from these activities. Because these areas are classified for shellfish harvesting, and harvest is prohibited in these areas, they are considered impaired. Because most of the closures are automatic, and the larger water body of the Pamlico Sound remains open to shellfish, these waters are not a high priority for attention at this time.

6.4.7 Roanoke Sound and Small Portions of Albemarle and Currituck Sounds (Subbasin 56)

Overview

This small subbasin includes primarily the Roanoke Sound and that portion of the Outer Banks that contains Nags Head, Kill Devil Hills and Kitty Hawk.

Issues and Recommended Management Strategies

Roanoke Sound is classified for shellfishing, and a small portion of it is closed to harvesting due to elevated fecal coliform bacteria levels. Therefore, these waters are considered impaired (partially supporting their uses). The primary contributors to impairment appear to be urban runoff, septic systems, marinas and wastewater treatment plants. The NPS team should consider any closed areas not related to automatic closures (waters near marinas or wastewater treatment plant outfall) and that have a significant shellfish resource as a priority for their efforts. Two discharges that were both permitted in the early 1980's have been required to meet stringent permit limits and also must examine the feasibility of removing their discharge to the waters at every permit renewal (which occurs at five year intervals).

Growth in this subbasin has been dramatic (see Chapter 2). Local governments should consider the tools presented in section 6.2.1 of this Chapter from the *Blueprint to Protect Coastal Water Quality: A Guide to Successful Growth Management in the Coastal Region of North Carolina* (Center For Watershed Protection, 1995). Copies of this document are available from DWQ upon request. Local planning will be critical to minimizing impacts from continued coastal growth in this region.

6.5 IDENTIFICATION AND PROTECTION OF HIGHLY VALUED RESOURCE WATERS

6.5.1 Overview of High Quality and Outstanding Resource Waters as well as Special Classifications and Habitats

Waters considered to be biologically sensitive or of high resource value may be given protection through reclassification to HQW (high quality waters), ORW (outstanding resource waters), Tr (trout) or WS (water supply), or they may be protected through more stringent NPDES permit conditions. Waters eligible for reclassification to HQW or ORW may include primary nursery areas designated by the Division of Marine Fisheries, designated critical habitat for threatened or endangered species (as designated by the NC Wildlife Resources Commission), waters having excellent water quality or those classified 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. Refer to Chapter 2 and Appendix I for more information on classifications and standards.

The Pasquotank River Basin includes one ORW (the Alligator River area) and two HQWs (Scarboro and Doughs Creeks - tributaries to Shallowbag Bay). The HQWs received this protective classification due to their designation as primary nursery areas by the DMF.

There are several waterbodies in the Pasquotank River basin that are currently under consideration for either HQW or ORW classification. These are presented below in Table 6.8.

Table 6.8. Potential ORW and HQW Reclassifications in the Pasquotank River Basin.

Waterbody	County	From Class	To Class
Broad Creek	Camden	SC	SC HQW
Deep Creek	Currituck	SC	SC HQW
East Lake	Dare	SC Sw	SC Sw HQW
Jean Guite Creek	Dare	SC	SC HQW
Little Alligator River	Tyrrell	SC Sw	SC Sw HQW
Lutz Creek	Currituck	SC	SC HQW
Phelps Lake	Washington	C Sw	C Sw ORW
Tull Creek and Bay	Currituck	B Sw, C Sw	B Sw HQW, C Sw HQW

All but one of the waters listed above are being considered for HQW designation because they have been designated as inland primary nursery areas by the Wildlife Resources Commission. Phelps Lake is being considered for ORW designation as a result of a reclassification request received from the Division of Parks and Recreation.

There are ten species listed by the NC Natural Heritage Program as Special Concern, Significantly Rare, Threatened or Endangered in the Pasquotank River basin. These species are given special protection status by the North Carolina Wildlife Resources Commission and/or the North Carolina State Endangered Species Act (G.S. 113-331 to 113-337). The species and the status of each can be found in Section 2.5.

Where waters are known to support state or federally listed endangered or threatened species or species of concern, consideration will be given during the NPDES permitting process to minimize wastewater discharge impacts to habitat areas consistent with the requirements of the federal Endangered Species Act and North Carolina's endangered species statutes. Possible protection measures may include but are not limited to dechlorination or alternative disinfection, tertiary or advanced tertiary treatment, outfall relocation, and backup power provisions to minimize accidental plant spills. 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.

6.5.2 Strategies for Controlling Discharges to High Quality Waters (HQWs) and Outstanding Resource Waters (ORWs)

High Quality Waters (HQWs)

As mentioned above, two streams in the Pasquotank River basin are classified as high quality waters. For HQWs, a distinct set of management strategies applies to wastes discharged from a facility. New discharges and expanding discharges that have an increase in pollutant load to HQW streams are subject to the following management strategies adopted by DWQ pursuant to 15A NCAC 2B.0224 (1) and 15A NCAC 2B .0224 (1)(b)(vii):

- Discharges from new single family residences will be prohibited. Those that must discharge must install a septic tank, dual or recirculating sand filters, disinfection and step aeration. (15A NCAC 2B.0224 (1)(a)).

- All new or expanded wastewater discharges (except single family residences) will be required to meet effluent limitations for oxygen consuming wastes as follows: BOD_5 = 5 mg/l, NH_3-N = 2 mg/l, and DO = 6 mg/l. More stringent limitations will be set, if necessary, to ensure that the cumulative pollutant discharge of oxygen consuming wastes will not cause the DO of the receiving water to drop more that 0.5 mg/l below background levels, and in no case below the standard. Where background information is not readily available, evaluations will assume a percent saturation determined by staff to be generally applicable to that hydroenvironment. (15A NCAC 2B .0224 (1)(b)(i)).

- Emergency Requirements: Failsafe treatment designs will be employed (except single family residences), including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs. (15A NCAC 2B .0224 (1)(b)(iv).

- Volume: The total volume of treated wastewater for all discharges combined will not exceed 50 percent of the total instream flow under 7Q10 conditions. (15A NCAC 2B 0.224 (1)(b)(v)).

- Toxics: In cases where complex wastes (those containing or potentially containing toxicants) may be present in a discharge, a safety factor will be applied to any chemical or whole effluent toxicity allocation. The limit for a specific chemical constituent will be allocated at one half of the normal standard at design conditions. Whole effluent toxicity will be allocated to protect for chronic toxicity at an effluent concentration equal to twice that which is acceptable under design conditions. In all instances there may be no acute toxicity in an effluent concentration or 90 percent. Ammonia toxicity shall be evaluated according to EPA guidelines promulgated in "Ambient Water Quality Criteria for Ammonia - 1984"; EPA document number 440/5-85-001; NTIS number PB85-227114; July 29, 1985 (50 FR 30784).

- North Carolina does not have a numeric water quality standard for suspended solids. 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.

Outstanding Resource Waters (ORWs)

The Alligator River area is a large ORW in the Pasquotank River Basin. The only type of new or expanded NPDES permitted discharges that are allowed are non-domestic, non-process industrial discharges in accordance with 15 NCAC 2B .0225 (e)(6) (see Appendix I).

6.5.3 Other Controls to Protect ORWs in Coastal Areas

All saltwater ORWs are protected by the following restrictions described in 15 NCAC 2B .0225 (c)(2):

- New development must comply with stormwater provisions for saltwater ORWs described in 15A NCAC 2H .1007. This rule requires low density development within 575 feet of the mean high water line of the designated ORW.
- New non-discharge (land application) permits must meet reduced loading rates and increased buffer zones, as determined on a case-by-case basis.
- No dredge or fill activities are allowed in areas where significant shellfish or submerged rooted vegetation exist, except for maintenance dredging.
- A public hearing is mandatory for any proposed permits to discharge to classified ORW waters.

6.6 GENERAL MANAGEMENT STRATEGIES FOR PROTECTING WATER QUALITY IN THE BASIN

6.6.1 Management Strategies for Controlling Nonpoint Source Pollution from Agriculture

Agricultural nonpoint source (NPS) pollution is reported as the leading probable source of water quality impacts to surveyed rivers and lakes, the third largest probable source of impairments to surveyed estuaries. And it is also a major contributor to ground water contamination and wetlands degradation.

Agricultural activities that may cause NPS pollution include confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilizing, planting and harvesting. The major agricultural NPS pollutants that result from these activities are sediment, nutrients, pathogens, pesticide, and salts. Agricultural activities also can damage habitat and stream channels. Agricultural impacts on surface and groundwater can be minimized by properly managing activities the can cause NPS pollution. The following table is a list of recommendations for state and federal agencies and farmers.

Table 6.9. Recommended Actions to Address NPS Pollution from Agriculture

State and Federal Agencies	Enforce all existing regulation. Target funds to control agricultural NPS pollution. State and federal agencies should target funds for the application of BMPs toward areas where it is most need and where it would be most effective. Promote agricultural best management practices (BMPs). State and federal agencies should increase programs which provide cost-share, technical assistance, and economic incentives to implement agricultural BMPs. Generate more "on-the-ground" water quality improvement demonstration projects. These projects will help to generate enthusiasm for more cooperative effects between farmers and various agencies. Create education programs. These programs increase farmers awareness of water quality impact of agricultural NPS pollution. And the programs also provide farmers a set of tool to control agricultural NPS pollution. Topics can include environmentally sound BMPs for agriculture and numerous field days for local and regional interests.
Farmers	Participate in the NPS team process. The NPS team process will provide a good opportunity to influence state policy in basinwide planning. The NPS team will describe current water quality initiatives, identify priority NPS-impaired waterbodies and implement solutions addressing these waterbodies. Participate in North Carolina Agricultural Cost Share program. The North Carolina Agricultural Cost Share program provides technical assistance and cost sharing to landowners in implementing BMPs. Practice a number of cost effective agricultural BMPs through the basin.

References/Resources:

Nonpoint Source Planning Group of the Division of Water Quality at (919)733-5083

6.6.2 Management Strategies For Urban and Industrial Stormwater Control

Recommendations for Controlling Industrial Stormwater

Throughout the Pasquotank River basin various types of industrial activities with point source discharges of stormwater are required to be permitted under the NPDES stormwater program. These include facilities engaged in: construction; mining/borrow pits; metal waste recycling and manufacture of metal products and equipment; manufacture of timber products; apparel, printing, paper, leather, and rubber products manufacturing; vehicle maintenance, transportation, and postal service activities, public warehousing and petroleum bulk stations and terminals; used automobile parts and scrap yards; ready mixed concrete production; manufacture of asphalt paving mixtures and blocks; production of textile mill products; ship and boat building/repairing and marinas.

Surface waters can be significantly impacted by stormwater runoff from industrial facilities, particularly those that store or transfer materials out of doors. The types of chemicals, industrial operations and various ancillary sources influence the pollution potential of each individual facility. As such, industrial facilities can reduce stormwater impacts by developing a comprehensive site-specific Stormwater Pollution Prevention Plan (SPPP or Plan) which is based on an accurate understanding of the pollution potential of the site. The Plan provides a flexible basis for developing site-specific measures to minimize and control the amounts of pollutants in stormwater runoff by implementing best management practices (BMPs). With respect to stormwater, the ultimate BMP is the elimination of exposure of any significant materials to rainfall or runoff.

Facilities subject to NPDES stormwater permitting are required to develop and implement a SPPP. The SPPP approach focuses on two major objectives: 1) to identify sources of pollution potentially affecting the quality of stormwater discharges from the facility; and 2) to describe and ensure that practices are implemented to minimize and control pollutants in stormwater discharges from the facility. The basic components of a SPPP include a site plan detailing the facility layout and locations of potential pollutant sources, a stormwater management plan describing materials management practices and feasibility of employing best management practices, a spill prevention and response plan, a preventive maintenance and housekeeping plan, annual employee training and semi-annual facility inspections. The facility SPPP must be periodically reviewed and updated to reflect changes at the facility.

In addition to the SPPP, all permitted facilities are required to perform qualitative monitoring. This monitoring requires the periodic visual inspection of each stormwater outfall. Inspections are performed for parameters including color, odor, clarity, floating and suspended solids, foam, oil sheen, and other obvious indicators of stormwater pollution. Facilities with significant stormwater pollution potential are also required to perform quantitative analytical monitoring.

Recommendations for Urban Stormwater Control

Urban stormwater runoff can be a significant contributor to water quality problems. In the Pasquotank River basin, urban development is relatively limited at present. As land is converted to impervious surfaces with construction of housing developments and commercial areas, careful attention to stormwater control will be more important. Stormwater problems are likely to be centered around the urban areas in the basin. There are no municipalities in the Pasquotank River Basin required to obtain NPDES permits to manage stormwater runoff within their jurisdiction. Stormwater permits are required for any development activities requiring a Sedimentation and Erosion Control Plan or a CAMA major permit in the 20 coastal counties.

The best time to address urban stormwater impacts are when it is most effective and least costly to do so -- before development occurs. Numerous studies have demonstrated a serious decline in the health of receiving waters when 10 to 15 percent of a watershed is turned into impervious surfaces (Schueler 1995).

The entire community plays a role in controlling the quality and quantity of urban stormwater. Table 6.10 is a list of recommendations for local governments, citizens, businesses, developers, and state agencies.

Table 6.10. Recommendations for Urban Stormwater Control

Local governments	Create public education programs. These programs advise citizens about how to care for their homes, businesses, and neighborhoods while minimizing stormwater pollution. Topics that can be covered include environmentally sensitive methods of caring for lawns and vehicles (see Table 6.11). Support stream clean-up programs. Clean-up programs such as Big Sweep remove harmful debris from streams and instill a sense of pride that will protect the waterbody in the long-term. Create and enforce strict penalties for improper waste disposal. In addition, local governments should protect dumpsters by fencing around them and cleaning them regularly. Institute land use planning to protect water quality. Through planning, local governments can reduce flooding by limiting the total area of impervious surfaces and directing runoff into vegetated areas or stormwater control devices. In addition, planning can be used to protect surface waters by directing growth away from sensitive areas/waters such as floodplains, steep slopes, wetlands, high quality waters, and water supplies. Review local ordinances pertaining to parking and curb and gutter. Local ordinances often require larger parking lots than are needed. Parking lots should be designed to handle the average parking needs with overflow areas in grass. When possible, it is best to eliminate curbs and gutters to allow runoff to flow off the street or parking lot in sheet flow. Protect open spaces and streamside buffers in and around urban areas. This will preserve recreational areas and significant natural resources near the town or city. Attend stormwater workshops for local government officials. Various agencies like DWQ offer workshops on stormwater management or reference materials. For more information, contact the DWQ stormwater group at (919)733-5083. Map the storm sewer system. If local governments map the inlets, pipes, and outlets that make up their storm drain system, they will be well equipped to identify the source of any observed stormwater problems. Offer hazardous waste collection days.
Citizens	Participate in stream clean-up programs. Clean-up programs remove harmful debris from streams and instill a sense of pride that will protect the waterbody in the long-term. An annual Big Sweep event is held each year in September. Stream clean-up is a great service activity for groups such as Scouts, 4-H, Rotary Clubs, etc. Practice environmentally-friendly lawn care. Table 6.11 has a list of suggestions for keeping a green lawn while minimizing harm to the environment. When possible, use less-harmful substances in the home for cleaning or painting. Any time hazardous substances are used, there is a risk that they can enter the water by interfering with the proper functioning of septic tanks, leaking out of sanitary sewers, etc. When possible, use less hazardous substances such as latex instead of oil paint (see Table 6.11). Educate adults and children about how to protect water quality. Educational materials can be obtained from the NC Office of Environmental Education, (919)733-0711. Utilize hazardous waste collection centers for paints, petroleum products, and other chemicals. Never dispose of oil, yard wastes, or other materials in storm drain inlets or dump these materials on lands. Storm drains connect directly to nearby streams without any treatment of the water. Maintain and protect riparian buffers on private property. Buffers provide a critical right of way for streams during storms. When buffers contain the 100-year floodplain, they are an extremely cost-effective form of flood insurance. Buffers remove a wide array of pollutants, including sediment, nutrients, and toxic substances. They can also increase property value. Support your local government's land use planning initiatives.
Developers	Incorporate stormwater management in the planning of projects. Plan developments to reduce impervious areas (roads, driveways, and roofs). Do not build in environmentally sensitive areas such as floodplains and wetlands. (This is also a flood insurance policy.) Maintain natural drainageways and buffers along streams.

Table 6.10 continued:

Businesses	Maintain and protect riparian buffers on commercial property. Buffers provide a critical right of way for streams during storms. When buffers contain the 100-year floodplain, they are an extremely cost-effective form of flood insurance. Buffers remove sediment, nutrients, and toxic substances. Cover and contain waste materials. This will prevent runoff from the disposal area from becoming contaminated and polluting the receiving water. Practice good housekeeping. A clean and litter-free facility will promote good water quality. Institute hazardous waste collection sites. Automobile service centers, hardware stores, and other pertinent businesses can institute hazardous waste collection sites for used oil, antifreeze, paint, and solvents.
State and Federal Agencies	Provide technical information about urban stormwater. State and federal agencies should strive to increase their communication with local governments, businesses, and citizens. Create and maintain stormwater wetlands along streams. Like buffers, stormwater wetlands treat stormwater and reduce flows. Stormwater wetlands must be designed and maintained properly to be effective.

Table 6.11. How to Take Care of Your Lawn and Car and Protect Water Quality

If you are caring for...	This is the environmentally-friendly practice.
your lawn	• Use only fertilizers that are needed, based on soil tests and plant needs. • Keep fertilizers off driveways and sidewalks. • Avoid using fertilizers within 75 feet of any waterbody. • If you use a lawn service, request natural rather than chemical management. • Plant hardy, native species that do not require chemical inputs. • Contact your Cooperative Extension Agent for more information.
your vehicle	• Maintain motor vehicles and repair leaks promptly. • Dispose of used motor oil and antifreeze in recycling centers. • Avoid gas tank overflows during refueling.

from S.C. Dept. of Health and Environmental Control, "Turning the Tide" (1995)

Table 6.12. Substitutions for Household Hazardous Substances

Instead of...	Try...
• Ammonia-based Cleaners	• Vinegar + Salt + Water
• Abrasive Cleaners	• Lemon Dipped in Borax or Salt + Baking Soda
• Furniture Polish	• Lemon Juice + Olive Oil
• Toilet Cleaner	• Baking Soda + Toilet Brush
• Oven Cleaner	• Liquid Soap + Borax + Warm Water
• Drain Cleaners	• Boiling Water + Baking Soda + Vinegar
• Upholstery Cleaners	• Dry Cornstarch
• Mothballs	• Cedar Chips or Lavender Flowers
• Window Cleaner	• White Vinegar + Water
• Oil-Based Paints and Stains	• Water-based Paints and Stains

from S.C. Dept. of Health and Environmental Control, "Turning the Tide" (1995)

<u>References/Resources for Urban Stormwater</u>:

- *Stormwater Management Guidance Manual*, 1993, Cooperative Extension Service
- *Stormwater Management in North Carolina: A Guide for Local Officials*, 1994, Land-of-Sky Regional Council, Asheville, NC (Eaker 1994)
- Stormwater Fact Sheets by Land-of-Sky Regional Council, 1994
  1. *Stormwater Problems and Impacts: Why all the Fuss?*
  2. *Stormwater Control Principles and Practices*
  3. *Stormwater Management Roles and Regulations*
  4. *Local Stormwater Program Elements and Funding Alternatives*
  5. *Municipal Pollution Prevention*
  6. *Managing Stormwater in Small Communities: How to Get Started*
  7. *Maintaining Wet Detention Ponds*
  8. *Plan Early for Stormwater in Your New Development*
  9. *How Citizens Can Help Control Stormwater Pollution*
- *Stormwater Best Management Practices*, 1995, NC Division of Environmental Management.
- US. EPA. 1993. Guidance Specifying Managment Measures for Sources of Nonpoint Source Pollution in the Coastal Waters. Pub. No. 840-B-92-002, Office of Water, Washington, DC.
- Asheville Regional Office of DWQ, Stormwater Group: (704)251-6208.

6.6.3 Management Strategies for Controlling 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 on the state's waterways. Point source controls are typically NPDES permit limitations on total phosphorous (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.

In the Pasquotank River basin nutrient enrichment has been implicated as a potential source of water quality degradation in Currituck Sound and in some of the rivers feeding the Albemarle Sound. These situations will continue to be monitored and the NPS team will be considering areas to target their efforts which may include actions to prevent nutrient loads to surface waters.

6.6.4 Management Strategies for Controlling Fecal Coliform Bacteria

Fecal coliform bacteria are typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of disease-causing bacteria and viruses. They enter surface waters from a number of sources including failing onsite wastewater systems, broken sewer lines, improperly treated discharges of domestic wastewater, pump station overflows, straight piping and runoff carrying livestock and wildlife wastes. In coastal areas, the Division of Environmental Health (DEH) uses fecal coliform concentrations to determine whether or not consumption of shellfish by humans is safe. Levels that exceed the 14 coliforms/100 milliliters result in the prohibition of shellfish harvesting. DEH's program is described further in Chapter 3.

In the Pasquotank River basin there are some classified shellfishing waters where harvesting has been prohibited by DEH. Their closure status has resulted in a use support rating of partially supporting. These waters are therefore considered impaired. Activities contributing to the problem include urban runoff, septic tanks and marinas.

Several general management strategies for addressing fecal coliform contamination include:

- Proper maintenance and annual inspections of onsite waste disposal systems such as septic tanks.
- Maintenance and repair of sanitary sewer lines by WWTP authorities.
- Maintenance and establishment of riparian vegetative buffers.
- Maintenance of natural drainage patterns to maximize filtration and minimize runoff.
- Elimination of direct unpermitted discharges of domestic waste (also known as "straight piping").
- Proper management of livestock to keep wastes from reaching surface waters.
- Encouragement of local health departments to routinely monitor waters known to be used for body contact recreation (e.g., swimming).

The 1996 General Assembly established a program designed to eliminate domestic sewage or wastewater discharges from both direct (straight pipe) and from overland flow of failing septic systems. The focus of the program contains three components:

1) the identification and elimination of domestic sewage discharges into streams proposed or currently used for public water supplies,
2) an amnesty period to end December 31, 1997 during which time violations for identification of domestic dischargers will not be incurred, and
3) a public education program about the amnesty period will be implemented. The majority of the funds allocated to this program are recurring funds.

Septic tanks are used widely throughout this basin, particularly since many citizens live outside of the service area of a regional wastewater treatment plant. Unfortunately, many citizens are not aware of how to care for their septic tanks. Some of the actions that homeowners, local governments, and state and federal agencies can take to reduce pollution from septic tanks are listed in Table 6.13.

Table 6.13. Recommended Actions for Proper Maintenance of Septic Tanks

Homeowners	Do not put harmful substances in your septic tank. These substances include: cooking grease, oils, fats, pesticides, paints, solvents, disinfectants, and other household chemicals. These substances can kill the microorganisms that help purify the groundwater and can themselves pollute groundwater. Know the location of your system and keep heavy vehicles and plant roots away from drain field pipes. These things can compact soils and inhibit the proper functioning of the system. Conserve water and stagger intensive uses. Some intensive water uses include showers, laundry, dishwasher, etc. Look for ways to reduce (e.g.., full loads) and to not use all at once. Have the septic system inspected annually and pumped out every three to five years. This is a small price to pay to ensure that your household has functioning wastewater treatment. Look for "greener grass over the septic tank." This could be a sign that the septic tank is failing. Divert overland runoff from your property away from the drainfield area. This will reduce the likelihood of saturating the soil and causing malfunctions.
County Health Departments	Require regular inspections of septic systems. Enforce severe penalties for uncorrected septic system malfunctions. Ensure that citizens understand how to maintain their septic tank when they first obtain property in the county. Pursue legislation to mandate inspections.
NC Div. of Environmental Health	Provide leadership to county health offices. Encourage county health offices to require regular inspections. Provide public education materials.

6.6.5 Management Strategies For Controlling Toxic Substances

Toxic substances, or toxicants, routinely regulated by DWQ include metals, organics, chlorine, and ammonia, as described in Chapter 3.

The waters of the Pasquotank River basin need to be protected from immediate acute effects and the residual chronic effects of toxic substances. Toxic limitations for point source discharges are based on the volume of the effluent released and the 7Q10 flow condition of the receiving stream. Six (6) facilities in the Pasquotank basin are required to monitor whole effluent toxicity by their NPDES permit. Other facilities may be tested by DWQ's Aquatic Toxicology Laboratory.

There are two fish consumption advisories in the Pasquotank River Basin. One is for dioxin in the western Albemarle Sound. This advisory is related to industrial inputs of dioxin into the Roanoke and Chowan rivers. All contributing facilities have eliminated dioxin from their discharge and levels of the contaminant in fish tissue are being monitored until they fall consistently below FDA and EPA standards and the consumption advisory can be lifted.

Phelps Lake is under a fish consumption advisory for mercury. The source of contamination has been difficult to determine. It is suspected that atmospheric deposition of mercury may be the source, and the NC Division of Air Quality is currently conducting an intensive study at the lake to determine the legitimacy of this suspicion. Until a better understanding of the route of contamination is developed, specific recommended management strategies to reduce or eliminate the input cannot be made. It should be noted that mercury contamination is widespread along the Atlantic Seaboard from Maine to Florida.

Refer to Section 6.4 for further strategies used to protect Highly Valued Resource Waters, such as HQWs and ORWs, in the basin.

6.6.6 Management Strategies For Oxygen-Consuming Wastes

Maintenance of dissolved oxygen (DO) is critical to the survival of aquatic life and to the general health of surface waters. The daily average dissolved oxygen standard for most waters in the state, except for waters classified as trout and swamp waters is 5.0 mg/l. Many waters in the Pasquotank Basin have the supplemental swamp classification which allows for DO level below 5.0 mg/l due to natural conditions. Ambient data indicates that there are areas experiencing low DO levels and acidic pH values indicative of swamp conditions.

Biochemical oxygen demand (BOD) and ammonia nitrogen (NH_3-N) associated with wastewater treatment plants are generally the types of oxygen-consuming wastes of greatest concern. During summertime conditions, when temperature is high and stream flow is low, point source BOD and NH_3-N have the greatest impact on instream dissolved oxygen concentrations. NPDES permits for wastewater facilities generally limit BOD_5 (or $CBOD_5$) and NH_3-N in point source discharge effluents to ensure protection of the DO standard during warm, low flow conditions. Under these conditions, nonpoint source pollution input, which typically occurs as a result of rainfall events, has a minor impact.

Where residual BOD is significant, management of nonpoint sources to reduce loading is recommended by implementation of best management practices. Additionally, constructed wetlands can be strategically engineered and positioned in the landscape to reduce the input of oxygen demanding wastes. Constructed wetland treatment systems can remove between 50% and 90% of the BOD_5 from primary effluent (Bastian and Benforado 1988).

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

<u>**Discharges to Low Flow Streams**</u>
Many low flow streams exist across the state. In 1980 studies were performed on zero flow streams (7Q10 and 30Q2 = 0 cfs) to determine the effect of wastewater discharges to these waterbodies. The studies concluded that:

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

As a result of the study, regulations were developed that prohibit new or expanded discharges of oxygen-consuming wastes to zero flow streams. Existing facilities discharging to zero flow streams were evaluated for alternatives to discharge. Many facilities found alternatives to a surface water discharge and some facilities built new treatment plants to meet advanced tertiary limits for

BOD_5 and NH_3-N. Facilities that currently discharge to a zero flow stream but which have not yet been evaluated will receive the following language in their NPDES permit:

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

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

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

Discharges to Swamp Waters

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

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

Until these studies are completed, new discharges will not be permitted at limits less stringent than 15 mg/l BOD_5 and 4 mg/l NH_3-N. More stringent limits may be needed on a case-by-case basis if existing data or conditions suggest that adverse impacts are occurring. Existing facilities will receive current permit limits unless they expand or site specific information is available which indicates more stringent limits are needed. Upon expansion, they will receive existing loading (mass basis).

6.6.7 Management Strategies For Controlling Sedimentation

Sedimentation is a widespread nonpoint source-related water quality problem that results from land-disturbing activities. The most significant of these activities include agriculture and land development (e.g., highways, shopping centers, and residential subdivisions). For each of these major types of land-disturbing activities, there are programs being implemented by various government agencies at the state, federal and/or local level to minimize soil loss and protect water quality. Some of these programs are listed in Table 6.14 and are briefly described in Appendix VI.

Table 6.14. State and Federal Sediment Control-Related Programs

Agricultural Nonpoint Source (NPS) Control Programs	North Carolina Agriculture Cost Share Program NC Cooperative Extension Service and Agricultural Research Service Watershed Protection and Flood Prevention Program (PL 83-566) Food Security Act of 1985 (FSA) and the Food, Agriculture, Conservation and Trade Act of 1990 (FACTA). (Includes Conservation Reserve Program, Conservation Compliance, Sodbuster, Swampbuster, Conservation Easement, Wetland Reserve and Water Quality Incentive Program)
Construction, Urban and Developed Lands	Sediment Pollution Control Act Federal Urban Stormwater Discharge Program Water Supply Protection Program ORW and HQW Stream Classification
Forestry NPS Programs	Forest Practice Guidelines National Forest Management Act Forest Stewardship Program
Mining	The Mining Act of 1971
Wetlands Regulatory NPS Programs	Section 10 of the Rivers and Harbors Act of 1899 Section 404 of the Clean Water Act Section 401 of the Water Quality Certification (from CWA) North Carolina Dredge and Fill Act (1969)

Construction activities, private access roads, and state road construction are discussed below. These sources are discussed separately below. Golf courses, urban stormwater, and agriculture are other potential sources of sediment that are discussed in separate sections.

<u>Construction Activities</u>

Construction activities can dramatically increase the sediment delivered to streams. Construction activities can be especially harmful in the mountains where slopes are steep and rainfall is frequent.

Construction activities are controlled under the Sedimentation and Erosion Control Act administered by the NC Division of Land Resources (DLR). This act requires anyone disturbing more than one acre of land to submit a Sedimentation and Erosion Control Plan to DLR. One of the major requirements is that there are adequate erosion control measures to retain all sediment on a development site during the 25-year storm. Generally, a land owner must install acceptable Best Management Practices (BMPs) when the land is disturbed by construction or development activities. Management practices may include barriers, filters, or sediment traps to reduce the amount of sediment that leaves a site. Under this act, local governments may take responsibility for reviewing and enforcing the Sedimentation and Erosion Control Program within their jurisdiction; however, their program must be at least as stringent as DLR's.

Development pressure in the Pasquotank River basin will continue to be strong. In order to match the pace of land disturbing activity, more staff hours will be needed within the DLR in order to effectively administer and fully enforce the provisions of the Act. At present, planning and inspection staff are stretched thinly across large geographic areas and a wide variety of projects. Careful planning prior to construction, perhaps the most important part of erosion control, may often be neglected due to lack of available staff time.

The responsibility for controlling sediment from construction activities falls on many shoulders. The parties with the greatest responsibility include: homeowners, developers/contractors, local governments, and the NC Division of Land Resources. Table 6.15 presents actions that will help to address sediment problems associated with construction activities.

No sediment control measures are 100% effective so some level of sedimentation will occur with land-disturbing activities. Education and promotion of stewardship are keys to reducing sedimentation, along with judicious strengthening of regulations and enforcement.

State Road Construction

Like any impervious surface, roadway systems have the potential to generate stormwater runoff problems. Various types of pollutants from the road surface can be carried to surface waters by rainfall. In addition, roadway construction, roadside vegetation management and roadway operation and maintenance activities can contribute to stormwater pollution problems.

The Division of Water Quality is currently working with the NC Department of Transportation (DOT) to finalize a stormwater management permit for DOT activities. This permit will address pollution from stormwater runoff related to roadways, road construction, vegetation management, operation and maintenance and other related DOT activities throughout the state. The major permit requirements are the implementation of a comprehensive stormwater management program, monitoring programs to direct the stormwater program and annual reports to outline the effectiveness and direction of the program.

The initial emphasis of the stormwater programs will be on high volume roadway segments in sensitive water areas such as coastal areas and water supply watersheds. The stormwater management programs will try to locate and characterize pollutant problems and to develop and implement appropriate best management practices to protect surface waters.

DOT is responsible for its own sedimentation and erosion control program. DOT has a number of projects with effective sedimentation and erosion control in mountain areas. Table 6.16 presents recommended road construction measures.

Table 6.15 Recommended Actions to Address Construction-Related Sediment Problems

Homeowners	Fit the development to existing site conditions. When a development follows natural contours and avoids areas subject to flooding and highly erodible soils, it is much easier to control erosion and sedimentation. Establish, maintain, and protect vegetation beside streams on your property. Buffers provide a filter for sediment and other pollutants. Carefully monitor the construction process. Ensure that permanent vegetation is established and maintained on the construction site as soon as possible. Continue to control sediment after construction is complete.
Developers/ Contractors	Fit the development to existing site conditions. When a development follows natural contours and avoids areas subject to flooding and highly erodible soils, it is much easier to control erosion and sedimentation. Minimize the extent and duration of exposure. Schedule construction according to weather and season. Try to pick dry times. Protect areas to be disturbed from stormwater runoff. Use dikes, diversions, and waterways to intercept runoff and divert it away from cut-and-fill slopes or other disturbed areas. To reduce erosion, install these measures before clearing and grading. Keep runoff velocities low. Convey stormwater away from steep slopes to stabilized outlets, preserving natural vegetation when possible. Inspect and maintain control structures during the construction process. If not properly maintained, some erosion control measures can cause more damage than they correct. Retain sediment on-site. Protect low points below disturbed areas by building barriers to reduce sediment loss. When possible, plan and construct sediment traps before other land disturbing activities. Stabilize disturbed areas as soon as possible after construction. Apply mulch and vegetation to land and line channels for protection. Consider future repairs and maintenance of these measures. Train equipment operators to execute erosion and sediment control practices.
Citizens	Report any serious sediment problems on construction sites. This would include bare soil that has not been stabilized within 30 days, brown or red runoff during a storm, or obviously malfunctioning erosion/sediment controls.
Local Govts. Without Delegated Sediment/ Erosion Control Programs	Educate citizens as to the importance of erosion and sediment control before they begin construction activities. Report any serious problems on construction sites. This would include bare soil that has not been stabilized within 30 days, brown or red runoff during a storm, or obviously malfunctioning erosion/sediment controls. If your resources allow, consider taking responsibility for sediment and erosion control in your jurisdiction. This will allow greater control over implementation and enforcement of the program. It will also offer the opportunity to require sediment control on developments disturbing under one acre. Maintain publicly-owned open space. This will prevent sediment contributions from certain tracts of land.
Local Govts. With Delegated Sediment/ Erosion Control Programs	Educate citizens as to the importance of erosion and sediment control before they begin construction activities. Maintain publicly-owned open space. This will prevent sediment contributions from certain tracts of land. Evaluate the effectiveness of current sediment control enforcement. Identify staff resource needs. When possible, coordinate efforts with other agencies such as the Dept. of Transportation, Div. of Forest Resources, and Soil and Water Conservation Districts.

Table 6.15 continued:

NC Div. of Land Quality	Continue to promote effective implementation and maintenance of erosion and sediment control measures on construction sites. Research innovative new ways to control sediment on construction sites. Evaluate the effectiveness of current sediment control enforcement. Identify staff resource needs. When possible, coordinate efforts with other agencies such as the Dept. of Transportation, Div. of Forest Resources, and Soil and Water Conservation Districts. Encourage more delegated programs by local governments where resources allow, especially in rapidly developing areas.

References/Resources:

- The following can be ordered from the NC Division of Land Resources at P.O. Box 27687, Raleigh, NC 27611, (919)733-3833:
  1) *NC Erosion and Sediment Control "Planning and Design Manual"* ($55 for in-state, $75 for out-of-state)
  2) *NC Erosion and Sediment Control "Inspector's Guide"* ($20 for in-state or out-of-state)
  3) *NC Erosion and Sediment Control "Field Manual"* ($20 for in-state or out-of-state)
  4) *NC Erosion and Sediment Control "Video Modules"* ($15 for in-state, $50 for out-of-state)
- Washington Regional Office of the Division of Land Resources at (919)946-64818.

Table 6.16 Recommended State Road Construction Measures

NC Dept. of Transportation	Implement high quality sediment and erosion control. This is extremely important in areas with steep slopes. Increase training for DOT staff to ensure that sedimentation and erosion control devices are properly sized and installed. It is also important to include specific instructions for sediment and erosion control and phasing on the plans so that contractors can understand their responsibility. Inspect sedimentation and erosion control devices frequently. This is particularly important when contractors are responsible for the work. Implement pre-, during, and post-construction water quality monitoring at selected sites. This is the only way to tell for sure if sediment and erosion controls are working effectively. Reduce the threshold of exposed area when roads are constructed on steep slopes. Reduce stormwater runoff from bridges where feasible.
Citizens and Local Governments	Contact the district DOT office if you observe sediment problems at a road construction site. Some things to watch out for include: bare soil that is not mulched and/or planted within 30 days, washed-out sediment basins and filter cloths, and soil disposal sites that are placed in or directly adjacent to creeks.

References/Resources:

- D.R. Conner, District Office of DOT, (919)332-4021.

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CHAPTER 7

FUTURE INITIATIVES

7.1 OVERVIEW OF PASQUOTANK RIVER BASINWIDE GOALS AND OBJECTIVES

Near-term objectives, or those achievable at least in part during the next five years, include coordinating with various agencies to implement the control strategies outlined in Chapter 6. These strategies are aimed at reducing point and nonpoint source loadings of nutrients and other pollutants. These steps are necessary to progress towards restoring impaired waters, protecting threatened waters from further degradation, protecting waters with a high resource value and maintaining the quality of other waters currently supporting their uses.

The long-term goal of basinwide management is to protect the water quality standards and uses of the basin's surface waters while accommodating reasonable economic growth.

Attainment of these goals and objectives will require determined, widespread public support; the combined cooperation of state, local and federal agencies, agriculture, forestry, industry and development interests; and considerable financial expenditure on the parts of all involved. However, with the needed support and cooperation, DWQ believes that these goals are attainable through the basinwide water quality management approach.

7.2 FUTURE ACTIVITIES IN THE PASQUOTANK RIVER BASIN

7.2.1 Nonpoint Source Control Strategies and Priorities

Improving our knowledge of and controlling nonpoint source pollution will be a high priority over the next five years. Nonpoint source pollution is primarily responsible for the impaired and threatened waters in the Pasquotank River Basin. The following initiatives (described in Section 7.2.2, 7.2.3 and 7.2.4) are underway to address the protection of surface waters from nonpoint sources of pollution.

7.2.2 The Pasquotank River Basin Nonpoint Source (NPS) Team

In July 1996, DWQ contacted potential NPS Team Members in the Pasquotank River basin. NPS Team Members met to describe what is known about nonpoint sources in the basin and to obtain local input on issues and recommendations for addressing nonpoint source pollution. The team will work toward creating Action Plans consisting of voluntary commitments made by the various agencies to address nonpoint source pollution. A list of agencies which comprise the NPS Team is presented in Table 7.1.

The Action Plans will be evaluated and updated every five years as part of the basinwide planning process. The responsibilities of the NPS Team members can be summarized as follows.

- Describe existing programs for nonpoint source pollutant control.
- Prioritize impaired waters for development and implementation of restoration strategies.
- Prioritize NPS issues for remedial action.
- Develop five-year Action Plan for improving water quality in targeted watersheds.
- Determine what is needed to address the priority waters and NPS issues.
- Implement Action Plans.
- Monitor effectiveness of management strategies.

Table 7.1 Pasquotank River Basin NPS Team Members

Category	Agency/Group
Agriculture	NC Department of Agriculture USDA - Natural Resources Conservation Service NCSU - Cooperative Extension Service NC Division of Soil and Water Conservation Soil and Water Conservation District NC Farm Bureau
Construction/Mining	NC Division of Land Resources
Forestry	NC Division of Forest Resources
Groundwater	NC Division of Water Quality - Groundwater Section
On-site wastewater treatment	NC Division of Environmental Health
Solid waste	NC Division of Solid Waste Management
Surface water	US Fish and Wildlife Service NC Division of Water Quality NC Division of Coastal Management NC Division of Marine Fisheries NC Wildlife Resources Commission U.S. Army Corps of Engineers
Urban	Division of Water Quality NC Department of Transportation
Local Government	NC League of Municipalities Camden County Chowan County Currituck County Dare County Gates County Pasquotank County Perquimans County Northampton County Tyrrell County Washington County Town of Nags Head
Additional	NC Coastal Federation NC Wildlife Federation Natural Resources Leadership Institute Albemarle Environmental Association Sierra Club

7.2.3 Use Restoration Waters

The North Carolina Division of Water Quality is currently developing the Use Restoration Waters (URW) program to restore surface waters to their designated uses. If adopted, this program will allow the state to work with local governments, businesses, and residents to develop management strategies appropriate for the area. In order to be effective, the URW program will include a mix of voluntary and mandatory programs. The voluntary and mandatory programs will be coordinated on a watershed-specific basis by DWQ and a group of stakeholders who have an interest in the impaired water body and associated watershed. In addition, the URW program will attempt to develop cooperative relationships among these agencies so that overlapping efforts can be consolidated and targeted to restore designated water body uses.

7.2.4 Further Evaluation Of Swamp Systems

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

7.2.5 Wetlands Restoration

The NC General Assembly approved the establishment of a wetland restoration program in this state. North Carolina is beginning a concentrated effort to inventory and digitally map wetlands throughout the state. As the program progresses, a restoration plan will be developed for each river basin and incorporated into the basinwide planning process. Through this, the water quality protection function of wetlands can be used more effectively in areas prioritized during basinwide planning.

7.2.6 Regional Councils

The Comprehensive Conservation and Management Plan (CCMP) for the Albemarle/Pamlico (A/P) Sounds region recommended that regional councils be formed in each of the A/P region's five river basins. An Executive Order was signed by Governor Hunt in March 1995 calling for the establishment of the five regional councils. The Neuse River Basin Regional Council was the first formed (November 1995). The other four, including one for the Pasquotank, are to be formed in 1997.

Each council will include local government representation (one municipal and one county rep from each county in the basin) as well as representation from non-governmental stakeholder groups in each basin. The groups would have the potential to help target and implement the water quality and resources issues of greatest concern to stakeholders in the basin and to forge the link between the APES program, the CCMP and basinwide planning.

7.2.7 Improved Monitoring Coverage and Coordination with Other Agencies

Monitoring of the chemical and biological status of receiving waters will provide critical feedback on the success of the basin management strategy. As discussed in Chapter 4, monitoring data will be collected from (1) ambient water chemistry, (2) sediment chemistry, (3) biological communities, (4) contaminant concentrations in fish and other biota, (5) ambient toxicity, and (6) facility self-monitoring data. The specific parameters measured will relate directly to the long-term water quality goals and objectives defined within the basinwide management strategy.

In addition to this, DWQ and other environmental agencies have been discussing the potential for coordination of field resources. One of the principal constraints with the frequency of ambient water quality monitoring is that significant water quality events could be missed because the monitoring did not occur during the event. If individuals from another environmental agency are visiting certain waterbodies to investigate fish populations or wetland areas, they could also collect water quality data from these areas. The coordination of these activities should help to better blend the activities of the various agencies as well as increase the frequency and coverage of the monitoring.

7.2.8 Potential Research Projects

During the basinwide planning process, several research needs were identified either by DWQ or others that have commented on the plan. These potential projects are listed here in order to be considered by researchers for future study.

- investigation into the connection between water quality and fishery resources;
- site-specific studies on the soils of the basin as they relate to nutrient export into surface waters;
- research into the effects of salt wedge stratification - how do hydrological influences change their occurrence and how do they effect the biology of the system.

7.3 PROGRAMMATIC INITIATIVES

7.3.1 NPDES Program Initiatives

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

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

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

7.3.2 Addressing Inflow and Infiltration (I&I) Problems at Municipal Wastewater Treatment Plants

There is a need to provide financial assistance to help local governments in the Pasquotank and other basins for correction of inflow and infiltration (I & I) problems in municipal wastewater sewage collection systems. Virtually every municipal wastewater treatment plant in the basin has deteriorating sewer lines that are either allowing groundwater to seep in (infiltration) and/or that have lines that receive excessive flows of surface waters from cross-connections with stormwater systems or flooding of manholes (inflow). I & I problems can overwhelm the hydrologic capacity of waste treatment plants causing both raw wastewater overflows and upsetting of the plant's biology which impacts it's ability to treat wastes for some time after the event. Many towns have to construct oversized waste treatment plants to compensate for this problem (it's often cheaper to build a bigger plant than correct the I & I problem).

A number of municipal wastewater treatment facilities in the Pasquotank Basin use land application systems instead of discharging to surface waters. These facilities have been running into problems when the amount of water getting into the system exceeds the hydrologic capacity of the land onto which the treated effluent is applied. Unless corrected, towns will be seeking permission to discharge their wastewater to streams instead of land-applying it. Correcting this problem will be a very costly, but ultimately necessary in order to protect the river basin.

Because of the cost and widespread nature of the problem, this is an issue that will probably require attention by the general assembly to address.

7.3.3 Promotion of Non-Discharge Alternatives/Regionalization

DWQ requires all new and expanding dischargers to submit an alternatives analysis as part of its NPDES permit application. Non-discharge alternatives, including tying on to an existing WWTP or land-applying wastes are preferred from an environmental standpoint. If the Division determines that there is an economically reasonable alternative to a discharge, DWQ may recommend denial of the NPDES permit.

7.3.4 Coordinating Basinwide Management With the Construction Grants and Loans Program

The potential exists to use the basinwide planning process as a means of identifying and prioritizing wastewater treatment plants in need of funding through DWQ's Construction Grants and Loan Program. Completed basin documents are provided to this office for their use.

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

DWQ is in the process of centralizing and improving its computer data management systems. Most of its water quality program data including permitted dischargers, waste limits, compliance information, water quality data, stream classifications, and so on, will be put in a central data center which will then be made accessible to most staff at desktop computer stations. Much of this information is also being entered into the state's GIS computer system (Center for Geographic Information and Analysis or CGIA). As this and other information is made available to the GIS system, including land use data from satellite or air photo interpretation, and as the system becomes more user friendly, the potential to graphically display the results of water quality data analysis will be tremendous.

Research Triangle Institute performed a pilot study in the Tar-Pamlico River Basin in which high priority waterbodies for nonpoint source control programs were mapped. These maps were used by the various nonpoint source agencies for planning purposes. As resources become available, this tool will be developed for other basins.

7.4 WATER QUALITY RECOMMENDATIONS OF THE FISHERIES MORATORIUM STEERING COMMITTEE

Depending upon legislative actions that may occur in 1997, DWQ may be required to perform some new duties with regard to coastal water quality management fisheries resource protection.

In July 1994, the North Carolina General Assembly declared a two-year moratorium on new vessel, crab and shellfish licenses and non-vessel endorsements to sell fish. The moratorium was extended in 1995 to last until 1997 to allow for the development of recommendations and the solicitation of public comment on those recommendations. The moratorium resulted from the concerns of fishermen, fisheries managers and others regarding the health of the state's coastal fisheries resources.

The General Assembly also appointed an 18 member panel of commercial and recreational fishermen, scientists, fisheries managers and representatives of legislature. The panel, known as the Moratorium Steering Committee, was instructed to study the problems and provide recommendations for solutions. The Committee divided into five working groups (subcommittees) to tackle specific issues - License, Marine Fisheries Commission and Division of Marine Fisheries Organization, Law Enforcement, Habitat and Gear.

In August 1996, the Committee approved a set of draft recommendations. They subsequently held 19 hearings across the state in August and September. In late October, the recommendations were finalized after revisions were made based on public input. In February of 1997, the Joint Legislative Commission on Seafood and Aquaculture considered these recommendations and by a close vote (7 - 6), decided not to forward them for further consideration by the General Assembly. However, recommendations made by the Moratorium Steering Committee may be considered in whole or in part at a later date.

Some of the recommendations of the Habitat Subcommittee directly relate to water quality protection. Highlights of some of the recommendations made by the Habitat Subcommittee include, but are not limited to, (from Report of the Habitat Subcommittee to the Moratorium Steering Committee - Adopted by the Moratorium Steering Committee for Recommendation to the "Joint Legislative Commission on Seafood and Aquaculture" on October 24, 1996"):

- the General Assembly should amend appropriate legislation to give more weight to Division of Marine Fisheries objections to permits approved by other state agencies [such as NPDES permits issued by DWQ];
- the General Assembly should require the Coastal Resources Commission, Environmental Management Commission and Marine Fisheries Commission to adopt a Habitat Protection Plan for critical coastal fishery habitats as soon as possible but no later than July 1, 1999; and
- the General Assembly should establish and fund a comprehensive state program to acquire, preserve, and restore habitats critical to marine and/or estuarine fisheries.

APPENDIX I

Summary of North Carolina's Water Quality Classifications and Standards

Antidegradation Policy

High Quality Waters

Outstanding Resource Waters

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STANDARDS

PRIMARY CLASSIFICATIONS	BEST USAGE	DISCHARGE RESTRICTIONS[1]	STORMWATER MANAGEMENT	OTHER REQUIREMENTS[2]
Freshwater:				
C (standards apply to all freshwaters, unless pre-empted by more stringent standard for more protective classification)	Secondary recreation (including swimming on an unorganized or infrequent basis); wildlife; fish and other aquatic life propagation and survival; agriculture and any other usage, except for primary recreation, water supply or other food-related ruses	Domestic and industrial wastewater dischargers allowed	Stormwater Management Rules apply in the 20 coastal counties as described in 15A NCAC 2H .1000	
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; wastewater treatment reliability requirements (dual train design; backup power capability) may apply to protect swimming uses (15A NCAC 2H .0124)	Same as for Class C	
WS-I Water Supply	Water supplies in natural and undeveloped watersheds	No point source discharges	Not applicable since watershed is undeveloped	No landfills; residual or petroleum contaminated soils application not allowed in the watershed
WS-II Water Supply	Water supplies in predominantly undeveloped watersheds	Only general permit wastewater discharges allowed in watershed	Local land management program required as per 15A NCAC 2B .0214; 6% built upon area in Critical Area; 12% built upon area in the Balance of the Watershed; up to 24% built upon area in the Critical Area and 30% in the Balance of the Watershed allowed with engineered stormwater controls for the 1" storm[3]	Buffers required along perennial waters; no new landfills allowed in the Critical Area and no new discharging landfills outside of Critical Area; no new residual or petroleum contaminated soils application allowed in the Critical Area
WS-III Water Supply	Water supplies in low to moderately developed watersheds	General permits allowed throughout watershed; domestic and non-process industrial discharges allowed outside of the Critical Area	Local land management program required as per 15A NCAC 2B .0215; 12% built upon area in Critical Area; 24% built upon area outside of Critical Area; up to 30% in Critical Area and 50% built upon area outside Critical Area allowed with engineered stormwater controls for the 1" storm[3]	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 residual or petroleum contaminated soils application allowed in the Critical Area

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

PRIMARY CLASSIFICATIONS	BEST USAGE	DISCHARGE RESTRICTIONS[1]	STORMWATER MANAGEMENT	OTHER REQUIREMENTS[2]
WS-IV Water Supply	Water supplies in moderately to highly developed watersheds	General permits, domestic and industrial discharges allowed throughout watershed[4]	Local land management program required as per 15A NCAC 2B .0216: 24% built upon area in Critical Area and Protected Area [5,6]; up to 50% in Critical Area and 70% built upon area outside Critical Area with engineered stormwater controls for the 1" storm[3]	Buffers required along perennial waters; no new landfills allowed in the Critical Area; no new residual or petroleum contaminated soils application allowed in the Critical Area
WS-V Water Supply	Former or industrial use water supplies	No categorical restrictions on development or wastewater dischargers	Stormwater Management Rules apply in the 20 coastal counties as described in 15A NCAC 2H .1000	Instream water quality standards for water supply waters are applicable

NOTES: Please refer to 15A NCAC 2B .0101, .0104, .0202, .0211 and .0301 for more specific requirements for surface water supply protection.

1 Groundwater remediation discharges allowed when no alternative exists.
2 See attached tables: *Water Quality Standards for Freshwater Classes* and *Water Quality Standards for Saltwater Classes* for numeric standards associated with specific classes.
3 If the high density option is utilized engineered stormwater control systems must be designed for 85% TSS removal. Refer to Stormwater Management Rules (15 A NCAC 2H .1000) for specific design information.
4 New industrial process wastewater discharges in the Critical Area are allowed but must meet additional treatment requirements.
5 Applies to projects requiring an Erosion/Sedimentation Control Plan.
6 36% built-upon area is allowed for projects without a curb and gutter street system in the Protected Area.

- Critical area is 1/2 mile and draining to water supplies from normal pool elevation of reservoirs, or 1/2 mile and draining to a river intake.
- Protected Area is 5 miles and draining to water supplies from normal pool elevation of reservoirs, or 10 miles upstream of and draining to a river intake.
- Agricultural activities are subject to provisions of the Food Security Act of 1985 and the Food, Agriculture, Conservation and Trade Act of 1990. In WS-I watersheds and Critical Areas of WS-II, WS-III and WS-IV areas, agricultural activities must maintain a 10 foot vegetated buffer or equivalent control 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	DISCHARGE RESTRICTIONS	STORMWATER MANAGEMENT	OTHER REQUIREMENTS
Saltwater:				
SC	Saltwaters protected for secondary recreation, aquatic life propagation and survival and other uses as described for Class C	Domestic and industrial wastewater discharges allowed	Stormwater Management Rules (15A NCAC 2H .1000) apply to all waters in the 20 coastal counties; low density option: 30% built upon area or structural stormwater controls with higher density, as specified	
SB	Saltwaters protected for primary recreation and all Class SC uses (similar to Class B)	Same as Class SC; wastewater treatment reliability requirements (dual train design; backup power capability) may apply to protect swimming uses (15A NCAC 2H .0124)	Same as for Class SC	
SA	Shellfishing and all Class SC and SB uses	No domestic discharges and only non-process industrial discharges such as seafood packing houses or cooling water discharges	Same as for Class SC except low density option is 25% built upon area	

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	DISCHARGE RESTRICTIONS	STORMWATER MANAGEMENT	OTHER REQUIREMENTS
HQW High Quality Waters	Waters rated as Excellent by DEM; Primary Nursery Areas; Native or Special Native Trout Waters; WS-I, WS-II and SA waters are HQW by definition	For new or expanded discharges advanced treatment requirements are: BOD_5=5 mg/l; NH_3-N= 2 mg/l; DO=6 mg/l	For projects requiring Erosion/ Sedimentation Control Plan and that are within 1 mile and draining to HQW waters: 12% built upon area or higher density with engineered structural controls allowed; 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 Antidegradation Policy: Rule 15A: NCAC 2B .0201)

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

SUPPLEMENTAL CLASSIFICATIONS	BEST USAGE	DISCHARGE RESTRICTIONS	STORMWATER MANAGEMENT	OTHER REQUIREMENTS
ORW Outstanding Resource Waters	Unique and special waters having exceptional water quality and being of an exceptional state or national ecological or recreational significance; must meet other conditions and have 1 or more of 5 outstanding resource value criteria as described in Rule 15A NCAC 2B .0225	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 the Stormwater Management Rules (generally 25% built upon area around SA waters and 30% around other waters)	Other management strategy components as described in 15A NCAC 2B .0225
TR Trout Waters	Protected for natural trout propagation and survival of stocked trout	Domestic and industrial wastewater discharges allowed with stricter treatment requirements		More protective standards for cadmium, total residual chlorine, chlorophyll-a, dissolved oxygen, turbidity and toluene to protect these sensitive species
NSW Nutrient Sensitive Waters	Waters needing additional nutrient management due to their being subject to excessive growth of microscopic and macroscopic vegetation	No increase of nutrients over background levels permitted; domestic and industrial wastewater discharges allowed	Nutrient management strategies developed on a case-by-case basis	Nutrient management strategies developed on a case-by-case basis
SW Swamp Waters	Waters with low velocities and other characteristics different from other waterbodies (generally, low pH, DO, high organic content)			pH as low as 4.3 and DO less than 5 mg/l allowed if due to natural conditions
FWS Future Water Supply	Waters designated for future water supply use	Discharge restrictions will be reflective of those of primary water supply classification	Stormwater management options will be reflective of those of primary water supply classification; not required until after FWS supplemental classification is removed	Requirements for landfill permits, NPDES wastewater discharges, land application of residuals and road construction activities in Critical Area and Balance of Watershed or Protected Area as appropriate (15A NCAC 2H .0101)

Water Quality Standards For Freshwater Classifications — August 2, 1995

Parameters (ug/l unless noted)	Standards for All Freshwater *		Standards to Support Additional Uses			
	Aquatic Life	Human Health[1]	WS Classes[2]	Trout Waters	HQW	Swamp Waters
Arsenic	50					
Barium			1000			
Benzene		71.4	1.19			
Beryllium	6.5	0.117	0.0068			
Cadmium	2.0			0.4		
Carbon tetrachloride		4.42	0.254			
Chloride	230000 (AL)		250000			
Chlorinated benzenes			488 (N)			
Chlorine, total residual	17 (AL)			17		
Chlorophyll a, corrected	40 (N)			15 (N)		
Chromium, total	50					
Coliform, total (MFTCC/100ml)[3]			50 (N)[4]			
Coliform, fecal (MFFCC/100ml)[3]		200 (N)				
Copper, total	7 (AL)					
Cyanide	5.0					
Dioxin		0.000000014	0.000000013			
Dissolved gases	(N)					
Dissolved oxygen (mg/l)	5.0[5]			6.0		(N)[6]
Fluoride	1800					
Hardness, total (mg/l)			100			
Hexachlorobutadiene		49.7	0.445			
Iron (mg/l)	1000 (AL)					
Lead	25 (N)					
Manganese			200			
MBAS (Methylene-Blue-Active-Substances)	500					
Mercury	0.012					
Nickel	88		25			
Nitrate nitrogen			10			
Pesticides						
Aldrin	0.002	0.000136	0.000127			
Chlordane	0.004	0.000588	0.000575			
DDT	0.001	0.000591	0.000588			
Demeton	0.1					
Dieldrin	0.002	0.000144	0.000135			
Endosulfan	0.05					
Endrin	0.002					
Guthion	0.01					
Heptachlor	0.004	0.000214	0.000208			
Lindane	0.01					
Methoxychlor	0.03					
Mirex	0.001					
Parathion	0.013					
Toxaphene	0.0002					
2,4-D			100			
2,4,5-TP (Silvex)			10			
pH (units)	6.0-9.0					(N)[6]
Phenolic coumpounds		(N)	1.0 (N)			
Polychlorinated biphenyls[7]	0.001	0.000079				
Polynuclear aromatic hydrocarbons[8]		0.0311	0.0028			
Radioactive substances		(N)				
Selenium	5					
Silver	0.06 (AL)					
Solids, total dissolved (mg/l)			500			
Solids, total suspended (mg/l)					10 Tr, 20 other	
Solids, setteable	(N)					
Sulfates			250000			
Temperature	(N)					
Tetrachloroethane (1,1,2,2)		10.8	0.172			
Tetrachlorethylene			0.8			
Toluene	11			0.36		
Toxic substances	(N)				(N)	
Trialkyltin	0.008					
Trichloroethylene		92.4	3.08			
Turbidity (NTU)	50; 25 (N)			10 (N)		
Vinyl chloride		525	2.0			
Zinc	50 (AL)					

* These standards apply to all freshwater classifications. For the protection of WS and supplemental classifications, standards listed under Standards to Support Additional Uses should be used unless standards for aquatic life or human health are listed and are more stringent.

(AL) Values represent action levels as specified in 2B .0211(4). WS Classes - Water Supply Classifications, same standards for all WS Classes.

(N) See 2B .0211(3) for narrative description of limits. HQW - High Quality Waters, standards for HQW areas only. Tr - Trout Waters.

1 Human health standards are based on consumption of fish only unless dermal contact studies available. See 2B .0208 for equation.

2 Water Supply standards are based on consumption of fish and water. See 2B .0208 for equation.

3 MFTCC/100ml means membrane filter total coliform count per 100 ml of sample. MFFCC/100ml means membrane filter fecal coliform count per 100 ml of sample.

4 Applies only to unfiltered water supplies.

5 An instantaneous reading may be as low as 4.0 mg/l, but the daily average must be 5.0 mg/l or more.

6 Designated swamp waters may have a dissolved oxygen less than 5.0 mg/l and a pH as low as 4.3, if due to natural conditions.

7 Applies to total PCBs present and includes PCB 1242, 1254, 1221, 1232, 1248, 1260, and 1016. See 2B .0208 & .0211.

8 Applies to total PAHs present and includes benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. See 2B .0208, .0212, .0214, .0215, .0216, & .0218.

Water Quality Standards For Saltwater Classifications

April 1, 1995

Parameters (ug/l unless noted)	Standards for All Saltwater: Aquatic Life	Human Health[1]	Standards to Support Additional Uses: Class SA	HQW	Swamp Waters
Arsenic	50				
Benzene		71.4			
Beryllium		0.117			
Cadmium	5.0				
Carbon tetrachloride		4.42			
Chlorophyll a	40 (N)				
Chromium, total	20				
Coliform, fecal (MFFCC/100ml)[2]		200 (N)	14 (N)		
Copper	3 (AL)				
Cyanide	1.0				
Dioxin		0.000000014			
Dissolved gases	(N)				
Dissolved oxygen (mg/l)	5.0			6.0	(N)[3]
Hexachlorobutadiene		49.7			
Lead	25 (N)				
Mercury	0.025				
Nickel	8.3				
Pesticides					
Aldrin	0.003	0.000136			
Chlordane	0.004	0.000588			
DDT	0.001	0.000591			
Demeton	0.1				
Dieldrin	0.0002	0.000144			
Endosulfan	0.009				
Endrin	0.002				
Guthion	0.01				
Heptachlor	0.004	0.000214			
Lindane	0.004				
Methoxychlor	0.03				
Mirex	0.001				
Parathion	0.178				
Toxaphene	0.0002				
pH (units)	6.8-8.5				(N)[3]
Phenolic compounds		(N)			
Polychlorinated biphenyls[4]	0.001	0.000079			
Polynuclear aromatic hydrocarbons[5]	0.0311				
Radioactive substances		(N)			
Salinity	(N)				
Selenium	71				
Silver	0.1 (AL)				
Solids, total suspended (mg/l)				10 PNA, 20 other	
Solids, settleable (mg/l)	(N)				
Temperature	(N)				
Tetrachloroethane (1,1,2,2)		10.8			
Toxic substances	(N)			(N)	
Trialkyltin	0.002				
Trichloroethylene		92.4			
Turbidity (NTU)	25 (N)				
Vinyl chloride		.525			
Zinc	86 (AL)				

(AL) Values represent action levels as specified in 2B .0220(4).
(N) See 2B .0220 for narrative description of limits.
HQW - High Quality Waters, standards for HQW areas only.

Class SA - shellfishing waters see 2B .0101(d)(3) for description.
PNA - Primary Nursery Areas

1 Human health standards are based on consumption of fish only unless dermal contact studies are available. See 2B .0208 for equation.
2 MFFCC/100ml means membrane filter fecal coliform count per 100 ml of sample.
3 Designated swamp waters may have a dissolved oxygen less than 5.0 mg/l and a pH as low as 4.3, if due to natural conditions.
4 Applies to total PCBs present and includes PCB 1242, 1254, 1221, 1232, 1248, 1260, and 1016. See 2B .0208 & .0220.
5 Applies to total PAHs present and includes benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. See 2B .0208.

.0201 ANTIDEGRADATION POLICY

(a) It is the policy of the Environmental Management Commission to maintain, protect, and enhance water quality within the State of North Carolina. Pursuant to this policy, the requirements of 40 CFR 131.12 are hereby incorporated by reference including any subsequent amendments and editions. This material is available for inspection at the Department of Environment, Health, and Natural Resources, Division of Environmental Management, Water Quality Planning Branch, 512 North Salisbury Street, Raleigh, North Carolina. Copies may be obtained from the U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402-9325 at a cost of thirteen dollars ($13.00). These requirements will be implemented in North Carolina as set forth in Paragraphs (b), (c) and (d) of this Rule.

(b) Existing uses, as defined by Rule .0202 of this Section, and the water quality to protect such uses shall be protected by properly classifying surface waters and having standards sufficient to protect these uses. In cases where the Commission or its designee determines that an existing use is not included in the classification of waters, a project which will affect these waters will not be permitted unless the existing uses are protected.

(c) The Commission shall consider the present and anticipated usage of waters with quality higher than the standards, including any uses not specified by the assigned classification (such as outstanding national resource waters or waters of exceptional water quality) and will not allow degradation of the quality of waters with quality higher than the standards below the water quality necessary to maintain existing and anticipated uses of those waters. Waters with quality higher than the standards are defined by Rule .0202 of this Section. The following procedures will be implemented in order to meet these requirements:

(1) Each applicant for an NPDES permit or NPDES permit expansion to discharge treated waste will document an effort to consider non-discharge alternatives pursuant to 15A NCAC 2H .0105(c)(2).

(2) Public Notices for NPDES permits will list parameters that would be water quality limited and state whether or not the discharge will use the entire available load capacity of the receiving waters and may cause more stringent water quality based effluent limitations to be established for dischargers downstream.

(3) The Division may require supplemental documentation from the affected local government that a proposed project or parts of the project are necessary for important economic and social development.

(4) The Commission and Division will work with local governments on a voluntary basis to identify and develop appropriate management strategies or classifications for waters with unused pollutant loading capacity to accommodate future economic growth.

Waters with quality higher than the standards will be identified by the Division on a case-by-case basis through the NPDES permitting and waste load allocation processes (pursuant to the provisions of 15A NCAC 2H .0100). Dischargers affected by the requirements of Paragraphs (c)(1) through (c)(4) of this Rule and the public at large will be notified according to the provisions described herein, and all other appropriate provisions pursuant to 15A NCAC 2H .0109. If an applicant objects to the requirements to protect waters with quality higher than the standards and believes degradation is necessary to accommodate important social and economic development, the applicant can contest these requirements according to the provisions of General Statute 143-215.1(e) and 150B-23.

(d) The Commission shall consider the present and anticipated usage of High Quality Waters (HQW), including any uses not specified by the assigned classification (such as outstanding national resource waters or waters of exceptional water quality) and will not allow degradation of the quality of High Quality Waters below the water quality necessary to maintain existing and anticipated uses of those waters. High Quality Waters are a subset of waters with quality higher than the standards and are as described by 15A NCAC 2B .0101(e)(5). The procedures described in Rule .0224 of this Section will be implemented in order to meet the requirements of this part.

(e) Outstanding Resource Waters (ORW) are a special subset of High Quality Waters with unique and special characteristics as described in Rule .0225 of this Section. The water quality of waters classified as ORW shall be maintained such that existing uses, including the outstanding resource values of said Outstanding Resource Waters, will be maintained and protected.

History Note: *Authority G.S. 143-214.1; 143-215.1; 143-215.3(a)(1);*
Eff. February 1, 1976;
Amended Eff. October 1, 1995; February 1, 1993; April 1, 1991; August 1, 1990.

.0223 NUTRIENT SENSITIVE WATERS

(a) In addition to existing classifications, the Commission may classify any surface waters of the state as nutrient sensitive waters (NSW) upon a finding that such waters are experiencing or are subject to excessive growths of microscopic or macroscopic vegetation. Excessive growths are growths which the Commission in its discretion finds to substantially impair the use of the water for its best usage as determined by the classification applied to such waters.

(b) NSW may include any or all waters within a particular river basin as the Commission deems necessary to effectively control excessive growths of microscopic or macroscopic vegetation.

(c) For the purpose of this Rule, the term "nutrients" shall mean phosphorous or nitrogen. When considering the assignment of this classification, the Commission may specify as a "nutrient" any other chemical parameter or combination of parameters which it determines to be essential for the growth of microscopic and macroscopic vegetation.

(d) Those waters additionally classified as nutrient sensitive shall be identified in the appropriate schedule of classifications as referenced in Section .0300 of this Subchapter.

(e) For the purpose of this Rule, the term "background levels" shall mean the concentration(s), taking into account seasonal variations, of the specific nutrient or nutrients upstream of a nutrient source.

(f) Quality standards applicable to NSW: no increase in nutrients over background levels unless it is shown to the satisfaction of the Director that the increase:

(1) is the result of natural variations; or

(2) will not endanger human health, safety or welfare and that preventing the increase would cause a serious economic hardship without equal or greater benefit to the public.

History Note: *Authority G.S. 143-214.1;*
Eff. October 1, 1995.

.0224 HIGH QUALITY WATERS

High Quality Waters (HQW) are a subset of waters with quality higher than the standards and are as described by 15A NCAC 2B .0101(e)(5). The following procedures shall be implemented in order to implement the requirements of Rule .0201(d) of this Section.

(1) New or expanded wastewater discharges in High Quality Waters shall comply with the following:

(a) Discharges from new single family residences shall be prohibited. Those existing subsurface systems for single family residences which fail and must discharge shall install a septic tank, dual or recirculating sand filters, disinfection and step aeration.

(b) All new NPDES wastewater discharges (except single family residences) shall be required to provide the treatment described below:

(i) Oxygen Consuming Wastes: Effluent limitations shall be as follows: BOD_5= 5 mg/l, NH_3-N = 2 mg/l and DO = 6 mg/l. More stringent limitations shall be set, if necessary, to ensure that the cumulative pollutant discharge of oxygen-consuming wastes shall not cause the DO of the receiving water to drop more than 0.5 mg/l below background levels, and in no case below the standard. Where background information is not readily available, evaluations shall assume a percent saturation determined by staff to be generally applicable to that hydroenvironment.

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) shall be limited to effluent concentrations of 10 mg/l for trout waters and PNA's, and to 20 mg/l for all other High Quality Waters.

(iii) Disinfection: Alternative methods to chlorination shall be required for discharges to trout streams, except that single family residences may use chlorination if other options are not economically feasible. Domestic discharges are prohibited to SA waters.

(iv) Emergency Requirements: Failsafe treatment designs shall be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs.

(v) Volume: The total volume of treated wastewater for all discharges combined shall not exceed 50 percent of the total instream flow under 7Q10 conditions.

(vi) Nutrients: Where nutrient overenrichment is projected to be a concern, appropriate effluent limitations shall be set for phosphorus or nitrogen, or both.

(vii) Toxic substances: In cases where complex wastes (those containing or potentially containing toxicants) may be present in a discharge, a safety factor shall be applied to any chemical or whole effluent toxicity allocation. The limit for a specific chemical constituent shall be allocated at one-half of the normal standard at design conditions. Whole effluent toxicity shall be allocated to protect for chronic toxicity at an effluent concentration equal to twice that which is acceptable under design conditions. In all instances there may be no acute toxicity in an effluent concentration of 90 percent. Ammonia toxicity shall be evaluated according to EPA guidelines promulgated in "Ambient Water Quality Criteria for Ammonia - 1984"; EPA document number 440/5-85-001; NTIS number PB85-227114; July 29, 1985 (50 FR 30784) or "Ambient Water Quality Criteria for Ammonia (Saltwater) - 1989"; EPA document number 440/5-88-004; NTIS number PB89-169825. This material related to ammonia toxicity is hereby incorporated by reference including any subsequent amendments and editions and is available for inspection at the Department of Environment, Health, and Natural Resources Library, 512 North Salisbury Street, Raleigh, North Carolina. Copies may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 at a cost of forty-seven dollars ($47.00).

(c) All expanded NPDES wastewater discharges in High Quality Waters shall be required to provide the treatment described in Sub-Item (1)(b) of this Rule, except for those existing discharges which expand with no increase in permitted pollutant loading.

(2) Development activities which require an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or local erosion and sedimentation control program approved in accordance with 15A NCAC 4B .0218, and which drain to and are within one mile of High Quality Waters (HQW) shall be required to follow the stormwater management rules as specified in 15A NCAC 2H .1000. Stormwater management requirements specific to HQW are described in 15A NCAC 2H .1006.

If an applicant objects to the requirements to protect high quality waters and believes degradation is necessary to accommodate important social and economic development, the applicant may contest these requirements according to the provisions of G.S. 143-215.1(e) and 150B-23.

History Note: Authority G.S. 143-214.1; 143-215.1; 143-215.3(a)(1);
Eff. October 1, 1995;

.0225 OUTSTANDING RESOURCE WATERS

(a) General. In addition to the existing classifications, the Commission may classify certain unique and special surface waters of the state as outstanding resource waters (ORW) upon finding that such waters are of exceptional state or national recreational or ecological significance and that the waters have exceptional water quality while meeting the following conditions:

(1) there are no significant impacts from pollution with the water quality rated as excellent based on physical, chemical or biological information;

(2) the characteristics which make these waters unique and special may not be protected by the assigned narrative and numerical water quality standards.

(b) Outstanding Resource Values. In order to be classified as ORW, a water body must exhibit one or more of the following values or uses to demonstrate it is of exceptional state or national recreational or ecological significance:

(1) there are outstanding fish (or commercially important aquatic species) habitat and fisheries;

(2) there is an unusually high level of water-based recreation or the potential for such recreation;

(3) the waters have already received some special designation such as a North Carolina or National Wild and Scenic River, Native or Special Native Trout Waters, National Wildlife Refuge, etc, which do not provide any water quality protection;

(4) the waters represent an important component of a state or national park or forest; or

(5) the waters are of special ecological or scientific significance such as habitat for rare or endangered species or as areas for research and education.

(c) Quality Standards for ORW.

(1) Freshwater: Water quality conditions shall clearly maintain and protect the outstanding resource values of waters classified ORW. Management strategies to protect resource values shall be developed on a site specific basis during the proceedings to classify waters as ORW. At a minimum, no new discharges or expansions of existing discharges shall be permitted, and stormwater controls for all new development activities requiring an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or an appropriate local erosion and sedimentation control program shall be required to follow the stormwater provisions as specified in 15A NCAC 2H .1000. Specific stormwater requirements for ORW areas are described in 15A NCAC 2H .1007.

(2) Saltwater: Water quality conditions shall clearly maintain and protect the outstanding resource values of waters classified ORW. Management strategies to protect resource values shall be developed on a site-specific basis during the proceedings to classify waters as ORW. At a minimum, new development shall comply with the stormwater provisions as specified in 15A NCAC 2H .1000. Specific stormwater management requirements for saltwater ORWs are described in 15A NCAC 2H .1007. New non-discharge permits shall meet reduced loading rates and increased buffer zones, to be determined on a case-by-case basis. No dredge or fill activities shall be allowed where significant shellfish or submerged aquatic vegetation bed resources occur, except for maintenance dredging, such as that required to maintain access to existing channels and facilities located within the designated areas or maintenance dredging for activities such as agriculture. A public hearing is mandatory for any proposed permits to discharge to waters classified as ORW.

Additional actions to protect resource values shall be considered on a site specific basis during the proceedings to classify waters as ORW and shall be specified in Paragraph (e) of this Rule. These actions may include anything within the powers of the commission. The commission shall also consider local actions which have been taken to protect a water body in determining the appropriate state protection options. Descriptions of boundaries of waters classified as ORW are included in Paragraph (e) of this Rule and in the Schedule of Classifications (15A NCAC 2B .0302 through .0317) as specified for the appropriate river basin and shall also be described on maps maintained by the Division of Environmental Management.

(d) Petition Process. Any person may petition the Commission to classify a surface water of the state as an ORW. The petition shall identify the exceptional resource value to be protected, address how the water body meets the general criteria in Paragraph (a) of this Rule, and the suggested actions to protect the resource values. The Commission may request additional supporting information from the petitioner. The Commission or its designee shall initiate public proceedings to classify waters as ORW or shall inform the petitioner that the waters do not meet the criteria for ORW with an explanation of the basis for this decision. The petition shall be sent to:

Director
DEHNR/Division of Environmental Management
P.O. Box 29535
Raleigh, North Carolina 27626-0535

The envelope containing the petition shall clearly bear the notation: RULE-MAKING PETITION FOR ORW CLASSIFICATION.

(e) Listing of Waters Classified ORW with Specific Actions. Waters classified as ORW with specific actions to protect exceptional resource values are listed as follows:

(1) Roosevelt Natural Area [White Oak River Basin, Index Nos. 20-36-9.5-(1) and 20-36-9.5-(2)] including all fresh and saline waters within the property boundaries of the natural area shall have only new development which complies with the low density option in the stormwater rules as specified in 15A NCAC 2H .1005(2)(a) within 575 feet of the Roosevelt Natural Area (if the development site naturally drains to the Roosevelt Natural Area).

(2) Chattooga River ORW Area (Little Tennessee River Basin and Savannah River Drainage Area): the following undesignated waterbodies that are tributary to ORW designated segments shall comply with Paragraph (c) of this Rule in order to protect the designated waters as per Rule .0203 of this Section. However, expansions of existing discharges to these segments shall be allowed if there is no increase in pollutant loading:

- (A) North and South Fowler Creeks,
- (B) Green and Norton Mill Creeks,
- (C) Cane Creek,
- (D) Ammons Branch,
- (E) Glade Creek, and
- (F) Associated tributaries.

(3) Henry Fork ORW Area (Catawba River Basin): the following undesignated waterbodies that are tributary to ORW designated segments shall comply with Paragraph (c) of this Rule in order to protect the designated waters as per Rule .0203 of this Section:

- (A) Ivy Creek,
- (B) Rock Creek, and
- (C) Associated tributaries.

(4) South Fork New and New Rivers ORW Area [New River Basin (Index Nos. 10-1-33.5 and 10)]: the following management strategies, in addition to the discharge requirements specified in Subparagraph (c)(1) of this Rule, shall be applied to protect the designated ORW areas:

- (A) Stormwater controls described in Subparagraph (c)(1) of this Rule shall apply within one mile and draining to the designated ORW areas;
- (B) New or expanded NPDES permitted wastewater discharges located upstream of the designated ORW shall be permitted such that the following water quality standards are maintained in the ORW segment:
  - (i) the total volume of treated wastewater for all upstream discharges combined shall not exceed 50 percent of the total instream flow in the designated ORW under 7Q10 conditions;
  - (ii) a safety factor shall be applied to any chemical allocation such that the effluent limitation for a specific chemical constituent shall be the more stringent of either the limitation allocated under design conditions (pursuant to 15A NCAC 2B .0206) for the normal standard at the point of discharge, or the limitation allocated under design conditions for one-half the normal standard at the upstream border of the ORW segment;
  - (iii) a safety factor shall be applied to any discharge of complex wastewater (those containing or potentially containing toxicants) to protect for chronic toxicity in the ORW segment by setting the whole effluent toxicity limitation at the higher (more stringent) percentage effluent determined under design conditions (pursuant to 15A NCAC 2B .0206) for either the instream effluent concentration at the point of discharge or twice the effluent concentration calculated as if the discharge were at the upstream border of the ORW segment;
- (C) New or expanded NPDES permitted wastewater discharges located upstream of the designated ORW shall comply with the following:
  - (i) Oxygen Consuming Wastes: Effluent limitations shall be as follows: BOD = 5 mg/l, and NH3-N = 2 mg/l;
  - (ii) Total Suspended Solids: Discharges of total suspended solids (TSS) shall be limited to effluent concentrations of 10 mg/l for trout waters and to 20 mg/l for all other waters;
  - (iii) Emergency Requirements: Failsafe treatment designs shall be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs;
  - (iv) Nutrients: Where nutrient overenrichment is projected to be a concern, appropriate effluent limitations shall be set for phosphorus or nitrogen, or both.

(5) Old Field Creek (New River Basin): the undesignated portion of Old Field Creek (from its source to Call Creek) shall comply with Paragraph (c) of this Rule in order to protect the designated waters as per Rule .0203 of this Section.

(6) In the following designated waterbodies, no additional restrictions shall be placed on new or expanded marinas. The only new or expanded NPDES permitted discharges that shall be allowed shall be non-domestic, non-process industrial discharges. The Alligator River Area (Pasquotank River Basin) extending from the source of the Alligator River to the U.S. Highway 64 bridge including New Lake Fork, North West Fork Alligator River, Juniper Creek, Southwest Fork Alligator River, Scouts Bay, Gum Neck Creek, Georgia Bay, Winn Bay, Stumpy Creek Bay, Stumpy Creek, Swann Creek (Swann Creek Lake), Whipping Creek (Whipping Creek Lake), Grapevine Bay, Rattlesnake Bay, The Straits, The Frying Pan, Coopers Creek, Babbitt Bay, Goose Creek, Milltail Creek, Boat Bay, Sandy Ridge Gut (Sawyer Lake) and Second Creek, but excluding the Intracoastal Waterway (Pungo River-Alligator River Canal) and all other tributary streams and canals.

(7) In the following designated waterbodies, the only type of new or expanded marina that shall be allowed shall be those marinas located in upland basin areas, or those with less than 30 slips, having no boats over 21 feet in length and no boats with heads. The only new or expanded NPDES permitted discharges that shall be allowed shall be non-domestic, non-process industrial discharges.

(A) The Northeast Swanquarter Bay Area including all waters northeast of a line from a point at Lat. 35• 23• 51• and Long. 76• 21• 02• thence southeast along the Swanquarter National Wildlife Refuge hunting closure boundary (as defined by the 1935 Presidential Proclamation) to Drum Point.

(B) The Neuse-Southeast Pamlico Sound Area (Southeast Pamlico Sound Section of the Southeast Pamlico, Core and Back Sound Area); (Neuse River Basin) including all waters within an area defined by a line extending from the southern shore of Ocracoke Inlet northwest to the Tar-Pamlico River and Neuse River basin boundary, then southwest to Ship Point.

(C) The Core Sound Section of the Southeast Pamlico, Core and Back Sound Area (White Oak River Basin), including all waters of Core Sound and its tributaries, but excluding Nelson Bay, Little Port Branch and Atlantic Harbor at its mouth, and those tributaries of Jarrett Bay that are closed to shellfishing.

(D) The Western Bogue Sound Section of the Western Bogue Sound and Bear Island Area (White Oak River Basin) including all waters within an area defined by a line from Bogue Inlet to the mainland at SR 1117 to a line across Bogue Sound from the southwest side of Gales Creek to Rock Point, including Taylor Bay and the Intracoastal Waterway.

(E) The Stump Sound Area (Cape Fear River Basin) including all waters of Stump Sound and Alligator Bay from marker Number 17 to the western end of Permuda Island, but excluding Rogers Bay, the Kings Creek Restricted Area and Mill Creek.

(F) The Topsail Sound and Middle Sound Area (Cape Fear River Basin) including all estuarine waters from New Topsail Inlet to Mason Inlet, including the Intracoastal Waterway and Howe Creek, but excluding Pages Creek and Futch Creek.

(8) In the following designated waterbodies, no new or expanded NPDES permitted discharges and only new or expanded marinas with less than 30 slips, having no boats over 21 feet in length and no boats with heads shall be allowed.

(A) The Swanquarter Bay and Juniper Bay Area (Tar-Pamlico River Basin) including all waters within a line beginning at Juniper Bay Point and running south and then west below Great Island, then northwest to Shell Point and including Shell Bay, Swanquarter and Juniper Bays and their tributaries, but excluding all waters northeast of a line from a point at Lat. 35• 23• 51• and Long. 76• 21• 02• thence southeast along the Swanquarter National Wildlife Refuge hunting closure boundary (as defined by the 1935 Presidential Proclamation) to Drum Point and also excluding the Blowout Canal, Hydeland Canal, Juniper Canal and Quarter Canal.

(B) The Back Sound Section of the Southeast Pamlico, Core and Back Sound Area (White Oak River Basin) including that area of Back Sound extending from Core Sound west along Shackleford Banks, then north to the western most point of Middle Marshes and along the northwest shore of Middle Marshes (to include all of Middle Marshes), then west to Rush Point on Harker's Island, and along the southern shore of Harker's Island back to Core Sound.

(C) The Bear Island Section of the Western Bogue Sound and Bear Island Area (White Oak River Basin) including all waters within an area defined by a line from the western most point on Bear Island to the northeast mouth of Goose Creek on the mainland, east to the southwest mouth of Queen Creek, then south to green marker No. 49, then northeast to the northern most point on Huggins Island, then southeast along the shoreline of Huggins Island to the southeastern most point of Huggins Island, then south to the northeastern most point on Dudley Island, then southwest along the shoreline of Dudley Island to the eastern tip of Bear Island.

(D) The Masonboro Sound Area (Cape Fear River Basin) including all waters between the Barrier Islands and the mainland from Carolina Beach Inlet to Masonboro Inlet.

(9) Black and South Rivers ORW Area (Cape Fear River Basin) [Index Nos. 18-68-(0.5), 18-68-(3.5), 18-68-(11.5), 18-68-12-(0.5), 18-68-12-(11.5), and 18-68-2]: the following management strategies, in addition to the discharge requirements specified in Subparagraph (c)(1) of this Rule, shall be applied to protect the designated ORW areas:

(A) Stormwater controls described in Subparagraph (c)(1) of this Rule shall apply within one mile and draining to the designated ORW areas;

(B) New or expanded NPDES permitted wastewater discharges located one mile upstream of the stream segments designated ORW (upstream on the designated mainstem and upstream into direct tributaries to the designated mainstem) shall comply with the following discharge restrictions:

(i) Oxygen Consuming Wastes: Effluent limitations shall be as follows: BOD = 5 mg/l and NH3-N = 2 mg/l;

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) shall be limited to effluent concentrations of 20 mg/l;

(iii) Emergency Requirements: Failsafe treatment designs shall be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs;

(iv) Nutrients: Where nutrient overenrichment is projected to be a concern, appropriate effluent limitations shall be set for phosphorus or nitrogen, or both.

(v) Toxic substances: In cases where complex discharges (those containing or potentially containing toxicants) may be currently present in the discharge, a safety factor shall be applied to any chemical or whole effluent toxicity allocation. The limit for a specific chemical constituent shall be allocated at one-half of the normal standard at design conditions. Whole effluent toxicity shall be allocated to protect for chronic toxicity at an effluent concentration equal to twice that which is acceptable under flow design criteria (pursuant to 15A NCAC 2B .0206).

History Note: *Authority G.S. 143-214.1;*
Eff. October 1, 1995;
Amended Eff. April 1, 1996; January 1, 1996

APPENDIX II

DWQ Water Quality Monitoring Programs:

- Benthic Macroinvertebrate Sampling
- Fisheries Studies
- Lakes Assessment
- Effluent Toxicity Testing

A - II.1 BENTHIC MACROINVERTEBRATES

Freshwaters

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily aquatic insect larvae in freshwater systems, and polychaetes, crustacea, and mollusks in estuarine systems. The use of benthos data has proven to be a reliable monitoring tool, as benthic macroinvertebrates are sensitive to subtle changes in water quality. The benthic community also integrates the effects of a wide array of potential pollutant mixtures. Criteria have been developed for freshwater to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera, and Trichoptera (EPT S). Higher taxa richness values are associated with better water quality. Likewise, ratings can be assigned with a Biotic Index. This index summarizes tolerance data for all taxa in each collection. The two rankings are given equal weight in final site classification for qualitative samples. Taxa richness alone is used to assign bioclassifications for EPT samples. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is poorly assessed by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont, and coastal) within North Carolina. Criteria are being developed for estuarine benthos samples, but at the present time estuarine samples cannot be given a water quality evaluation.

Classification Criteria by Ecoregion*

A. EPT taxa richness values

	10-sample Qualitative Samples			4-sample EPT Samples		
	Mountains	Piedmont	Coastal	Mountains	Piedmont	Coastal
Excellent	>41	>31	>27	>35	>27	>23
Good	32-41	24-31	21-27	28-35	21-27	18-23
Good-Fair	22-31	16-23	14-20	19-27	14-20	12-17
Fair	12-21	8-15	7-13	11-18	7-13	6-11
Poor	0-11	0-7	0-6	0-10	0-6	0-5

B. Biotic Index Values (Range = 0-10)

	Mountains	Piedmont	Coastal
Excellent	<4.05	<5.19	<5.47
Good	4.06-4.88	5.19-5.78	5.47-6.05
Good-Fair	4.89-5.74	5.79-6.48	6.06-6.72
Fair	5.75-7.00	6.49-7.48	6.73-7.73
Poor	>7.00	>7.48	>7.73

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

Saltwaters

The effort to develop a method to assess water quality based on estuarine macroinvertebrates started in North Carolina in late 1990. By 1992, several standard methods of sampling and data analysis had been tested and found to be inadequate for North Carolina waters. In 1993, it was demonstrated that an Estuarine Biotic Index designed for Florida could also be used in North Carolina to accurately rank sites of varying water quality. It was also shown that sampling by epibenthic trawl was more effective at ranking sites than infaunal sampling with a petite ponar. Even so, using the Florida Estuarine Biotic Index (FEBI) on ponar-collected data was found to yield accurate results more often than not and more consistently than any other metric tested. It was also found that another Florida sampling technique, a semi-quantitative timed sweep, yielded results comparable to our historical samples, so a change in methods would not necessarily nullify previous estuarine work. Sampling for long term databases after December 1993 used the semi-quantitative sweep.

In 1994, further use of this semi-quantitative sweep method and FEBI suggested that they might also be useful at low salinities. A separate test in 1994 suggested that the FEBI was the only one of 17 metrics to accurately rank variably impacted sites for each of three sampling methods (petite ponar, epibenthic trawl, semi-quantitative sweep). Additionally, it was found that for semi-quantitative sweeps, the metrics Total taxa (S) and Amphipoda and Caridian shrimp (A+) taxa could also correctly rank the sites. In an early attempt at biocriteria development, it appeared that in high salinity waters, Total taxa (S), Biotic Index (BI), and Amphipoda and Caridian shrimp (A+) were most useful for delineating the highest quality areas.

These observations were confirmed with additional sampling during which it was also found that the metrics % Crustacean taxa and % Spionid and Capitellid polychaete taxa correctly ranked petite ponar samples 75% of the time. The FEBI was modified to create the North Carolina Estuarine Biotic Index (EBI) which more closely reflects taxa and tolerances in North Carolina.

A - II.2 FISHERIES

Fish Communtiy Structure Assessment

The North Carolina Index of Biotic Integrity (NCIBI) is a modification of the Index of Biotic Integrity (Karr, 1981; Karr et al., 1986). The method was developed for assessing a stream's biological integrity by examining the structure and health of its fish community. The scores derived from this index are a measure of the ecological health of the waterbody and may not necessarily directly correlate to water quality. A stream with excellent water quality, but poor to fair habitat would not rate excellent in this index; however, a stream which rates excellent on the NCIBI would be expected to have excellent water quality. The NCIBI is not applicable to high elevation trout streams, lakes, or estuaries.

The Index incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). The assessment of biological integrity using the NCIBI is provided by the cumulative assessment of 12 parameters, or metrics. While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

NCIBI scores and integrity classes are presented in Tables A-II.1 and A-II.2.

Table A-II.1 <u>NCIBI Scores and Integrity Classes</u>

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

Classes listed above, but not below, have attributes of two classes.

Table A-II.2 <u>NCIBI Integrity Classes and attributes of those classes</u> (modified from Karr et al., 1986)

Integrity Class	Attributes
Excellent	Comparable to the best situations without human disturbance; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of size classes; balanced trophic structure.
Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundances or size distributions; trophic structure shows some signs of stress.
Fair	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure.
Poor	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; diseased fish often present.
Very poor	Few fish present, mostly introduced or tolerant forms, disease fin damage and other anomalies regular
No fish	Repeated sampling finds no fish.

Streams with larger watersheds or drainage areas are expected to support more fish species and a larger number of fish.

Fish TIssue

Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources, including freshwater, estuarine, and marine fish and shellfish species, have been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation either directly or through aquatic food webs and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.

Fish tissue analysis results are used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

In evaluating fish tissue analysis results, several different types of criteria are used. Human health concerns related to fish consumption are screened by comparing results with Federal Food and Drug Administration (FDA) action levels, U. S. Environmental Protection Agency (EPA) recommended screening values, and criteria adopted by the North Carolina Division of Epidemiology.

The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish tissue consumption. A list of fish tissue analytes accompanied by their FDA criteria are presented below. At present, the FDA has only developed metals criteria for mercury. Individual parameters which appear to be of potential human health concern are evaluated by the North Carolina Division of Epidemiology by request of the Water Quality Section.

Food and Drug Administration (FDA) Action Levels

Metals

Mercury	1.0 ppm

Organics

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

In the guidance document, Fish Sampling and Analysis: Volume 1 (EPA823-R-93-002), the EPA has recommended screening values for target analytes which are formulated from a risk assessment procedure. EPA screening values are the concentrations of analytes in edible fish tissue that are of potential public health concern. The DEM compares fish tissue results with EPA screening values to evaluate the need for further intensive site specific monitoring. A list of target analytes and EPA recommended screening values for the general adult population is presented below.

The North Carolina Division of Epidemiology has adopted a selenium limit of 5 ppm for issuing fish consumption advisories. Total DDT includes the sum of all its isomers and metabolites (i.e. p,p DDT, o,p DDT, DDE, and DDD). Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane. Although the EPA has suggested a screening value of 7.0 x 10-7 ppm for dioxins, the State of North Carolina currently uses a value of 3.0 ppt in issuing fish consumption advisories.

Environmental Protection Agency (EPA) Screening Values

Metals

Cadmium	10.0 ppm
Mercury	0.6 ppm
Selenium	50.0 ppm

Organics

Chlorpyrifos	30.0 ppm
Total chlordane	0.08 ppm
Total DDT	0.3 ppm
Dieldrin	0.007 ppm
Dioxins	7.0×10^{-7} ppm
Endosulfan (I and II)	20.0 ppm
Endrin	3.0 ppm
Heptachlor epoxide	0.01 ppm
Hexachlorobenzene	0.07 ppm
Lindane	0.08 ppm
Mirex	2.0 ppm
Total PCB's	0.01 ppm
Toxaphene	0.1 ppm

Results of fish tissue analyses from sampling stations in the Pasquotank River Basin have been presented in Chapter 4.

A - II.3 LAKES ASSESSMENT PROGRAM

Lakes are valued for the multitide of 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, lakes which supply domestic drinking water, and lakes (public or private) where water quality problems have been observed. Data are used to determine the trophic state (a relative measure of nutrient enrichment and productivity) of each lake, and whether the designated uses of the lake have been threatened or impaired by pollution.

Tables presented in each subbasin summarize data used to determine the trophic state and use support status of each lake. These determinations are based on information from the most recent summertime sampling (date listed). The most recent North Carolina Trophic State Index (NCTSI) value is shown followed by the descriptive trophic state classification (O=oligotrophic, M=mesotrophic, E=eutrophic, H=hypereutrophic, D=dystrophic).

Numerical indices are often used to evaluate the trophic state of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NCDNRCD, 1982). The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), Secchi depth (SD in inches), and chlorophyll-a (CHL in µg/l). Lakewide means for these parameters are manipulated to produce a NCTSI score for each lake using the following equations:

$$\text{TON score} = \frac{\text{Log(TON)} + (0.45)}{0.24} \times 0.90$$

$$\text{TP score} = \frac{\text{Log(TP)} + (1.55)}{0.35} \times 0.92$$

$$\text{SD score} = \frac{\text{Log(SD)} - (1.73)}{0.35} \times -0.82$$

$$\text{CHL score} = \frac{\text{Log(CHL)} - (1.00)}{0.43} \times 0.83$$

$$\text{NCTSI} = \text{TON score} + \text{TP score} + \text{SD score} + \text{CHL score}$$

In general, NCTSI scores relate to trophic classifications as follows: less than -2.0 is oligotrophic, -2.0 to 0.0 is mesotrophic, 0.0 to 5.0 is eutrophic, and greater than 5.0 is hypereutrophic. When scores border between classes, best professional judgment is used to assign an appropriate classification. NCTSI scores may be skewed by highly colored water typical of dystrophic lakes. Some variation in the trophic state of a lake between years is not unusual due to the potential variability of data collections which usually involve sampling on a single day during the growing season. This survey methodology does not adequately evaluate changes which might occur throughout the year between lake samplings. More intensive (monthly) monitoring is required to identify lake specific variability. However, monitoring a lake once per growing season does provide a relatively valuable assessment of water quality conditions on a large number of lakes.

Lakes are classified for their "best usage" and are subject to the state's water quality standards. Primary classifications are C (suited for aquatic life propagation/protection and secondary recreation such as wading), B (primary recreation, such as swimming, and all class C uses), and WS-I through WS-V(water supply source ranging from highest watershed protection level I to lowest watershed protection V, and all class C uses). Lakes with a CA designation represent water supplies with watersheds that are considered to be Critical Areas (i.e., an area within 1/2 mile and draining to water supplies from the normal pool elevation of reservoirs, or within 1/2 mile and draining to a river intake). Supplemental classifications in the New Fear River basin may include SW (slow moving Swamp Waters where certain water quality standards may not be applicable), NSW (Nutrient Sensitive Waters subject to excessive algal or other plant growth where nutrient controls are required), HQW (High Quality Waters which are rated excellent based on biological and physical/chemical characteristics), and ORW (Outstanding Resource Waters which are unique and special waters of exceptional state or national recreational or ecological value). A complete listing of these water classifications and standards can be found in Title 15 North Carolina Administrative Code, Chapter 2B, Section .0100 and .0200.

The summary tables presented within the body of this document list lakewide averages of total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), chlorophyll *a* (CHLA in µg/l), and Secchi depth, followed by surface water classification. Causes of use impairment are explained below each table. Algal Growth Potential Tests (AGPT) have not been conducted on these lakes. There were three lakes in the Pasquotank River Basin sampled as part of the Lakes Assessment Program. These are Alligator Lake, Swan Creek Lake and Lake Phelps.

Each lake is individually discussed in the appropriate subbasin section in Chapter 4 with a focus on the most recent available data. Lake Phelps was sampled most recently in 1995. The other two lakes were sampled last in 1989.

A-II.4 AQUATIC TOXICITY MONITORING

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, Ceriodaphnia dubia). Results of these tests have been shown by several researchers to be predictive of discharge effects on receiving stream populations. Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Other facilities may be tested by DEM's Aquatic Toxicology Laboratory. The Aquatic Survey andToxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and DEM administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

The following table presents the facilities in the Pasquotank River Basin that are monitoring effluent toxicity.

Table A-II.3 NPDES Discharge Facilities in the Pasquotank River Basin Required to Monitor Whole Effluent Toxicity

Facility Name	NPDES No.	Subbasin	Monitoring Frequency	Limit
Elizabeth City WWTP	NC0025011/01	030150	quarterly	24-hour, pass/fail, acute - 90%
US Coast Guard	NC0079499/02	030150	annually, only when disch.	monitoring only; 24-hour, LC50, acute
Manteo WWTP	NC0079057/01	030151	quarterly	24-hour, pass/fail, acute - 90%
Dare Co. - Reverse Osmosis	NC0070157/01 and 02	030155	quarterly	24-hour, pass/fail, acute - 90%

APPENDIX III

Modeling Information

Modeling Information

INTRODUCTION

In order to assess the impact of pollutants on surface water quality, the Division must often develop and apply water quality models. A water quality model is a simplified representation of the physical, chemical, and biological processes which occur in a water body. The type of model used is dependent on the purpose for which it is needed, the amount of information that is available or attainable for its development, and the degree of accuracy or reliability that is warranted. In most cases, the Division develops and applies a given model to predict the response of the system to a given set of inputs that reflect various management strategies. For example, water quality models such as QUAL2E or the Division's Level B model are used to predict what the instream dissolved oxygen concentration will be under various sets of NPDES wasteflows and discharge limits. The following sections briefly summarize the types of models used by the Division.

Oxygen-Consuming Waste Models

Several factors are considered when choosing an oxygen-consuming waste model including: the type of system (stream, lake, or estuary), whether one, two, or three dimensions are needed, the temporal resolution needed, and the type of data available. Many of the factors are related. For example, in streams, flow usually occurs in one direction and one can assume that a steady state model will result in adequate predictions. A steady state model is one in which the model inputs do not change over time. However, in open water estuaries, the tide and wind affect which way water moves, and they must often be represented by 2 or 3 dimensional models. In addition, the wind and tide can affect the model reaction rates, and therefore a dynamic model must be used rather than one which is steady state. The last factor, the amount of data available, dictates whether an empirical or calibrated model will be used. An empirical model is used when little water quality information is available for a given water body, and hydraulics and decay rates are estimated through the use of equations. For example, in North Carolina's empirical stream model (referred to as a Level B analysis) velocity is determined through a regression equation developed from North Carolina stream time-of-travel (TOT) studies which includes stream slope and flow estimates as independent variables. Stream slope can be measured from a topographic map, and flow is estimated at a given site by the U.S. Geological Survey. Therefore, the empirical model can be run without TOT information specific to a given stream since parameters are estimated through the use of information which can easily be obtained in the office environment. More information regarding the empirical dissolved oxygen model used by DEM can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Field calibration of a BOD/DO model requires collection of a considerable amount of data. For example, in order to develop hydraulics equations specific to a given stream, TOT studies using rhodamine dye are recommended under at least two flow scenarios including one summer low flow period. In addition, during one summer low flow study, dissolved oxygen, temperature, long term BOD and nitrogen series data are collected. Sediment oxygen demand (SOD) data may also be collected. These data are then used to calibrate reaction rates specific to the stream. QUAL2E is the most commonly used calibrated DO/BOD model for streams in North Carolina. A copy of the model guidance can be obtained from EPA's Environmental Research Lab in Athens, Georgia, and further information on North Carolina's calibration procedures can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Data collection for an estuary DO model is even more extensive. Since the system is multi-dimensional and not steady-state, many more data are needed. Dye is often injected into a system over a period of time, and the dye cloud is then followed for a period of time which may last for days. In addition, several tide gages may need to be set up. Due to the stratification which occurs in an estuary, depth integrated data must also be collected. Calibrated estuary models which have been used by DEM include WASP and GAEST. WASP is also supported by EPA, and a user manual may be obtained from them. You should note that both GAEST is a one dimensional and is not applicable to many of North Carolina's estuaries.

Lakes are rarely modeled for BOD. Tributary arms of lakes are modeled as slow-moving streams if it is clearly indicated that the flow goes in one direction at all times. Depending on the system, a one, two, or three dimensional model may be used. If a one dimensional model is needed, the modeler may choose the Level B (if little or no data), or QUAL2E. In multidimensional lake systems, WASP will be used.

The calibrated model will be more accurate than the empirical model since it is based on data collected specifically for a given stream in the State. However, it is much more expensive to develop a calibrated model. Not only do a number of staff spend several days to weeks collecting field data (sometimes having to wait months for appropriate conditions), but it also takes the modeling staff several months to develop and document the calibrated model. An empirical model can be developed and applied in a matter of hours. Therefore, due to resource constraints, the majority of the BOD/DO models developed in North Carolina are empirical.

Eutrophication Models

Eutrophication models are used to develop management strategies to control trophic response of a system to nutrient inputs (usually total phosphorus (TP) or total nitrogen (TN)). Nutrient management strategies are typically needed in areas which are sensitive to nutrient inputs due to long residence times, warm temperature, and adequate light penetration. These characteristics are found in deep slow moving streams, ponds, lakes, and estuaries. Modeling and insitu research are used to relate nutrient loading to the trophic response to the system allowing the manager to establish nutrient targets. Models which may be used include the Southeastern Lakes Model (Reckhow, 1987), Walker's Bathtub Model (Walker, 1981), QUAL2E, and WASP.

Once the nutrient targets are known, watershed nutrient budgets are developed to evaluate the relative nutrient loadings from various point and nonpoint sources. Land use data are obtained for the basin, and export coefficients based on literature values are applied to each land use. An export coefficient is an estimate of how may pounds of nutrient will runoff from each acre of land in a given year.

Toxics Modeling

Toxics modeling is done to determine chemical specific limits which will protect to the "no chronic" level in a completely mixed stream. The standards developed for the State of North Carolina are based on chronic criteria. These chemical specific toxics limits are developed through the use of mass balance models:

(Cup)(Qup) + (Cw)(Qw) = (Cd)(Qd) where

Cup = concentration upstream
Qup = flow upstream
Cw = concentration in wastewater (known being solved for in WLA)
Qw = wasteflow

Cd = concentration downstream (set = to standard or criteria)
Qd = flow downstream (= Qup + Qw)

When no data are available concerning the upstream concentration, it is assumed to be equal to zero. The upstream flow is the 7Q10 at the discharge point unless the parameter's standard is based on human health concerns, in which case the average flow is used.

REFERENCES CITED - MODELING APPENDIX

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APPENDIX IV

STATUS OF THE IMPLEMENTATION OF THE WATER QUALITY RECOMMENDATIONS CONTAINED IN THE COMPREHENSIVE CONSERVATION AND MANAGEMENT PLAN

IMPLEMENTATION of the CCMP:

Summary of the CCMP's Water Quality Plan
for the Pasquotank River Basinwide Management Plan

WATER QUALITY PLAN

GOAL: Restore, maintain or enhance water quality in the Albemarle-Pamlico region so that it is fit for fish, wildlife and recreation.

OBJECTIVE A: IMPLEMENT A COMPREHENSIVE BASINWIDE APPROACH TO WATER QUALITY MANAGEMENT.

Effective management of water resources ultimately relies on the consideraton of system-wide processes and the cumulative impacts of activities across a river basin. The Division of Water Quality is approaching water quality research, management, and discharge permitting from a basinwide scale. This approach allows for a better balancing of point and nonpoint source contributions and control strategies.

Management Action 1: Develop and begin implementing basinwide plans to protect and restore water quality in each basin according to the schedule established by the Division of Environmental Management's Water Quality Section. The plans would include provisions for basinwide wetland protection and restoration.

The Division of Water Quality (DWQ) continues to develop basinwide management plans for all seventeen major river basins in the state according to schedule. DWQ coordinates with appropriate state and federal agencies to develop comprehensive basinwide plans that provide mechanisms to characterize water quality and biological resources within basins, target problematic watersheds, and manage water resources to support long-term growth. DWQ is currently incorporating wetland protection initiatives and targeting sites for wetland restoration, whenever wetland inventories are available, into the basinwide water quality management plans. This initiative began with the Roanoke River Basin Plan and has been incorporated in the Pasquotank River Basin Plan. This effort will become more comprehensive as additional wetland resource information is developed.

Management Action 2: Establish total maximum daily loads (TMDLs) and associated control strategies for all impaired streams in the Albemarle-Pamlico region by 1999.

DWQ uses TMDLs (total maximum daily loads) as a strategy for establishing water quality based controls on point and nonpoint sources of a given pollutant identified as contributing to a waterbody's impairment. TMDLs for exact locations are completed each time the DWQ performs a Waste Load Allocation for a NPDES permit. There are approximately 2000 of these completed for state waters at this time. The basinwide water quality management plans developed by the Division of Water Quality, contains information on specific and general TMDLs located in each respective river basin. General TMDLs for specific water quality parameters have been completed for many locations.

Management Action 3: **Renew all discharge permits in a river basin simultaneously by 1999.**

DWQ's scheduled basinwide plans allow for synchronous renewal of discharge permits within respective river basins of the state. Under this approach, a basinwide NPDES permitting cycle was established in 1990. This is part of the basinwide management process currently underway in the Pasquotank River Basin. Basinwide NPDES permitting is scheduled to commence in February 1998 for this river basin. All NPDES permit renewals in the Albemarle-Pamlico region will be handled in this manner by 1999.

Management Action 4: **Consider the potential for long-term growth and its impacts when determining how a basin's assimilative capacity will be used.**

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.

Wasteload allocations (WLAs) are performed by DWQ using models of varying scope and complexity, depending on the type of waste of interest and the characteristics of the receiving waters. DWQ uses models 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. For new dischargers or for expanding dischargers, DWQ utilizes models to determine the existing assimilative capacity for that waterbody.

Management Action 5: **Improve the scientific models for understanding the estuarine system, the effects of human activities on the system and the viability of alternative management strategies.**

DWQ is working to enhance scientific modeling capabilities in the Neuse River Basin. The goal of the current Neuse River Basin modeling efforts is to provide tools to assist with efforts to determine appropriate and effective nitrogen control measures that will protect water quality in the Neuse River Estuary. To achieve this goal, three major modeling efforts are underway. Land Use Models will be used with point source discharge data to estimate total nitrogen loading to the river basin. A Fate and Transport Model will then be used to estimate how much of the total nitrogen load will arrive at the Estuary. And finally, a Nutrient Response Model will be used to predict how changes in nitrogen loading will impact water quality. It is intended that the information resulting from this modeling effort be applied in the Pasquotank River Basin to enhance our understanding of that system.

<u>Management Action 6</u>: **Continue long-term, comprehensive monitoring of water quality in the APES system, collecting data to assess general system health and target regional problems.**

DWQ's water quality monitoring programs continue to monitor water quality through a network of fixed stations within the Pasquotank River Basin. DWQ's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. DWQ has also benefitted from data collected by the US Geological Survey under that agency's NAWQUA water quality sampling program.

The Albemarle-Pamlico Citizen Water Quality Monitoring Program, a volunteer effort established in 1987, has also contributed to water quality monitoring efforts in the Pasquotank Basin. Currently, there are six sites being monitored by citizens in this basin.

OBJECTIVE B: REDUCE SEDIMENTS, NUTRIENTS AND TOXICANTS FROM NONPOINT SOURCES.

Nonpoint sources of pollution are varied and are usually difficult to regulate. Targeted reductions can be accomplished by building on present programs and efforts. To accomplish true reductions, the CCMP recommends a three-pronged approach consisting of research and demonstration projects, incentive-based programs, and regulatory action and enforcement.

<u>Management Action 1</u>: **For each river basin, develop and implement a plan to control nonpoint source pollution as part of the basinwide management plans.**

Water Quality problems encountered in the Pasquotank River basin are primarily due to agricultural nonpoint source runoff. A river basin nonpoint source team has been established for the Pasquotank River Basin. The nonpoint source team will work toward creating Action Plans to address nonpoint source concerns for the Pasquotank River basin. The Action Plans will be an integral part of the basinwide planning process being implemented by DWQ.

<u>Management Action 2</u>: **Expand funding to implement nonpoint source pollution controls, particularly agricultural best management practices through the N.C. Agriculture Cost Share Program, and also to develop a broader Water Quality Cost Share Program. Expand the cost share programs to include wetlands restoration. Increase cost share funds to problem areas.**

The 1996 NC General Assembly increased the amount of money available to farmers under the NC Agriculture Cost Share Program by $1,750,000 for the Neuse River Basin and an additional $5,750,000 for the remaining river basins of the state. The Division of Soil & Water Conservation (DSWC) and Soil & Water Conservation Districts will target funding and technical assistance to priority areas identified through the basinwide nonpoint source control plans. DSWC has hired additional personnel to provide technical assistance to farmers in implementing BMPs to control runoff.

Though it is not considered a cost share program, the General Assembly has recently approved the establishment of a Wetlands Restoration Program within the state. With initial funding of over $9 million, this program is intended to help restore the functions and values to degraded wetland areas located across the state.

Management Action 3: Continue to research and develop alternative septic systems and new best management practices to reduce nonpoint source pollution.

Failing septic tanks have been identified as a source of fecal coliform bacteria in some surface waters of the Pasquotank River Basin. The Division of Environmental Health (DEH) has established a research/education facility in Chatham County to determine the effectiveness of alternative septic systems and to train personnel regarding the installation, maintenance, and repair of the various types of systems. DEH plans to establish similar sites near Asheville (mountains) and Plymouth (coastal plain) that would facilitate efforts by the On-site Wastewater Section to develop and demonstrate alternative septic systems under a variety of site and soil conditions. Research from the pending Plymouth facility could provide very useful information regarding septic system improvememts in the Pasquotank River basin.

BMPs for urban, agricultural, and forestry settings have been evaluated for their cost-effectiveness in controlling nutrients in the Neuse River basin. Much emphasis is placed on nutrient management planning and controlled drainage as important BMPs used to control nutrients. Several projects have recently received funding to improve knowledge of effectiveness of various traditional and innovative BMPs in improving water quality.

Management Action 4: Strengthen current enforcement to detect and correct ground and surface water quality violations from nonpoint sources.

The NC General Assembly (summer 1995) approved eight new positions (three for Use Restoration Waters; five for animal operations) to enhance inspection and enforcement of DWQ's surface water and ground water protection efforts.

Management Action 5: Strengthen implementation of forestry best management practices through training, education, technical assistance and enforcement.

The Division of Forest Resources (DFR) received limited, temporary funding to hire three BMP foresters statewide. This funding occurred in FY 1994-95 and 1995-96. These temporary positions were used to provide on-the-ground training, classroom education, technical assistance, and enforcement efforts. The need to hire permanent water quality (BMP) foresters exists statewide as well as in the five DFR districts which encompass the Albemarle-Pamlico region .

The DFR examined 3318 tracts statewide for FPG/BMP compliance in FY 1995-96. Of the 192 initially in a non-compliance status, nine had to be referred to either the Division of Land Resources or Division of Water Quality for enforcement action.

In a joint statewide educational effort, the DFR, the NC Forestry Association, the Cooperative Extension Service and forest industry have worked to provide forest management and water quality protection training to more than 1550 loggers and timber buyers through the ProLogger Program.

Management Action 6: **Enhance stormwater runoff control by strengthening existing regulations and developing new ones, if needed, by 1995. Improve enforcement to ensure that stormwater management systems are properly installed and regularly maintained.**

The Pasquotank River Basin has experienced a significant increase in population over the past twenty years. In addition, thousands of tourists flock to this area each season, increasing demand for roads, resorts, restaurants, and recreational facilities. Environmental planning will be essential to conserve and protect the region's water quality, vital habitats, natural heritage, and fisheries.

Throughout the Pasquotank River basin various types of industrial activities with point source discharges of stormwater are required to be permitted under the NPDES stormwater program. Industrial facilities can reduce stormwater impacts by developing a comprehensive site-specific Stormwater Pollution Prevention Plan. In addition, all permitted facilities are required to perform qualitative monitoring (periodic visual inspection of each stormwater outfall).

Stormwater problems are likely to be associated with urban areas in the basin. According to the nonpoint source team established for this basin, increased development is leading to problems with sedimentation and wastewater discharge. There are no municipalities in the Pasquotank River basin required to obtain NPDES permits to manage stormwater runoff within their jurisdiction. Table 6.9 of this basin plan contains recommendations for urban stormwater control.

Management Action 7: **Implement an inter-agency state policy that addresses marina siting and integrates best management practices through permitting and better public education.**

The current permitting process allows for inter-agency coordination for the review of new marina permits. However, there has been no formal organization of an inter-agency marinas policy committee to address the cumulative impacts of marina sittings in the coastal zone as referred to in this management action.

The Division of Coastal Management (DCM) has geo-located all marina and dockage facilities throughout the coastal area. GIS information include size, number of wet and dry slips, services, and support facilities. In addition to this information being made available to local governments for land use planning purposes, staff are using it to assess cumulative and secondary impacts of proposed new marinas and additions. DCM has also worked to develop a coordinated SEPA review and public trust lease review for all marinas with the Division of Water Quality, the Division of Marine Fisheries, the Wildlife Resources Commission and other state agencies.

To strengthen marina BMPs, DCM (via a grant from The Clean Vessel Act) provided funding to marina operators to install pump-out stations at their facilities. In 1995, 24 marinas were equipped with pump-out stations -- 12 of these marinas were located in the Albemarle-Pamlico region. This initiative continued through 1996.

OBJECTIVE C: REDUCE POLLUTION FROM POINT SOURCES, SUCH AS WASTEWATER TREATMENT FACILITIES AND INDUSTRY.

In addition to the reduction of point source impacts gained through the utilization of basinwide management planning, the CCMP indicates that further gains can be made through the use of proactive management strategies such as pollution prevention and increased emphasis on facility inspections and monitoring.

Management Action 1: **Promote pollution prevention planning and alternatives to discharge, where feasible, for all point sources to reduce the volume and toxicity of discharges.**

All of the state's major municipal dischargers, and most of the minor municipal dischargers, utilize pretreatment programs. There is increased coordination between the Office of Waste Reduction's Pollution Prevention Program and DWQ's Pretreatment Program to help reduce/improve inputs and operating costs from point source dischargers.

However, as identified in this basin plan, there is a need to improve pretreatment of the industrial wastes received by the wastewater treatment plants and to encourage pollution prevention at the various industrial facilities located in the Pasquotank River basin.

Municipal or industrial wastewater facilities are required to either land apply their waste (for municipal plants) or meet discharge limits for nitrogen and phosphorus. A number of municipal wastewater treatment facilities in the Pasquotank Basin use land application systems instead of discharging into surface waters. However, these facilities are experiencing problems when the amount of wastewater being applied exceeds the hydrolgic capacity of the land receiving the effluent.

Management Action 2: **Expand and strengthen enforcement of National Pollutant Discharge Elimination System (NPDES) permits. Increase site inspections and review of self-monitoring data to improve facility compliance by 1995.**

In order to be more proactive in preventing permit violations and resulting water quality degradation, the CCMP recommends an increase in staff for DWQ's Compliance Group.

This would allow a more thorough review of monitoring data by DWQ, as well as enhancing the agency's inspection effort. Increased inspections provide the benefit of improved communication between DWQ and dischargers and early detection of potential problems which prevents some violations before they occur. Due to budget limitations, DWQ's Compliance Group has not been able to increase staff to enhance this effort.

OBJECTIVE D: REDUCE THE RISK OF TOXIC CONTAMINATION TO AQUATIC LIFE AND HUMAN HEALTH.

The CCMP indicates that several sites within the Pasquotank River basin were identified as exceeding levels of concern for toxic contaminants in ambient water, sediment, and/or fish tissue. State and federal agencies should coordinate monitoring efforts for these environmental media to provide the maximum geographic and most cost-effective monitoring coverage. It is important to further evaluate the potential impact to aquatic life, wildlife, and human health, and to identify additional contaminated sites.

Management Action 1: **Increase efforts to assess and monitor the extent of estuarine sediment contamination, fish and shellfish tissue contamination, water quality violations, and to identify the causes and sources of these problems.**

Utilizing data from its monitoring program, DWQ is working to better identify the causes and sources of contaminants in the Pasquotank River basin. For instance, DWQ has determined that the largest areas of closed shellfish (SA) waters in the basin are in Roanoke Sound, Croatan Sound, and eastern Albemarle Sound and that urban runoff, failing septic tank systems and marinas are contributing to the impairment.

DWQ's Intensive Survey Group continues to monitor for water quality at those sites identified as being most contaminated. DWQ's Biological Assessment Group continues to monitor and analyze for chemical contaminants in fish tissues. Much of the analyses of fish tissues focuses on metals and dioxins. The Group conducts basin assessments of fish tissue contamination according to the schedule established by the Basinwide Management Program. When necessary, special studies are conducted in areas of concern. Over the years, there have been a few special studies conducted in the Pasquotank River basin -- the largest of these was an intensive water quality survey of Currituck Sound in response to a request to designate these waters as Outstanding Resource Waters (ORW).

DWQ and other environmental agencies are discussing ways to improve monitoring coverage through better coordination of field resources. Enhanced inter-agency coordination and cooperation would help create a more effective and comprehensive monitoring initiative in the Pasquotank River basin.

<u>Management Action 2</u>: **Continue to issue fish advisories as necessary to protect public health. Improve communication and education about the risks associated with eating contaminated fish and shellfish.**

As stated above, DWQ's Biological Assessment Group continues to monitor and analyze for chemical contaminants in fish tissues and special studies are conducted in the basin as necessary. When analysis of fish tissues result in levels exceeding FDA or EPA screening levels, the Biological Assessment Group notifies the Division of Epidemiology's Occupational and Environmental Epidemiology Section (OEES). The OEES reviews the fish tissue analysis and issues a fish consumption advisory as necessary. Currently, there are two fish consumption advisories in the Pasquotank River basin. One is for dioxin in the western Albemarle Sound and the other one is for mercury in Lake Phelps.

<u>Management Action 3</u>: **Remediate toxic contamination where necessary and feasible.**

Currently, no remedial action has occurred involving the removal of contaminated sediment. Known contaminated sediment sites are being monitored.

OBJECTIVE E: EVALUATE INDICATORS OF ENVIRONMENTAL STRESS IN THE ESTUARY AND DEVELOP NEW TECHNIQUES TO BETTER ASSESS WATER QUALITY DEGRADATION.

Several highly visible indications of environmental stress in the Albemarle-Pamlcio esturay include chronic algal blooms, fish and shellfish kills, and fish and shellfish disease. To provide the widest geographic and most cost-effective monitoring coverage and to better track these environmental stress indicators, the CCMP calls for improved coordination of monitoring efforts by state and federal agencies and citizen groups. Resources should be concentrated to establish a response network to identify and collect data on algal blooms, fish and shellfish kills, and fish and shellfish disease outbreaks; improve management tools to address shellfish contamination; and accelerate the development and application of new bio-assessment techniques to evaluate cumulative environmental impacts to estuarine waters.

<u>Management Action 1</u>: **Continue to track and evaluate indicators of environmental stress, including algal blooms, fish kills, and fish and shellfish diseases.**

There has been no formal organization of an environmental stress indicators response network as referred to by this management action. However, the Division of Water Quality, Division of Water Resources, and the Wildlife Resources Commission's Division of Boating and Inland Fisheries, within their existing field personnel structure, are in the process of creating a standardized fish kill information form that would incorporate all data by those agencies who are investigating fish kill episodes. This information will help to establish a single and more comprehensive data base on fish kills. A fish kill database comprised of data from these agencies will provide a more complete and accurate picture of the cause and extent of the kills. This should, in turn, lead to development of measures to help prevent future kills.

<u>Management Action 2</u>: Improve the techniques for evaluating the overall environmental health of estuarine waters.

DWQ's Biological Assessment Group recently developed an Estuarine Biotic Index to help improve techniques used to evaluate indicators of water quality degradation in estuarine waters. A final report was submitted to EPA in July 1995.

Based on habitat heterogeneity studies, conducted for preparation of the Estuarine Biotic Index, DWQ has learned that the best habitat for monitoring changes in water quality is sea grasses. Man-made structures, rocks, wood, crab pots and nets all scored as well as sea grasses for being inhabited by water quality sensitive taxa. Oyster bars appear to be the least useful place to sample. Despite the large number of taxa that can be collected near oyster bars, most are very pollution tolerant so differentiation of changes in water quality are difficult. DWQ has recently received additional funding from EPA to continue this effort.

<u>Management Action 3</u>: Develop and adopt better indicators of shellfish contamination as soon as possible.

Due to a lack of federal funding, efforts by NOAA's National Indicator Study to develop better indicators of shellfish contamination have been put on hold. Even if this program should receive future funding, it would take several more years of scientific research to develop the necessary indicators.

APPENDIX V

Lists of Best Management Practices (BMPs) For:

- Agriculture
- Urban Runoff
- Erosion and Sedimentation Control
- Onsite Wastewater Disposal
- Solid Waste Disposal
- Forestry
- Mining
  - Hydrologic Modifications

BMPs FOR AGRICULTURE

Detailed Implementation Plan*
September 1996 (Revised)

Definition of Practices

(1) An agrichemical handling facility means a permanent structure that provides an environmentally safe means of mixing agrichemicals and filling tanks with agrichemicals for the application and storage of agrichemicals to prevent accidental degradation of surface and ground water.

(2) A conservation tillage system means any tillage and planting system in which at least (30) thirty percent of the soil surface is covered by plant residue to reduce soil erosion and improve the quality of surface water.

(3) A critical area planting means an area of highly erodible land which can not be stabilized by ordinary conservation treatment on which permanent perennial vegetative cover is established and protected to reduce soil erosion and sedimentation and to improve the quality of surface water.

(4) A cropland conversion practice means to establish and maintain a conservation cover of grasses, trees, or wildlife plantings on fields previously used for crop production to reduce soil erosion and sedimentation and to improve the quality of surface water.

(5) A diversion means a channel constructed across a slope with a supporting ridge on the lower side to control drainage by diverting excess water from an area to reduce soil erosion and sedimentation and to improve the quality of surface water.

(6) A field border means a strip of perennial vegetation established at the edge of the field that provides a stabilized outlet for row water to reduce erosion, sedimentation and nutrient pollution to improve the quality of surface water.

(7) A filter strip means an area of permanent perennial vegetation for removing sediment, organic matter, and other pollutants from runoff and waste water to reduce erosion, sedimentation and nutrient pollution to improve the quality of surface water.

(8) A grade stabilization structure means a structure (earth embankment, mechanical spillway, detention-type, etc.) used to control the grade and head cutting in natural or artificial channels to reduce erosion and sedimentation and to improve the quality of surface water.

(9) A grassed waterway means a natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff to reduce erosion and sedimentation and to improve the quality of surface water.

(10) A heavy use protection area means an area used frequently and intensively by animals which must be stabilized by surfacing with suitable materials to reduce erosion, sedimentation and nutrient pollution to improve the quality of surface water.

(11) A livestock exclusion system means a system of permanent fencing (board, barbed, high tensile or electric wire) installed to exclude livestock from streams and critical areas not intended for grazing to reduce erosion, sedimentation and to improve the quality of surface water.

(12) A long term no-till practice means planting all crops for five consecutive years in at least 80 percent plant residue from preceding crops to reduce soil erosion and sedimentation and improve the quality of surface water.

(13) A pastureland conversion practice means establishing trees or perennial wildlife plantings on excessively eroding Class VII land being used for pasture that is too steep to mow or maintain with conventional equipment to reduce soil erosion and sedimentation and to improve the quality of surface water.

(14) A nutrient management practice means a definitive plan to manage the amount, form, placement, and timing of applications nutrients to minimize entry of nutrient to surface and groundwater and to improve water quality.

(15) A rock-lined outlet means a waterway having an erosionresistant lining of concrete, stone or other permanent material where an unlined or grassed waterways would be inadequate to provide safe disposal of runoff, reduce erosion and sedimentation and to improve the quality of surface water.

(16) A sediment basin means a basin constructed to trap and store waterborne sediment where physical conditions or land ownership preclude treatment of a sediment source by the installation of other erosion control measures to improve the quality of surface water.

(17) A sod-based rotation practice means an adapted sequence of crops and grasses established and maintained for a definite number of years which is designed to provide adequate organic residue for maintenance or improvement of soil filth to help reduce erosion and improve surface water quality.

(18) A stock trail or walkway means to provide a stable area used frequently and intensively for livestock movement by surfacing with suitable material to reduce erosion sedimentation and nutrient pollution to improve the quality of surface water.

(19) A stream protection system means a planned system for protecting streams and streambanks which eliminates the need for livestock to be in streams by providing an alternative watering source for livestock to reduce erosion and sedimentation and to improve the quality of surface water. System components may include:

- (A) A spring development means improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities.
- (B) A trough or tank means devices installed to provide drinking water for livestock at a stabilized location.
- (C) A well means constructing a drilled, driven or dug well to supply water from an underground source.
- (D) A windmill means erecting or constructing a mill operated by the wind's rotation of large vanes and is used as a source of power for pumping water.

(E) A stream crossing means a trail constructed across a stream to allow livestock to cross without disturbing the bottom or causing erosion on the banks.

(20) A stripcropping practice means to grow crops and sod in a systematic arrangement of alternating strips on the contour to reduce soil erosion and sedimentation and to improve the quality of surface water.

(21) A terrace means an earth embankment, a channel, or a combination ridge and channel constructed across the slope to reduce erosion, reduce sediment content in runoff water, and to improve the quality of surface water.

(22) A waste management system means a planned system in which all necessary components are installed for managing liquid and solid waste to prevent or minimize degradation of soil and water resources. System components may include:

(A) A waste storage pond means an impoundment made by excavation or earthfill for temporary storage of animal waste, waste water and polluted runoff.
(B) A drystack means a fabricated structure for temporary storage of animal waste.
(C) A composter/storage structure means a facility for the biological treatment, stabilization and environmentally safe storage of organic waste material (such as livestock and poultry manure and dead animal carcasses) to produce a material that can be recycled as a soil amendment and fertilizer substitute.
(D) A waste treatment lagoon means an impoundment made by excavation or earthfill for biological treatment and storage of animal waste.
(E) A waste application system means an environmentally safe system (such as solid set, dry hydrant, mobile irrigation equipment, etc.) for the conveyance and distribution of animal wastes from waste treatment and storage structures to agricultural field as part of an irrigation and nutrient management plan.
(F) A constructed wetlands for land application practice means an artificial wetland area into which liquid animal waste from a waste storage pond or lagoon is dispersed over time to lower the nutrient content of the liquid animal waste.
(G) A controlled livestock lounging area means a planned, stabilized and vegetated area in which livestock are kept for a short duration.
(H) A closure of abandoned waste treatment lagoons and waste storage ponds practice means the safe removal of existing waste and waste water and the application of this waste on land in an environmentally safe manner.
(I) A storm water management system means a system of collection and diversion practices (buttering, collection boxes, diversions, etc.) to prevent unpolluted storm water from flowing across concentrated waste area on animal operations.

(23) A water control structure means to provide control of surface and subsurface water through the use of permanent structures which increase infiltration and reduce runoff to improve the quality of surface and ground water.

(24) A waste utilization plan means a plan of using animal waste on land in an environmentally acceptable manner while maintaining or improving soil and plant resources to safeguard water resources.

(25) An insect control practice means an method of pest management used in an integrated pest management program to control target organisms and minimize contamination of soil, water, and air, and minimize impacts to non-target organisms through cultural, biological and physical practices including safe and prudent use of pesticides.

(26) A riparian buffer means an area adjacent to solid blue line streams as shown on 7.5 minute USGS maps where a permanent, long-lived vegetative cover (sod, shrubs, trees, or a combination of vegetation types) is established to reduce soil erosion, sedimentation, nutrient and pesticide pollution, and to improve the quality of surface water and shallow ground water.

(27) An odor control management system means a practice or combination of practices (planting windbreaks, precharging structures, incorporation of waste into soil, etc.) which manages or controls odors from confined animal operations, waste treatment and storage structures and waste applied to agricultural land.

*To be used in conjunction with the most recent version of the APA Rules for the North Carolina Agriculture Cost Share Program for Nonpoint Source Pollution Control and the NCACSP Manual.

Best Management Practices Eligible for Cost Share Payments

Best Management Practices eligible for cost sharing include the following practices and any approved District BMPs. District BMPs shall be reviewed by the Division for technical merit in achieving the goals of this program. Upon approval by the Division, the District BMPs will be eligible to receive cost share funding.

The minimum life expectancy of the BMPs is listed below. Practices designated by a District shall meet the life expectancy requirement established by the Division for that District BMP. The list of BMPs eligible for cost sharing may be revised by the Commission as deemed appropriate in order to meet program purpose and goals.

Practice	Minimum Life Expectancy (years)
Agrichemical Handling Facility	10
Conservation Tillage System	10
Critical Area Planting	10
Cropland Conversion	10
Diversion	10
Field Border	10
Filter Strip	10
Grade Stabilization Structure	10
Grassed Waterway	10
Heavy Use Area Protection	10
Insect Control	5
Livestock Exclusion	10
Long Term No-Till	5
Mobile Irrigation Equipment	10
Pastureland Conversion	10
Nutrient Reduction Management System	3
Rock-lined Waterway or Outlet	10
Sediment Control Structure	10
Sod-based Rotation	4 or 5
Stock Trail and Walkway	10
Stream Protection System	
Spring Development	10
Trough or Tank	10
Well	10
Windmills	10
Stream Crossing	10
Stripcropping	5

Riparian Buffer	10
Terrace	10

Best Management Practices Eligible for Cost Share Payments (continued)

Waste Management System	
Waste Storage Pond	10
Waste Storage Structure	10
Waste Treatment Lagoon	10
System for Land Application of Animal Waste	10
Wetlands Development for Land Application	10
Controlled Livestock Lounging Area	10
To-Be-Abandoned or Abandoned Confined	
Animal Operation (CAO)	5
Odor Control	1 to 10
Water Control Structure	10

Agricultural Best Management Practices

I. Crop and Pasture Lands

A. BMPs for Sediment Control
- Conservation Tillage System
- Critical Area Planting
- Cropland Conversion
- Diversion
- Field Border
- Filter Strip
- Grade Stabilization Structure
- Grassed Waterway
- Rock-lined Waterways or Outlets
- Sediment Control Structure
- Sod-based Rotation
- Stripcropping
- Terrace
- Water Control Structure
- Pastureland Conversion

B. BMPs for Nutrient Control
- Legumes in Rotation
- Soil Testing
- Liming
- Setting Realistic Crop Yield Goals (determines fertilization rates)
- Fertilizer Waste Application (method, rate, and timing)
- Sediment Control BMPs

C. BMPs for pesticide control
- Alternative Pesticides
- Optimize Pesticide Formulation, Amount, Placement Timing, Frequency
- Crop Rotation
- Resistant Crop Varieties
- Other Cultural or Biological Controls
- Optimize Crop Planting Time
- Plant Pest Quarantines
- Proper Disposal of Obsolete Pesticides and Containers
- Certification of Applicators
- Sediment Control BMP's

II. Animal Production (esp. Confined Animal Operations)

BMPs for bacteria and nutrient control
- Grade Stabilization Structures
- Heavy Use Area Protection
- Livestock Exclusion
- Spring Development
- Stock Trails and Walkways
- Trough or Tank
- Waste Management System
- Waste Storage Pond
- Waste Storage Structure
- Waste Treatment Lagoon
- Land Application of Waste
- Water Control Structure

BMPs FOR URBAN STORMWATER

Structural Best Management Practices for urban runoff control are typically designed to reduce sediment, its attached pollutants, and nutrients. In addition, other BMPs protect the riparian ecosystem, provide streambank stabilization, provide shade to water bodies and reduce the likelihood of excessive water temperatures. Non-structural BMPs, such as a design manual or a public education program, encourage the comprehensive and effective implementation of structural BMPs. The table below contains a list of both structural and non-structural BMPs. This list is taken from the *Stormwater Management Guidance Manual*, published by DWQ's Water Quality Planning Branch in 1995. The *Manual* provides a detailed discussion of each of the BMPs, including its characteristics, pollutant-specific effectiveness, reliability, feasibility, costs, unknown use factors, design considerations, and references for further information.

STRUCTURAL BMPs
I. Wet Detention Basin
II. Constructed Wetlands
• Wet Retention Basin
• Dry Detention Basin
• Infiltration Basin
• Vegetative Practices
◊ Filter Strips
◊ Grassed Swales with Check Dams
• Sand Filter
• Oil and Grease Separator
• Rollover-Type Curbing
NON-STRUCTURAL BMPs
I. Preventive Measures
II. Pollutant Minimization
• Exposure Reduction (proper scheduling, etc. - see Manual)
• Landscaping and Lawn Maintenance Controls
• Animal Waste Collection
• Curb Elimination
• Parking Lot and Street Cleaning
• Road Salt Application Control
• Catch Basin Cleaning
III. Riparian area protection
IV Design Manual for Urban BMPs
V Public Education
VI. Identification and Enforcement of Illegal Discharges
VII. Land-Use Control
• Low-Density Development
• Comprehensive Site Planning
• Buffer Zone
• Sanitary Waste Management
VIII. Conservation Easement

Structural BMPs may affect groundwater quality in certain situations. Devices that recharge groundwater pose the risk of passing soluble pollutants into groundwater systems. It is not currently known whether pollutant concentrations in recharged groundwater areas pose a significant environmental or health risk. USGS is presently studying groundwater quality effects of urban BMPs. In addition, if funds are made available, DWQ may conduct a similar study in North Carolina.

BMPs FOR EROSION AND SEDIMENTATION CONTROL

Best Management Practices suggested pursuant to the NC Sedimentation Pollution Control Act of 1973 are selected on the basis of performance in providing protection from the maximum peak rate of runoff from a 10-year storm. This allows the developer/designer of the control measures, structures, or devices to determine and submit for approval the most economical and effective means of controlling erosion and preventing sedimentation damage. Practices are therefore reviewed for acceptability based upon the characteristics of each individual site and its erosion potential. Ideally, the erosion control plan will employ both practices and construction management techniques which will provide the most effective and reasonable means of controlling erosion while considering the uniqueness of each site. The following table provides a list of practices commonly used in sedimentation and erosion control plans across North Carolina.

Check Dam	Sand Fence (Wind Fence)
Construction Road Stabilization	Sediment Basin
Dust Control	Sediment Fence
Grade Stabilization Structure	Sod Drop Inlet Protection
Grass-lined Channels	Sodding
Grass Channels with Liner	Structural Streambank Stabilization
Land Grading	Subsurface Drain
Level Spreader	Surface Roughening
Mulching	Temporary Block & Gravel Inlet Protection
Outlet Stabilization Structure	Temporary Diversions
Paved Channels	Temporary Excavated Drop Inlet Protection Fabric Drop Inlet Protection
Paved Flume (Chutes)	Temporary Gravel Construction Entrance/Exit
Perimeter Dike	Temporary Sediment Trap
Permanent Diversions	Temporary Seeding
Permanent Seeding	Temporary Slope Drains
Permanent Stream Crossing	Temporary Stream Crossing
Right-Of-Way Diversions	Topsoiling
Riprap	Tree Preservation & Protection
Riprap-lined Channels	Trees, Shrubs, Vines & Ground Covers
Rock Dam	Vegetative Dune Stabilization
	Vegetative Streambank Stabilization

BMPs FOR ON-SITE WASTEWATER DISPOSAL

To protect public health and water quality, best management practices (BMPs) need to be implemented throughout the life cycle of an on-site wastewater disposal system. Life-cycle management problems can be addressed in three phases (Steinbeck, 1984). The first phase includes system siting, design, and installation. The second phase involves the operation of the system and phase three involves maintenance and repair when the system malfunctions or fails. As BMPs are applied in each life-cycle phase, the primary factor the success of the system is the participation of the local influencing health department and the cooperation of the developer, owner, design engineer, system operator, and the state. The table that follows gives a summary of the current life-cycle management practices and penalties utilized in North Carolina to implement the on-site sewage systems program (Steinbeck, 1984).

1. Application -- The developer or property owner meets with the staff of the local health department to review the project proposal and submits an application to the local health department that contains information regarding ownership, plat of property, site plan, type of facility, estimated sewage flow, and proposed method of sewage collection, treatment, and disposal.
2. Site Evaluation -- The local health department, with technical assistance from the state, evaluates the proposed sewage effluent disposal site for several factors, including slope, landscape position, soil morphology, soil drainage, soil depth, and space requirements. Next, the local health department will assign a site suitability classification, establish the design sewage flow, and the design loading rate for the soil disposal system.
3. Design Review --The applicant is required to submit plans and specifications for the sewage collection, treatment, and disposal system prepared by a professional engineer, for complex systems, or for systems exceeding 3,000 gal/day. Reviews are made by both state and local health departments. The designer must also include in the plans and specifications, installation procedures, phasing schedules, operation and maintenance procedures, monitoring requirements, and designate the responsible agents for operation and maintenance.
4. Legal Document Review -- For systems with multiple ownership or off-site disposal, the applicant must prepare and submit to state and local health departments for their legal review documents applicable to the project.
5. Improvement Permit -- Issued only after a successful review of the proposed project, including each of the items discussed above and allows construction to begin for the on-site sewage system. The improvement permit must be issued prior to other construction permits and allows only temporary electrical power to the site. This permit contains the necessary conditions for construction of the projects with the plans, specifications, and legal documentation appended to it.
6. Operation Permit -- Issued to the owner of the on-site sewage system by the local health department when it determines that all the requirements in the rules, plans and specifications are met; all conditions on the improvement permit are met; and the design engineer for the sewage collection, treatment, and disposal system certifies in writing to the local health department that the on-site system has been installed in accordance with the approved plans and specifications. The operation permit is also conditioned to establish performance requirements and may be issued for a specific period of time. It allows the on-site sewage system to be placed into use, prevents permanent electrical service to the project and prevents occupancy of the facilities until issued. The operation permit applies to systems larger than 480 gallons per day. A certificate of completion is required for conventional septic tank systems when the design sewage flow is less than 480 gal/day.

On-Site Wastewater Disposal BMPs (continued)

7.	Surveillance -- Once an on-site sewage system is placed into operation the local health department must make routine inspections at least annually for large systems to determine that the system is performing satisfactorily and not creating a public health nuisance or hazard. Additionally, required monitoring reports are routinely submitted to the local health department as required in the permits. The state provides technical assistance to the local health department and the system operator in assuring adequate performance. While annual inspections are required, frequent performance checks must be made by the local health department.
8.	Remedies -- When voluntary compliance with the performance requirements for the on-site system is unsuccessful, the General Statutes (1983) provide for the following remedies:
a)	Right of Entry -- Allows the state or local health department to enter the premises to determine compliance with the laws and rules and provides for an administrative search and inspection warrant when entry is denied.
b)	Injunction -- The state or local health department may institute an action for injunctive relief against the owner to bring the on-site sewage system into compliance.
c)	Order of Abatement -- The state or local health department is empowered to issue an order of abatement directing the owner to take any necessary action to bring the system into compliance. However, if the on-site system is determined to be creating an imminent health hazard, the state or local health department may, after previous unsuccessful attempts at correction, take the necessary action to correct the problem and recover any costs for abatement from the owner. This is the least frequently applied remedy.
d)	Administrative Penalties -- The state may impose administrative penalties up to $300 per day for violation of the laws, rules, or any permit condition for on-site sewage systems serving multi-family residences with a flow greater than 480 gal/day. A penalty of up to $50 per day can be assessed for malfunctioning systems where the flow is less than or equal to 480 gal/day.
e)	Suspension and Revocation of Permits -- The state may suspend or revoke a permit for violations of the laws, rules, or permit conditions upon a finding that a violation has occurred.
f)	Misdemeanor -- The owner who violates the sewage laws or rules shall be guilty of a misdemeanor and punishable by a fine or imprisonment as determined by the courts. This is the most frequently used remedy.

BMPs FOR SOLID WASTE MANAGEMENT

Best Management Practices for solid waste management address the water quality impacts of leachate migration and surface erosion. A list of BMPs for controlling solid waste impacts on water quality can be found in the table below.

The BMPs offer significant benefits for groundwater quality. Landfill liners will prohibit or greatly decrease the volume of leachate entering groundwater. In turn, leachate collection systems capture leachate for subsequent treatment rather than groundwater disposal. For even greater protection, groundwater and surface water monitoring should detect failures in the liner or collection system.

Reduce, Recover, and Recycle Solid Waste to Maximum Extent
Incineration with Energy Recovery
North Carolina Water Quality Monitoring Guidance Document for Solid Waste Facilities, 1987
Liners (Clay or Synthetic) for All New Landfills
Leachate Collection Systems
Erosion Control Plan
Operation and Maintenance Plan
Buffers Between Landfill and Streams, Property Lines and Dwellings
Groundwater Quality Monitoring
Surface Water Quality Monitoring
Public Education
Stormwater Runoff Control
Sedimentation Control

BMPs FOR FORESTRY

A. Performance Standards for Forestry Site Disturbing Activities in North Carolina

Forest Practices Guidelines Related to Water Quality (15A NCAC 1I.0101-.0209) have been adopted as published in the NCR, Volume 4, Issue 11, pages 601-604, and were effective January 1, 1990. These guidelines are summarized below.

Streamside Management Zone(SMZ)
• Must establish SMZ along natural, intermittent and perennial streams and water bodies. (Not required along man-made ditches and canals, although erosion protection is needed).
• Must have sufficient width and adequate ground cover to confine visible sediment (usually best to protect existing ground cover).
• Place roads, trails and decks outside of SMZ.
• Limited cutting(harvesting) is permitted within the SMZ.
Prohibition of Debris Entering Streams
• Prevent debris(logging slash, soil) of all types that can cause stream flow impediment or water quality degradation from entering intermittent and perennial streams and water bodies.
• Remove debris that accidentally enters streams.
Access Road and Skid Trail Stream Crossing
• Avoid crossing streams where possible.
• Avoid using stream channels as roads or trails.
• Construct crossings to minimize sediment entering streams.
• Protect stream banks and channels from damage.
• Provide water control devices and/or structures and, within 10 working days of initial disturbance provide ground cover sufficient to restrain accelerated erosion and prevent stream sedimentation.
Access Road Entrance
• Prevent soil and debris from being deposited on public highways which may result in stream sedimentation.
Keep Waste from Entering Streams, Water bodies and Groundwater
• Prevent oil, fuels, fertilizer and other chemical waste from entering streams, water bodies and groundwater.
Pesticide Application
• Application must follow labeling and N.C. Pesticides Board rules. Includes insecticides, fungicides, herbicides, and rodenticides.
Fertilizer Application
• Apply in a manner to prevent adverse impacts on water quality.
Stream Temperature
• Retain shade sufficient to prevent temperature fluctuations which result in a violation.
Rehabilitation of Project Site
• Within 30 working days after ceasing operations, provide sedimentation control measures to prevent water quality damage.
• Permanently stabilize SMZ areas and other areas that may directly contribute visible sediment to streams.

The Forestry Best Management Practices Manual was prepared to provide the means of meeting the above standards. The Manual is available from any DFR office at no charge.

B. BMPs for Forestry Operations in Wetlands

The Division of Forest Resources is in the process of developing BMPs for forested wetlands. Economic pressure to expand forestry activities in wetlands continues to increase. This expansion will require a sound strategy to protect these environmentally sensitive areas.

A Forested Wetlands BMP Committee was established in the winter of 1987. Committee members represent federal and state agencies, industry, education, and environmental groups who have a role in the fate of wetlands.

A Forested Wetlands BMP Committee was established in 1987. The members represented state and federal agencies, industry, education and conservation groups which have an interest or role in the fate of wetlands. In 1990, the *Best Management Practices for Forestry in the Wetlands of North Carolina* was published. The committee has been reconvened and is currently working to revise and update the wetland BMPs. This update will take into account the Corps of Engineer's and EPA's Application of Best Management Practices to Mechanical Site Preparation Activities for the Establishment of Pine Plantations in the Southeast. This EPA guidance restricts the areas that can be mechanically site prepared for planting in loblolly pine without a Section 404 permit.

In addition to the state's voluntary wetland BMPs, the Corps of Engineers has produced 15 mandatory BMPs for forest and farm road construction and maintenance in forested wetlands. These BMPs must be followed, or else a Section 404 permit is required for the road construction or maintenance. The 15 BMPs are listed below.

• Permanent roads (for forestry), temporary access roads (for forestry), and skid trails (for logging) in waters of the U.S. shall be held to the minimum feasible number, width, and total length consistent with silvicultural and local topographic and climatic conditions;
• All roads shall be located sufficiently far from streams or other water bodies (except for portions of such roads that must cross water bodies) to minimize discharges of dredged or fill material into waters of the U.S.;
• Road fill shall be bridged, culverted, or otherwise designed to prevent the restriction of expected flood flows;
• Fill shall be properly stabilized and maintained to prevent erosion during and following construction;
• Discharges of dredged or fill material into waters of the U.S. to construct road fills shall be made in a manner that minimizes encroachment of trucks, tractors, bulldozers, and other heavy equipment into waters of the U.S. (including adjacent wetlands that lie outside the lateral boundaries of the fill itself);
• In designing, constructing, an maintaining roads, vegetative disturbance in waters of the U.S. shall be kept to a minimum;
• Design, construction and maintenance of road crossings shall not disrupt the migration or other movement of those aquatic species inhabiting the water body;
• Borrow material shall be taken from upland sources whenever feasible;
• The discharge shall not take, or jeopardize the continued existence of, a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species;
• Discharges into breeding and nesting areas for migratory waterfowl, spawning areas, and wetlands shall be avoided if practical alternatives exist;
• Discharge shall not be located in proximity to a public water supply intake;
• The discharge shall not occur in areas of concentrated shellfish production;
• Discharge shall not occur in a designated National Wild and Scenic River;
• Discharge shall be of suitable material free from toxic pollutants in toxic amounts; and
• All temporary fills shall be removed in their entirety and the area restored to its original elevation.

BMPs FOR MINING OPERATIONS

Significant environmental damage can and often times does occur during land-disturbing activities of mining operations, especially during the initial stages. The potential for such damage can be substantially reduced with the installation of BMPs. Once the mining has terminated, BMPs are used to reclaim or reasonably rehabilitate the site (for mined lands after June 11, 1971). The basic objective of the reclamation is to establish on a continuing basis the vegetative cover, soil stability, and water and safety conditions appropriate to the area. The BMPs are performance-oriented, allowing a mining permit applicant to design and propose the most economical and effective means of a) controlling erosion and preventing off-site sedimentation damage; b) preventing contamination of surface waters and groundwater; and, c) preventing any condition that will have unduly adverse effects on wildlife or freshwater, estuarine, or marine fisheries. BMP selection is site-specific and controlled in part by the pre- and post-mining land use(s). The acceptability of a BMP is therefore based upon the characteristics of the individual site and its potential for off-site damage.

The table which follows provides a list of BMPs used for activities associated with mining activities in North Carolina. This list is essentially the same as that provided for Sedimentation and Erosion Control, due to the similar nature of activities in both programs.

Check Dam	Sediment Basin
Construction Road Stabilization	Sediment Fence
Dust Control	Sod Drop Inlet Protection
Grade Stabilization Structure	Sodding
Grass-lined Channel	Structural Streambank Stabilization
Grass Channels with Liner	Subsurface Drain
Groundwater Monitoring Wells	Surface Roughening
Land Grading	Temporary Block and Gravel Inlet Protection
Level Spreader	Temporary Diversions
Mulching	Temporary Excavated Drop Inlet Protection
Outlet Stabilization Structure	Temporary Fabric Drop Inlet Protection
Paved Flume (Chutes)	Temporary Gravel Construction Entrance/Exit
Perimeter Dike	Temporary Sediment Trap
Permanent Diversions	Temporary Seeding
Permanent Seeding	Temporary Slope Drains
Permanent Stream Crossing	Temporary Stream Crossing
Right-of-Way Diversions	Topsoiling
Riprap	Tree Preservation and Protection
Riprap-lined Channels	Trees, Shrubs, Vines & Ground Covers
Rock Dam	Vegetative Dune Stabilization
Sand Fence (Wind Fence)	Vegetative Streambank Stabilization

BMPs FOR HYDROLOGIC MODIFICATION (related to mining operations)

BMPs for Discharges of Dredged or Fill Material (Adapted from 40 CFR 230 - Guidelines for Specification of Disposal Sites for Dredged or Fill Material)

1. Actions concerning the location of the discharge.
a) Minimize smothering of organisms;
b) Avoid disruption of periodic water inundation patterns;
c) Select a previously used disposal site;
d) Select a disposal site with substrate similar in composition to the material being disposed;
e) Minimize extent of any plume; and
f) Minimize or prevent creation of standing bodies of waters in areas of normally fluctuating water levels.
2. Actions concerning the material to be discharged.
a) Maintain physiochemical conditions and reduce potency and availability of pollutants;
b) Limit solid, liquid and gaseous components;
c) Add treatment substances; and
d) Utilize chemical flocculants in diked disposal areas.
3. Actions controlling the materials after discharge.
a) Reduce potential for erosion, slumping or leaching by
i) using containment levees, sediment basins and cover crops to reduce erosion; and
ii) using lined containment areas to reduce leaching.
b) Cap in-place contaminated material with clean material;
c) Prevent point and nonpoint sources of pollution; and
d) Time the discharge to minimize impact, especially during unusual high water flows, wind, wave and tidal actions.
4. Actions affecting the method of dispersion.
a) Maintain natural substrate contours and elevation;
b) Minimize undesirable obstruction to the water current or circulation pattern;
c) Confine suspended particulate/turbidity to a small area where settling can occur;
d) Mix, dilute and disperse the discharge;
e) Minimize water column turbidity;
f) Maintain light penetration for organisms; and
g) Set limitations on the amount of material to be discharged per unit of time or volume of receiving water.
5. Actions related to technology.
a) Use appropriate equipment and machinery, including protective devices;
b) Employ appropriate operation and maintenance of machinery, including training, staffing and working procedures;
c) Use machinery and techniques designed to reduce damage to wetlands, including devices that scatter rather than mound excavated materials, machines with specially designed wheels or tracks, and the use of mats under heavy machinery to reduce compaction and rutting; and
d) Design access roads and channel spanning structures to accommodate fluctuating water levels and circulation patterns.

BMPs for Hydrologic Modification (continued)

6. Actions affecting plant and animal populations.
a) Avoid changes in water current and circulation patterns;
b) Prevent or avoid creating habitat conducive to the development of undesirable predators or species;
c) Avoid sites having unique habitat or other value, including endangered or threatened species;
d) Institute habitat development and restoration;
e) Avoid spawning or migration seasons and other biologically critical time periods; and
f) Avoid destruction of remnant natural sites within areas already affected by development.
7. Actions affecting human use.
a) Prevent or minimize damage to the aesthetically pleasing features of an aquatic site, including water quality;
b) Avoid disposal sites valuable as natural aquatic areas;
c) Avoid seasons or periods when human recreational activity associated with the aquatic site is most important;
d) Avoid sites which will increase incompatible human activity or require frequent dredge or fill maintenance in remote fish and wildlife areas; and
e) Locate disposal site outside of the vicinity of a public water supply intake.

APPENDIX VI

Existing Point And Nonpoint Source Water Quality Programs

APPENDIX VI

EXISTING POINT AND NONPOINT SOURCE POLLUTION CONTROL PROGRAMS

NORTH CAROLINA'S POINT SOURCE CONTROL PROGRAMS

Discharge permits are issued under the authority of North Carolina General Statute (NCGS) 143.215.1 and the National Pollutant Discharge Elimination System (NPDES) program. NPDES permits establish effluent limitations on the maximum level of wastes or pollutants, that may be discharged into surface waters. North Carolina has a very comprehensive NPDES program that includes the following major components:

1. NPDES Permit Review and Processing,
2. Wasteload Allocation Modeling,
3. Compliance Monitoring and Enforcement,
4. Aquatic Toxicity Testing,
5. Pretreatment,
6. Operator Certification and Training and
7. Nondischarge and Regional Wastewater Treatment Alternatives.

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

NPDES Permit Review and Processing

In North Carolina, the issuance of discharge permits is coordinated with the basinwide planning process. Thus, DWQ issues all discharge permits within a given basin at approximately the same time. These permits are valid for five years. New discharge permits issued during an interim period between cycles will have a shorter expiration period in order to coincide with the next basin permitting cycle. Thus, DWQ can more effectively monitor and modify its permitting system consistently across the river basins.

DWQ will not process a permit application until the application is complete. The requirements for discharge permit application and processing are outlined in Administrative Code Section: 15A NCAC 2H .0100 - Wastewater Discharges to Surface Waters. Under this rule, all applications must include a feasibility analysis on alternative disposal options, such as spray irrigation, and justification for the selection of the discharge option.

Applications for new discharges greater than 500,000 gallons per day of wastewater, 10 million gallons per day (MGD) of cooling water, or 1 MGD of any other type of effluent 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. DWQ may also require an Environmental Impact Statement or Environmental Assessment, under the NC Environmental Policy Act for certain publicly funded projects.

DWQ staff establish waste limits for permit applications based on a wasteload allocation process (described in the following section). The staff review also includes a site inspection (for existing facilities up for renewal, the inspection may be conducted prior to submittal of a complete application). If DWQ finds the application acceptable, it will issue a public notice (called a Notice of Intent to Issue) in newspapers having wide circulation in the local area. The Notice of Intent includes all of the permit applications for a particular subbasin (or subbasins) that will be issued within a given month. The public then has a 30-day period to comment on the proposed permit. If the public expresses sufficient interest in one or more of the applications, DWQ may hold a public hearing.

DWQ also sends copies of the Notice of Intent 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 DWQ received and evaluates the comments, the Director of DWQ decides whether to issue or deny the permit. The final permit will include recommended waste limits and other special conditions that may be necessary to ensure protection of water quality standards.

Establishing Discharge Permit Effluent Limitations/Wasteload Allocations

Effluent limitations, also called waste limits, dictate the amounts of wastes (pollutants), that the permittee is allowed to discharge into surface waters under an NPDES permit. Before DWQ issues a discharge permit, it evaluates the projected impact of the discharge on the receiving waters. This determination, called a wasteload allocation (WLA), is usually based on a computer model which considers many factors, including the characteristics of the waste (e.g., flow and type) and the characteristics of the receiving waters (e.g., flow, waste assimilative capacity, channel configuration, rate of reaeration, water quality classification). DWQ determines permit limits using models called water quality-based limits. DWQ also bases some permit limits based on federal effluent guidelines established by the USEPA.

DWQ performs wasteload allocations by using various models, depending on the parameter (type of pollutant) of interest and the characteristics of the receiving waters. Model frameworks (discussed in more detail in Appendix IV) can range from simple mass balance analyses to 3-dimensional dynamic water quality models. Modeling fits into the basin plan by drawing on the current conditions within the basin and evaluating the effects of various management strategies. DWQ uses models for a number of objectives, including determining the fate and transport of pollutants, setting reduction goals for point and nonpoint sources, and to derive effluent limits for NPDES permits. For example, models can be used to predict concentrations of a parameter at a given site, such as instream DO or chlorophyll *a* in a lake.

Models can also be a tool for determining the level of pollutant reductions needed to protect instream standards. In addition, DWQ performs uncertainty analyses of water quality models to expand their predictive capabilities and increase confidence in results. 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.

When point sources are responsible for water quality problems, WLAs can yield appropriate permit limits that offer adequate water quality protection. Where a sole discharge is responsible for the water quality impacts, DWQ can perform a simple WLA without considering other discharges. In this case, DWQ will establish limits in accordance with the state'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.

A critical factor in determining the wasteload for an individual discharge is whether the receiving waters have a flow during 7Q10 or 30Q2 conditions. DWQ's policy prohibits new or expanded discharges into "no flow" streams that have a 7Q10 and a 30Q2 equal to zero. In addition, DWQ will look for ways to remove existing discharges on such streams unless it is determined that there are no reasonable alternatives. If it is not feasible to remove the discharge, 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).

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

Compliance Monitoring and Enforcement

Most dischargers are required to periodically sample the treated effluent from their discharge pipes. Also, many larger and more complex dischargers are required to sample points in the receiving waters both up and downstream from the discharge point. This process is called self-monitoring and it is typically required five days a week for some parameters (Monday through Friday) for major facilities. The sampling results (contained in a daily monitoring report or DMR) are then submitted each month to DWQ for compliance evaluations.

If a plant does not meet its permitted limits, DWQ may take one or more of the following actions: issue a notice of violation, initiate enforcement action, place the facility on moratorium, and/or enter into a Special Order by Consent (SOC). An SOC is a legal commitment entered into by the state and the discharger that establishes a time schedule for bringing the wastewater treatment plant back into compliance. During this time period, interim waste limits may be assigned to the facility until the improvements can be made. These interim limits may be less stringent than those in the permit although they are still required to protect water quality in the receiving waters.

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

Aquatic Toxicity Testing

There are thousands of chemicals and compounds that can enter wastewater systems and potentially be discharged to surface waters. Treatment plants are unable to monitor each of these chemicals individually due to limited funds and time, and limits in the ability of current analytical techniques to detect some pollutants. 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 uses an integrated approach to aquatic toxicity testing that includes monitoring specific chemicals, assessing resident aquatic populations, and analyzing whole effluent toxicity (WET). Whole effluent toxicity limits predict the impacts of toxicants by measuring those impacts in a laboratory setting. 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.

In February 1987, North Carolina implemented a policy to incorporate WET limits for all major and complex minor permits. As of June 1996, 567 permitted NPDES discharges were required to perform WET monitoring, and over 15,000 individual toxicity analyses had been performed for plants across the state. WET limits were developed to protect aquatic life from the discharge of 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 program, a change in WET limitations has been observed. Previously, DWQ had predicted that approximately 25% of the facilities tested to be acutely toxic instream; however, DWQ has lowered that prediction to ten percent.

Aquatic toxicity testing, like other complex analytical techniques, requires a great deal of quality assurance and control to achieve reliable results. In 1988, North Carolina initiated a program that requires all laboratories performing NPDES analyses in North Carolina to be certified by the state as a biological laboratory. As of June 1996, 22 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.

Pretreatment Program

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

Local pretreatment program address four areas of concern: (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 refers to any problem with plant operation, including physical obstruction and inhibition of biological activity. DWQ and the local government develop local pretreatment limits by determining the maximum amount of each pollutant the plant can accept at the influent (or headworks) and still protect the receiving water, the POTW itself, and the POTW's sludge disposal options.

Operator Certification and Training Program

Water pollution control systems must be operated by individuals certified by the North Carolina Water Pollution Control System Operators Certification Commission (WPCSOCC). The level of training and certification that the operator must have is based on the type and complexity of the wastewater treatment system. 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. The Commission currently certifies operators in four grades of wastewater treatment, four grades of collection system operation, subsurface operation, spray irrigation operation, animal waste management and a variety of specialized conditional exams for specific technologies (e.g. oil/water separators).

The Technical Assistance and Certification Group of the North Carolina Division of Water Quality provides staff support for the Commission and assists in organizing training for operators in cooperation with the North Carolina University System, the North Carolina Community College System and through the professional associations for operators and pollution control professionals. Specialty courses and seminars for operators are also offered by the North Carolina combined Section Of The Water Environment Association/American Water Works Association (WEA/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 effectively designed treatment system will not function efficiently. The goal of the WPCSOCC is to train competent and conscientious professionals that will provide the best wastewater treatment and thus protect the environment and public health.

Nondischarge and Regional Wastewater Treatment Alternatives

DWQ requires NPDES permit applicants to consider alternatives for disposal of wastewater effluent other than discharge to 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. Researchers in North Carolina are evaluating artificial wetlands as wastewater treatment systems. Permit requirements for nondischarging systems are listed in Administrative Code Section 15 NCAC 2H .0200 - Waste Not Discharged to Surface Waters.

Another alternative to a surface water discharge is to tie into an existing wastewater treatment system. Where possible, DWQ is encouraging smaller dischargers to connect to large established municipal systems. Regionalization, as this is called, has several advantages. Large municipal facilities, unlike smaller package-type plants, have a larger and better-trained staff, thereby reducing the potential for plant malfunctions. When malfunctions do occur in a large plant, they can be caught and remedied more quickly than in a small plant. Larger facilities provide a higher level of treatment more economically and more consistently than can smaller plants. Larger plants are monitored daily. Additionally, centralizing the discharges reduces the number of streams receiving effluent. As DWQ evaluates future permit expansion requests from regional facilities, it will look favorably upon plants that accept flows from smaller discharges.

Nondischarge permits are required for alternative methods of wastewater treatment. Nondischarge permits are also issued for the land application of residual solids (sludge) from wastewater treatment processes.

NONPOINT SOURCE CONTROL PROGRAMS

Agricultural Nonpoint Source (NPS) Control Programs

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

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

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

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

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

- **North Carolina Pesticide Law of 1971**

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

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

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

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

- **NCDA Pesticide Disposal Program**

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

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

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

- **Animal Waste Management**

  Regulations

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

  The deadline for submittal of registrations to DWQ for existing facilities was December 31, 1993. Animal waste management plans for existing facilities must be certified by a technical specialist designated by the Soil and Water Conservation Commission and submitted to DWQ by December 31, 1997. The standards and specifications of the USDA Natural Resources Conservation Service are the minimum criteria used for plan approval by the local Soil and Water Conservation Districts.

  Operator Training and Certification

  The North Carolina General Assembly ratified Senate Bill 974 (NCGS 143-215.74C - E) on July 29, 1995, which requires that the Department of Environment, Health and Natural Resources, in cooperation with the Cooperative Extension Service, develop and administer a training and certification program for operators of swine facilities with more than 250 swine that land apply animal waste. The Department assigned the task of developing and administering this program to the Technical Assistance and Certification Group of the Water Quality Section. The purpose of this program is to reduce nonpoint source pollution associated with the operation of animal waste management systems. Animal waste management systems are defined as a combination of structural and non-structural practices that collect, treat, store, or apply animal waste to the land. All animal operations with 250 or more swine (Sus scrofa) are required to designate an Operator in Charge who has primary responsibility for the operation of the animal waste management system. There are approximately 4,000 animal operations in the state that are required to designate an Operator in Charge.

A steering committee was established that includes representatives from the animal agriculture industry, environmental groups, North Carolina Department of Agriculture, Natural Resources Conservation Service, Division of Soil and Water Conservation, North Carolina Cooperative Extension Service and the Division of Environmental Management. The primary purpose of this committee was to develop the instructional manual and exam questions for the training and certification program. The manual has been completed and is being used in the training sessions that are primarily being conducted by the Cooperative Extensive Service in each county. Also involved in the training will be personnel from the NC Department of Agriculture, Natural Resources Conservation Service and pork producers. The training sessions for the operators began in April 1996. The examinations will be administered by the Technical Assistance and Certification Group in eighteen locations throughout the state beginning in May, 1996.

Persons who wish to be certified as operators of animal waste management systems must attend a minimum of six hours of training and demonstrate competence in the operation of animal waste management systems by passing an examination. The training and certification requirements must be completed once every five years. Participants in the training program will receive instruction in the following areas: 1) proper operation of animal waste management system components such as lagoons and irrigation systems; 2) waste utilization plans and proper waste, soil and tissue sampling techniques; 3) proper application of waste including calculation of application rates and calibration of equipment; and 4) consequences of improper management and environmental stewardship.

Inspection and Enforcement
Prior to July, 1995, DWQ's limited compliance resources were mostly directed toward getting existing facilities registered, insuring that new and existing facilities had approved waste management plans and responding to citizen complaints.

Following major lagoon dike breaks in late June and July, 1995, DWQ and the Department's natural resources divisions made a major commitment to inspecting all animal operations. As of December 1, 1995, over 4,000 operations were inspected.

These inspections have found a very high percentage of these facilities with problems. DWQ is currently working with these problem facilities to get them into compliance. These efforts include technical assistance, Notices of Violations, notification of loss of deemed permitted status and other appropriate enforcement actions. Approximately 1,800 out of the 3,922 reports entered in the Division's database indicate a compliance problem. As of May 13, 1996, approximately 200 facilities were found to have a discharge during an inspection.

As of May 13, 1996, 40 civil penalty cases were assessed and 8 court injunctions have been filed. Eighty-five facilities have lost their deemed permitted status and are required to obtain a certified waste management plan prior to the December 31, 1997 deadline.

Animal Inspection Database
May 13, 1996

Inspections	Total	Swine	Cattle	Poultry
Reports Entered	3922	3,012	803	107
Inadequate Freeboard	579	449	87	43
Seepage observed from lagoon	118	85	26	7
Erosion observed	426	376	32	18
Inadequate acreage available for spray	112	96	3	13
Cover crop inadequate	225	206	4	15
Man made conveyance of wastes	154	99	52	3
Inadequate Records	1,078	868	162	48
Non-Man made conveyance of wastes	59	43	8	8

This is preliminary information based on only the inspection reports entered as of the date of the report. These numbers are not considered accurate until a quality assurance procedure is in place. These numbers will change daily based on the entry of new reports and quality assurance checks of the information in the data base.

Swine Farm Siting Act

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

- **NC Cooperative Extension Service and Agricultural Research Service**

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

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

- **Soil, Plant Tissue, and Animal Waste Testing Program**

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

Tissue and Animal Waste Testing Program is administered by the Agronomic Division of the North Carolina Department of Agriculture. Water and wastewater from lagoons is also tested for irrigation and fertilizer use.

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

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

- **Food Security Act of 1985 (FSA) and the Food, Agriculture, Conservation and Trade Act of 1990 (FACTA)**
There are several provisions authorized by the federal Food Security Act of 1985 (FSA) and re-authorized by the Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA) which offer excellent opportunities for the abatement of agricultural nonpoint source pollution. The FSA and FACTA make the goals of the USDA farm and conservation programs more consistent by encouraging the reduction of soil erosion and production of surplus commodities and the retention of wetlands. At the same time, the provisions can serve as tools to remove from production those areas which critically degrade water quality by contributing to sedimentation. Important water quality-related provisions are known as the Conservation Reserve, Conservation Compliance, Sodbuster, Swampbuster, and Conservation Easement, Wetland Reserve, and Water Quality Incentive Program. These provisions are administered by the USDA.

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

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

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

Sodbuster

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

Swampbuster

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

Conservation Easement

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

Wetland Reserve

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

Water Quality Incentive Program

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

Nonpoint Source Programs for Urban and Developed Lands

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

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

  The goal of the stormwater discharge permitting regulations in North Carolina is to prevent stormwater runoff pollution by controlling the source(s) of pollutants. Defining the potential pollutant sources and establishing controls of the sources that will reduce and minimize pollutant availability will result in an improvement to the water quality of the receiving streams, consistent with the overall goal of the water quality program. Authority to administer these

regulations has been delegated to the North Carolina Division of Water Quality (DWQ). The NPDES stormwater regulations require that facilities with stormwater point source discharges associated with industrial activity and municipalities defined as either large or medium municipal separate storm sewer systems be permitted.
The municipal permitting requirements are designed to lead to the formation of site-specific stormwater management programs for a municipal area. Therefore, the permits issued to municipalities for their municipal separate storm sewer systems will be explicitly written for each individual municipality. Municipal permits of this type in North Carolina are currently required for Charlotte, Durham, Greensboro, Raleigh, Winston-Salem and Fayetteville/Cumberland County. The municipalities will develop and implement comprehensive stormwater quality management programs to reduce the discharge of pollutants in stormwater to the maximum extent practicable (MEP). MEP will be defined separately for each municipality required to be permitted. Industrial facilities discharging through a municipal separate storm sewer system are required to submit a permit application to the state and receive their own NPDES stormwater permit.

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

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

- **Water Supply Watershed Protection Program**

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

The purpose of the Water Supply Watershed Protection Program is to encourage communities to work with the state to provide enhanced protection for their water supply from nonpoint pollution sources. There are five water supply classes that are defined according to existing land use and the amount and types of permitted wastewater discharges. (See Appendix I for a summary of the management requirements for the five water supply classifications.) By classifying a watershed as a water supply watershed, local governments with land use jurisdiction within the watershed will take steps to control nonpoint sources of pollution and thereby reduce the potential of pollutants contaminating drinking water supplies. In turn, the state limits the point source discharges that can locate within the watershed which 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 pollutants that enter water supplies from nonpoint sources have water quality standards. As more is learned about the types and effects of pollutants in our drinking waters, the state will be forced to adopt additional water quality standards. If these additional standards are imposed, one effect may be that water treatment facilities will be required to apply 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 alternative means of preventing nonpoint source pollution from entering drinking water supplies in the first place. The land-use requirements, including density controls, buffers along perennial streams and stormwater control requirements for high density developments are but a few ways to accomplish this.

The Water Supply Protection Program is administered by staff in the Operations Branch of the DWQ. These staff coordinate with the Division of Community Assistance (NCDCA) which helps local governments develop land-use ordinances, the Division of Environmental Health, which certifies that a proposed water supply is suitable for drinking water, and DWQ staff in NCDEHNR regional offices who are responsible for water quality sampling. Statewide, the compliance rate for submittals is 100%.

- **Coastal Stormwater Management**

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 aerial 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 DWQ. 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. DWQ 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 aerial 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.

- **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. The coastal nonpoint programs will provide additional control for sources of nonpoint pollution that impair coastal water quality. Sources subject to the 6217 Coastal NPS Program include: agriculture, forestry operations, urban and developing areas, marinas, hydromodification projects, and wetlands and riparian areas.

  Section 6217 requires coastal states to submit their coastal nonpoint control programs to the National Oceanic and Atmospheric Administration (NOAA) and the U.S. EPA for approval by July 1995. The programs are to be implemented by January, 1999. Failure to submit an approvable program by July 1995 will result in a state losing substantial portions of its Federal funding under section 306 of the CZMA and section 319 of the Clean Water Act. The coastal nonpoint program will be developed and administered jointly by the NC Division of Coastal Management and DWQ.

Summary of Changes Since 1989

- The N.C. DWQ has developed programs for the administration of NPDES stormwater permits for industries and municipalities.
- The N.C. DWQ has developed and issued eighteen general permits to cover a variety of facilities that discharge stormwater associated with industrial activity.
- Water Supply Protection Legislation was passed in N.C. which has resulted in the development and implementation of statewide water supply watershed protection requirements. This program is described in detail in the previous section.
- The stormwater management rules governing coastal areas, High Quality Waters and Outstanding Resource Waters have been modified. These rules were finalized and effective on September 1, 1995. These programs are described in more detail in the previous section.
- Educational Efforts: The N.C. DWQ has instituted a number of educational efforts related to stormwater management across the state. These efforts have included:

\- Guidance Manuals:
1 *Stormwater Management Guidance Manual*
2 *Stormwater Management In North Carolina: A Guide For Local Officials*
\- Fact Sheets on Stormwater Management
1 *Stormwater Problems and Impacts*
2 *Stormwater Control Principles and Practices*
3 *Stormwater Management Roles and Regulations*
4 *Local Stormwater Program Elements and Funding Alternatives*
\- Statewide Stormwater Conference - (1994)

- Statewide Workshops on The Water Supply Protection Program (1994 & 95)
- Statewide Workshops on Stormwater Management (1995)

- **ORW and HQW Stream Classifications**
  Outstanding Resource Waters (ORW) and High Quality Waters (HQW) have management strategies that address handling of urban stormwater. Controls for urban stormwater, either through development density limitations or stormwater treatment systems, are required by DWQ. Other NPS management agencies are expected to place priority on protecting these waters as well. For example, the NC Department of Transportation and the NC Division of Land Resources require more stringent sediment control on construction sites in ORW and HQW areas.

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

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

Construction - Sedimentation and Erosion Control Nonpoint Source Program

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

The sediment control program requires, prior to construction, the submission and approval of erosion control plans on all projects disturbing one or more acres. On-site inspections are conducted to determine compliance with the plan and to evaluate the effectiveness of the BMPs 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 with the approved plan is not achieved and violations occur, the Land Quality Section will pursue enforcement through civil penalties and injunctive relief. House Bill 448, passed in 1991, authorized the issuance of stop-work orders for violations of the SPCA. This additional enforcement mechanism will help improve the overall performance of the program.

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

Local programs are reviewed annually for compliance with the requirements of the Sedimentation Pollution Control Act. The Land Quality Section also conducts educational programs directed toward state and local government officials in order to strengthen the local programs. Persons engaged in land-disturbing activities and interested citizen groups are included in the educational effort.

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

On-Site Wastewater Disposal - Sanitary Sewage Systems Nonpoint Source Program

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

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

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

The Straight Pipe Elimination Amnesty Program was established in 1996 for the purpose of eliminating domestic sewage or wastewater discharges, from both straight pipes and overland flow of failing septic systems. The program contains three components: identification and elimination of domestic sewage discharges into streams currently or proposed to be used for public water supplies; an amnesty period to end on December 31, 1997 during which time violations of State rules and laws on domestic sewage and wastewater discharges identified as a result of this program will not result in legal consequences; and a public education effort on the program and the amnesty period.

<u>Solid Waste Disposal NPS Programs</u>

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

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

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

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

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

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

Forestry NPS Programs

- **Forest Practice Guidelines Related to Water Quality**
  Prior to January 1, 1990, all forestry operations were exempt from the permitting requirements of the Sedimentation Pollution Control Act (SPCA). Effective January 1, SPCA was amended to require all forestry operations to comply with nine performance standards in order to remain exempt from the permitting requirements of the SPCA. The nine performance standards are the *Forest Practice Guidelines related to Water Quality*. The FPGs, like the SPCA, are performance based. They require measures such as establishment of a streamside management zone along intermittent and perennial streams and waterbodies to restrain accelerated erosion and prevent visible sediment from entering intermittent and perennial streams and waterbodies.

  Use of Best Management Practices (BMPs) is encouraged to meet the FPG requirements. A *Forestry Best Management Practices Manual* and other publications are available to provide guidance in meeting the FPGs. DFR personnel work with landowners, timber buyers, and loggers when requested to help plan and prevent water quality problems. Under MOAs with the DLR, DWQ and NCDA, the DFR monitors compliance with the FPGs. If a potential violation is found, the DFR will attempt to get it corrected by the responsible party(ies) within a reasonable time frame. If it is not corrected, a referral of the project is made to the appropriate regulatory agency for enforcement action. If this happens, the project is deemed out of compliance with the FPGs and subject to permitting requirements of the SPCA.

- **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 Forest Stewardship Program was begun in 1991 by the US Forest Service, with the DFR as the lead agency in North Carolina. In cooperation with other natural resource agencies, the Forest Stewardship Program is intended to bring more forest land under management. Identifying four resource categories, (timber, fisheries and wildlife habitat improvement, recreation and aesthetics, and soil and water conservation), Forest Stewardship Plans are developed for landowners based on their individual goals and objectives. A landowner mush own at least 10 acres of woodland, and agree to manage it to improve at least three of the four resources while maintaining the fourth in at least the same condition. Primary cooperating agencies with the DFR are the NC WRC, USDA-NRCS, NC CES, and USDA-FSA.

Mining NPS Program

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

Act to the Mining Program within the Land Quality Section of the NCDEHNR Division of Land Resources.

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

Wetlands Regulatory NPS Programs

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

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

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

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

Several important state and federal wetland protection programs are described below. In addition to the following wetlands programs, provisions of the 1985 and 1990 Farm Bills, discussed in Section 5.3.1, should also help reduce wetlands impacts. Agriculture conversions should be reduced by the "swampbuster" provision of the 1985 Farm Bill, which encourages farmers not to convert wetlands for agriculture to prevent the loss of their USDA subsidies, loans, and price supports. Silviculture is exempted from the swampbuster provision and therefore, conversion of wetlands for intensive or managed forestry is not affected by this provision. A Wetland Reserve

Program was established by the 1990 Farm Bill with the goal of allowing one million acres of prior-converted wetlands to revert back to wetlands by 1995.

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

- **Section 404 of the Clean Water Act**
  The U.S. Army Corps of Engineers administers a national regulatory program under Section 404 of the Clean Water Act aimed at controlling the discharge of dredged or fill material into waters of the United States. Section 404 applies to the discharge of dredged or fill materials into waters of the United States including dredging. Waters of the United States refers to navigable waters, their tributaries, and adjacent wetlands. Activities covered under Section 404 include dams, dikes, marinas, bulkheads, utility and power transmission lines and bank stabilization. Although the 404 program does not fully protect wetlands, it is nonetheless the only existing federal tool for regulating wetland development statewide. State legislation has not been adopted to protect inland freshwater wetlands in North Carolina, as has been done for coastal wetlands, but the EMC in March of 1996 adopted rules which will formalize the wetlands protection measures associated with the 401 Water Quality Certification review process.

- **Section 401 Water Quality Certification (from CWA)**
  The Division of Water Quality is responsible for the issuance of 401 Water Quality Certifications. Section 401 of the federal Clean Water Act provides that no federal agency can issue any license or permit to conduct any activity that may result in a discharge to navigable waters unless the state in which the discharge may occur certifies that the discharge will not result in a violation of any state water quality or related standards. Thus, a 401 certification is required for, among other things, a discharge into surface waters or wetlands for projects that require a section 404 permit. A federal permit cannot be issued if a 401 certification is denied. Any conditions added to the 401 certification become conditions of the 404 permit. 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).

- **Wetlands Restoration Program/Funds**
  The Wetlands Restoration Program was established in 1996 as a nonregulatory program "...for the acquisition, maintenance, restoration, enhancement, and creation of wetland and riparian resources that contribute to the protection and improvement of water quality, flood prevention, fisheries, wildlife habitat, and recreational opportunities". The purposes of the program include: the restoration of wetlands function and values; to provide a consistent and simplified approach to mitigation requirements associated with permits or Corps of Engineers authorizations; to streamline the permitting process; to increase the ecological effectiveness of mitigation efforts; to achieve a net increase in wetlands acres, functions and values for each major river basin; to promote a comprehensive approach to environmental protection.

Through the Wetlands Restoration Program, basinwide plans for wetlands and riparian area restoration will be developed. The goals of the plans are to protect and enhance "...water quality, flood prevention, fisheries, wildlife habitat, and recreational opportunities..." These plans will be developed for each of the seventeen major river basins in the state beginning in July 1997. Compensatory mitigation (a required condition of section 404 permits issued by the U.S. Corps of Engineers) options will be addressed within the plans.

A Wetlands Restoration Fund has been established under the program. The Fund is a trust fund designed as a repository for monetary contributions and dedication of interest to real property under the compensatory mitigation options. These funds will primarily be used to restore, enhance, preserve or create wetlands and riparian areas in accordance with the basinwide plan.

Hydrologic Modification

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

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

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

Water Supply Legislation in North Carolina

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

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

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

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

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

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

Section 319 Nonpoint Source Management and Other Programs

- **Section 319**
  Clean Water Act Section 319(h) grant monies are made available to the states on an annual basis by EPA. Agencies in the state that deal with NPS problems submit proposals to DWQ each year for use of these funds in various projects. Projects that have been funded in the past include BMP demonstrations, watershed water quality improvement projects, data management, educational activities, modeling, stream restoration efforts, riparian buffer establishment, and others. North Carolina DWQ established a Workgroup process in 1995 for prioritizing and selecting projects from the pool of cost-share proposals for inclusion in its annual application to EPA. DWQ staff first reviews proposals for minimum 319 eligibility criteria such as:
  - support state Program milestones;
  - address targeted, high priority watersheds;
  - provide sufficient cost-share match (40% of project costs);
  - propose adequate time periods;
  - identify measurable outputs;
  - use compatible GIS products with those of the state; and
  - make commitment for educational activities and a final report.

  Workgroup members separately review and rank each proposal which meets the minimum 319 eligibility criteria. The Workgroup consists of representatives from the state and federal agencies that deal with NPS issues, including agricultural, silvicultural, on-site wastewater, mining, solid waste and resource protection. In their review, members consider such factors as: technical soundness; likelihood of achieving water quality results; degree of balance lent to the state Program in terms of project type; and competence/reliability of contracting agency. They then convene to discuss individual projects' merits, to pool all rankings and to arrive at final rankings for the projects. All proposals that rank above the funding target are included in the annual grant application to EPA, with DWQ reserving the right to make final changes to the list. Actual funding depends on approval from EPA and yearly Congressional appropriations.

- **Use Restoration Waters**
  The North Carolina Division of Water Quality is currently developing the Use Restoration Waters (URW) program to restore surface waters to their designated uses. If adopted, this program will allow the state to work with local governments, businesses, and residents to develop management strategies appropriate for the area. In order to be effective, the URW program will include a mix of mandatory and voluntary programs. The voluntary and mandatory programs will be coordinated on a site-specific basis by DWQ and a group of stakeholders who have an interest in the impaired water body and associated watershed. In addition, the URW program will attempt to develop cooperative relationships among these agencies so that overlapping efforts can be consolidated and targeted to restore designated water body uses.

  The URW Program will apply to polluted surface waters where the following conditions apply:
  - Biological, physical and/or chemical data indicate the specific sources of pollution.
  - A use attainment study indicates that the sources of pollution are not transitory.
  - It is possible to control the sources of pollution by implementing appropriate management strategies under the existing authority of the North Carolina Environmental Management Commission (EMC), other state commissions, and local agencies or voluntary actions implemented by citizens and other groups.

Based on current water quality data, there are approximately 4,300 miles of freshwater streams (or about 1.4 percent of total miles) and about 40,000 saltwater acres (or about 2 percent of total saltwater acres) that would be potential candidates for URW consideration.

The restoration strategies developed under the URW Program will be site-specific to the watershed of the nonsupporting or impaired water body. DWQ and the stakeholders will coordinate each URW strategy with other agencies' programs to create a holistic approach to address the array of pollution problems in the watershed.

- **The Nonpoint Source (NPS) Team Process**

Successfully managing NPS pollution requires not only a knowledge of science and technology, but also an understanding of the local resources and economy. Although there are some general management guidelines, there is no single technique for controlling NPS pollution. The most efficient and effective NPS solutions will be site-specific. Formulating NPS solutions often requires cooperation between different interested parties. Each group that contributes to the NPS problem must be part of the solution.

DWQ will coordinate the Watauga NPS Team to include a wide variety of stakeholders interested in the basin. This team will take the lead in identifying NPS problems and implementing solutions. The NPS Team process is discussed below and in Chapter 7.

1. Coordinate the NPS Team.
DWQ's goal in forming the Watauga NPS Team is to choose predominantly locally-based members that represent the federal, local, and state agencies, local governments, industries, and citizens' groups that have interests and responsibilities pertaining to NPS pollution. DWQ will consult local groups to determine which interests should be represented on the team.

Once the NPS Team is formed, DWQ and the team will work as partners to identify, prioritize, and address the NPS problems in the basin. DWQ will offer information from the state's water quality monitoring program and its staffs' knowledge of technical and financial resources. The NPS Team will describe current NPS initiatives, identify priority NPS-impaired waterbodies, and analyze NPS issues and needs. One of the most important missions of the DWQ-NPS Team partnership is to foster coordination and cooperation between the basin's diverse interest groups and agencies. The eventual goal of the NPS Team is to create and implement Action Plans that will address priority *NPS-impaired waterbodies* and *NPS issues* as part of the basinwide planning process. The implementation schedule will be determined as the plans are developed.

2. Take inventory of the initiatives and programs in place to address NPS pollution.
Each member of the NPS Team will describe the existing initiatives and programs of the agency or group he/she represents. A list of these initiatives is included in the basinwide plan to show readers some of the potential resources for addressing their NPS problems (see Chapter 5). This effort will provide an opportunity for mutual education, understanding and coordination with other stakeholders. An important responsibility of the NPS Teams will be to assess whether existing initiatives and programs in the basin are successfully improving water quality.

3. Choosing the priority NPS-impaired waterbodies and NPS issues.
Since the NPS Team will not be able to address all of the *NPS-impaired waterbodies* and *NPS issues* in the basin, it will have to follow a system for prioritization. The NPS Team will use the following process to target NPS-impaired waterbodies and select NPS issues.

Selecting the Priority NPS-impaired Waterbodies

Within the guidelines described below, the NPS Team will select at least one NPS-impaired waterbody for which an Action Plan will be developed. More than one waterbody may be selected if time and resources allow. The goal of the Action Plan will be to restore the designated use of the selected waterbody using a comprehensive, site-specific, and coordinated approach. The Actions Plans will be a prime candidate for funding under the federal Section 319(h) program.

The NPS Team will use both primary and secondary criteria to select the *priority NPS-impaired waterbodies*. The primary criteria are (in order of importance):

- Highly-valued resource waters, such as High Quality Waters and Water Supplies I-IV, that have a demonstrated pollution problem.
- Monitored waters that have an overall use support rating of non-supporting.
- Monitored waters that have a use support rating of partially supporting but have a high predicted loading for one or more pollutants.
- Highly valued resource waters, such as High Quality Waters and Water Supplies I-IV, that are in need of protection.
- Monitored waters that have an overall use support rating of partially supporting.

DWQ will provide a list of waterbodies that meet the primary criteria to the NPS Team.

The secondary criteria for selecting the priority *NPS-impaired waterbodies* are:

- Waters that pose a potential threat to human health,
- Waters that are important for ecological reasons not reflected in their classification and use support ratings (such as endangered species, unique habitats, or significant biological resources),
- Waters that are highly eroded or have other evidence of serious erosion problems that are not reflected in the use support ratings,
- Waters that have experienced a recent, rapid decline in water quality, and
- Waters that have identifiable pollution sources and a high likelihood of successful restoration.

An NPS-impaired waterbody that meets the primary criteria as well as one or more of the secondary criteria listed above is a good candidate for prioritization by the NPS Team. However, the NPS Team may select a priority NPS-impaired waterbody that does not meet the primary criteria but meets *several* of the secondary criteria. This allows the team to select waters that DWQ did not monitor or waters for which the use support rating failed to describe the extent of the NPS problem.

Selecting the Priority NPS Issues

In order to address problems in the remaining NPS-impaired or threatened waterbodies (ones not prioritized for specific Action Plans), the follwing criteria will be used to target NPS issues throughout the basin:

- Issues that apply throughout a significant portion of the basin or address one or more impaired waters that were not selected as a *priority NPS-impaired waterbody,*
- Issues that have a clearly defined "problem" and "solution," and
- Issues that are within the team's ability to address through educational efforts, improved coordination between stakeholders, focused new initiatives, or involvement of additional stakeholders.

4. Determine what is needed to address the priority NPS-impaired waterbody and the NPS issues the team selects.

The NPS Team will decide which actions are likely to restore the priority NPS-impaired waterbodies and address the NPS issues. Some of the possible needs include:

- Public education. When water quality problems result from citizens' lack of knowledge about how their local actions affect water quality or from land use decisions, public education is a key component of the solution.
- Implementation of best management practices (BMPs). BMPs are structural or nonstructural management practices used to reduce nonpoint source inputs to receiving waterbodies in order to achieve water quality protection goals. Often higher levels of pollutant removal can be achieved by using a combination of different BMPs.
    - Structural BMPs generally work by capturing, retaining, and treating runoff before it leaves an area. Some examples of structural BMPs include constructed wetlands and wet detention ponds in urban settings and controlled drainage on agricultural lands. Structural BMPs require regular maintenance.
    - There are a variety of nonstructural BMPs. One nonstructural BMP is source reduction, which reduces the amount of pollutants that are introduced into the environment. Some types of source reduction are nutrient management plans for crop production and hazardous waste collection sites in urban areas. Another nonstructural BMP is maintaining natural drainageways to allow the vegetation and soil to cleanse runoff before it enters a waterbody.
- Ecosystem restoration and management. If a stream's ecosystem is badly damaged, removing pollutants alone will not always restore the water's uses. In cases like these, it will be necessary to restore the ecosystem through measures such as riparian revegetation and streambank stabilization.
- Local water quality planning. Development sites can be planned in order to reduce their risk of harming water quality. Some planning techniques include steering development towards less environmentally sensitive areas, using natural drainage systems rather than curb and gutter, and planning for development densities that allow for open space, greenways, and wildlife corridors.

5. Develop comprehensive Action Plans consisting of management strategies to address the priority NPS-impaired waterbody and the NPS issues.

The NPS Team members will work together to develop "Action Plans." These Action Plans will consist of a list of Action Items that form a coordinated, comprehensive effort to address each priority NPS-impaired waterbody and NPS issue. Each Action Item will include lead contacts, goals, and a schedule for completion and may utilize one or more of the following vehicles for implementation:

- Efforts by NPS Team members: The NPS Team members can make commitments to target their agency's/group's existing resources to address the priority NPS-impaired waterbody or NPS issues. Team members can also agree to share their expertise on a volunteer basis.
- Section 319: Clean Water Act Section 319(h) grant monies are made available to the states on an annual basis by EPA. Agencies in the state that deal with NPS problems submit proposals to DWQ each year for use of these funds in various projects. Projects that have been funded in the past include BMP demonstrations, watershed water quality improvement projects, data management, educational activities, modeling, stream restoration efforts, riparian buffer establishment, and others. Refer to Section 5.7 for a complete program description.

- Agriculture Cost Share Program: Provides a number of cost-share practices designed to solve soil, water, and related environmental problems in agricultural areas including forested buffer strips.
- Wetlands Restoration Program. A bill recently ratified by the NC General Assembly establishes a statewide Wetland Restoration Program that will provide a leadership role in targeting and consolidating all wetland and riparian area restoration initiatives in NC.
- Proposed Use Restoration Waters (URW) Program. DWQ is currently developing the URW program to restore surface waterbodies to their designated uses. If adopted, this program would allow the state to work with local governments, businesses, and residents to develop focused management strategies appropriate for the area. Those affected by the URW program will be requested to meet well-defined milestones and goals for water quality improvement. If these milestones are not met on a voluntary basis within an established schedule, mandatory controls may be considered by the Environmental Management Commission.
- Federal Initiatives: There are a number of federal programs and resources that may be available to address the Priority NPS-impaired waterbody and NPS issues. These include US Fish and Wildlife Service funds, the USDA-NRCS Wetland Reserve Program, and the Environmental Quality Initiative Program (EQIP) provisions of the Farm Bill.
- Other Programs: There are numerous other programs sponsored by private and state agencies that could be initiated to address the NPS Team's priority waterbodies and issues. Some of these programs include corporate funding for educational programs, the Small Watershed Program, and US Fish and Wildlife Grants. A complete list of funding sources for NPS pollution is listed in Appendix VIII.

6. Implement Action Plans.
Implementation is the most important part of the state's NPS program since it is the only way to restore the priority NPS-impaired waterbody and address NPS issues. Most, if not all, members of the NPS Team will be involved with the implementation of one or more of the Action Items. During the implementation phase, the NPS Team will continue to meet on a regular basis. The purpose of these meetings will be for the team to update each other on their progress toward completing the Action Items and provide a forum for continuing the coordination between team members. When some of the team members experience setbacks in implementing an Action Item, the rest of the team can advise and/or provide additional help so that the item can be completed successfully.

7. Monitor to evaluate the effectiveness of management strategies.
The NPS Team will identify where additional water quality monitoring sites may be needed to document the effectiveness of its Action Plans. DWQ and the NPS Team will cooperate to assure that pre- and post-monitoring is in place before a new program, initiative or BMP is implemented. In order to supplement DWQ's monitoring programs, the team may seek the involvement of citizens' groups. Any agencies that receive 319 grants will be required to conduct pre- and post-evaluations as a part of their project.

8. Consider additional management strategies if the voluntary approaches do not result in an improvement in water quality.
If the NPS Team's management strategies do not show progress in improving water quality according to the designated schedule, DWQ and the team will work together to identify the reason for the lack of progress. Some of the potential courses of action are:

- Reevaluate the source of impairment.
- Increase and/or redirect voluntary measures.
- Consider additional measures.

APPENDIX VII

ESTIMATION OF NUTRIENT LOADS FOR WATERSHEDS IN THE PASQUOTANK BASIN

ESTIMATION OF NUTRIENT LOADS FOR FOUR NORTH CAROLINA SUBBASINS IN THE PASQUOTANK RIVER BASIN

Introduction

Although no portions of the Pasquotank River Basin have ever been been declared Nutrient Sensitive Waters the estuarine portions of the basin, particularly Albemarle and Currituck Sound experience regular and persistent algal blooms due to elevated nutrient levels. The blooms are not typical of those observed in other North Cartolina estuaries because they are almost entirely comprised of small filamentous blue-green algae (cyanophytes) which tend to remain suspended throughout the water column rather than blooming at the surface. These blooms can have such consequences as discolored water and increased turbidity in the water column which in turn impede the growth of aquatic vegetation, one of the key elements of the Sounds' ecosystems, and decay of the algae can also be associated with reduced dissolved oxygen levels. A more thorough discussion of algal bloom activity in Albemarle and Currituck Sounds is presented in chapter 4 of this basin plan. Despite the absence of Nutrient Sensitive Waters designation or a defined nutrient management stategy, nutrients are still a primary water quality issue in the Pasquotank Basin.

For purposes of the 1997 Pasquotank River Basinwide Water Quality Management Plan a comprehensive nutrient loading budget was developed for the North Carolina portion of the watershed utilizing the most up to date methods and data that where available. The nutrient budget was developed to estimate nutrient loadings from the six DEHNR subbasins that comprise the Chowan basin, and for the basin as a whole.

Both point and nonpoint source loads are included in the nutrient budget. Point source loads represent the annual loading from permitted dischargers in the watershed under current conditions (1996). Nonpoint source loads represent the net export of nutrients from areas of varying land use within each watershed. These loads were calculated using an export coefficient model utilizing land cover information derived from LANDSAT data and nutrient export estimates derived from the literature. Atmospheric loadings were also calculated using export coefficients. The specific methodology used is discussed below.

Point Source Loads

Discharge monitoring data for the period from January to December, 1996 were obtained from the DWQ (Division of Water Quality) Compliance Monitoring System data base via FOCUS retrieval for all facilities in the basin. Average daily nitrogen and phosphorus loads for facilities with available N and P data were calculated in the process of the retrieval and multiplied by 365 to determine annual loads. Calculations and loads for all facilities are shown in Table VII-2.

Nonpoint Source Loads

The nutrient export coefficient approach (Reckhow et al, 1989; Novotny and Olem, 1994) calculates mass nutrient export from a given parcel of land as the product of land area and a unit load. The unit load, or nutrient export coefficient, is a measure of the nutrient export (mass load) per unit area per unit time, for example, pounds of N per acre per year). Unit loads will vary by the type of land cover and the nature of land use practices in a particular area. Numerous field studies have been conducted to estimate the amount of nitrogen and phosphorus entering surface waters from various land uses.

The land use/land cover data set used to develop the nutrient loading estimates discussed here was developed by the NC Center for Geographic Information and Analysis (CGIA) utilizing 1988 LANDSAT data. CGIA classified the Albemarle-Pamlico Estuarine Study area into 18 land use/land cover categories, as described by Khorram et al (1992). In the near future CGIA will release an updated land use/land cover data set based on 1993 LANDSAT imagery, but that information was not available in time for use in publication of this basin plan. The 1988 LANDSAT data was the most recent data suitable for characterizing land cover at the scale of subbasins.

The export coefficients used for the various land cover categories (Table VII-2) are based upon a recent study carried out by RTI (Research Triangle Institute) under a contract with the DCM (Steven Stichter, NCDCM, personal communication, 1995). The RTI project involved a literature review of nutrient export studies performed on the eastern piedmont and coastal plain, updating similar work conducted by RTI in 1992 (Dodd et al). The median or most likely values from the literature were used.

Forested areas include both natural and managed forests. It was not feasible to develop separate estimates for each forest type, and all forest and freshwater wetland categories were assigned the median forest values. Nutrient export from urban areas includes runoff from residential and commercial areas, industrial facilities, on-site wastewater disposal and solid waste facilities. The median export values for urban areas were assigned to all three categories of developed land because the land cover data could not distinguish between low, medium and high density developed areas with sufficient accuracy (see Khorram et al, 1992). Agricultural land includes row crops, pasture land and confined animal operations. However the land cover data could not distinguish between these types of agricultural activities, and the export coefficient used represents the median unit load from a cross-section of agricultural activities.

Atmospheric deposition includes wet and dry deposition of nutrients from all sources, including nitrogen from the burning of fossil fuels and ammonium from sources such as fertilizer and animal waste lagoons. Values for atmospheric deposition were taken from Dodd et al (1992) and are applied to open water as well as sand and salt marsh. This assumes that all nutrients falling on bare sand and salt marsh from atmospheric sources is exported to surface waters, and that on average no net export otherwise occurs from these areas.

As shown in Table VII-2, the detailed categories were aggregated into 4 major classes. Disturbed land was classified as agricultural because these areas were found to consist primarily of recently plowed fields (Khorram et al, 1992).

No land use/land cover data were available for some areas because of cloud cover or difficulty in classification. Such land was apportioned to the various land cover categories in proportion to the area of known land cover in each hydrologic unit. The amount of unclassifiable land was not significant (<1% of each hydrologic unit).

Discussion

The export coefficient approach has a number of limitations. Some of these are inherent in the method itself, while others result from the specific data used.
(1) The available land use/land cover information is based on 1988 data, and significant land use changes may have occurred in some areas since that time. Land use/land cover data for the 1993-1995 period is under development and will be available in March 1997. This data set should provide greater refinement in characterizing types of agricultural and urban areas.
(2) Land management practices can affect the export of nutrients from a given category of land use. The export coefficient approach does not take into account variations in loading resulting from different land management practices (such as no-till farming) on a localized basis.

(3) The export coefficients are not based upon site-specific studies of the Pasquotank River basin area, but rely on literature estimates. These estimates are based on studies conducted in the piedmont and coastal plan regions, but soils and other features of the study sites may differ from areas in the Pasquotank basin.
(4) Export estimates for urban areas do not explicitly account for inputs from septic systems or other on-site disposal systems such as spray irrigation systems for animal operations or municipalities.
(5) As mentioned earlier, the current land use data do not allow us to distinguish between types of agricultural activity, and it is thus not possible to separately evaluate loads from cropland, pasture and confined animal operations.
(6) The export coefficient approach does not take nutrient fate and transport into account, but rather, yields an estimate of the total nutrient load to surface waters within a watershed. It does not estimate the load exerted at any particular location. Only a portion of the nutrients which enter streams in the upper part of these watersheds will actually reach the estuarine sections of the river.

The use of export coefficients to estimate nutrient loads is the best method available given that detailed watershed models have not been developed for any of the areas examined here. Despite the limitations of this approach, the results provide a rough approximation of the loading to particular watersheds and indicate the general sources of that loading. As noted above, future applications of nutrient export methods to these watersheds will be enhanced by the acquisition of more recent and detailed land use/land cover data.

References Cited

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Reckhow KH, Hartigen JP and Coffey S, 1989. Lake Nutrient Budget Development for State-Level Applications. pp 45-52, Proceedings of a National Conference on Enhancing State's Lake Management Programs. North American Lake Management Society. Washington, DC

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TABLE VII-1
CALCULATED POINT SOURCE TP AND TN LOADS
PASQUOTANK BASIN

PERMIT NUMBER	FACILITY NAME	SUB - BASIN	PERMITTED FLOW MGD	AVERAGE FLOW MGD	AVERAGE TN LBS / DAY	ANNUAL TN LBS/YR	AVERAGE TP LBS / DAY	ANNUAL TP LBS/YR
NC0025011	ELIZABETH CITY, CITY OF - WWTP	03-01-50	13.864	2.477	160.753	58674.91	53.965	19697.19
NC0079057	MANTEO, TOWN OF - WWTP	03-01-51	3.600	0.208	9.749	3558.40	3.936	1436.80
NC0021849	HERTFORD WWTP, TOWN OF	03-01-52	1.733	0.347	33.474	12218.01	0.542	197.66
NC0020443	COLUMBIA, TOWN OF	03-01-53	0.682	0.114	5.494	2005.21	0.228	83.07
NC0036315	ROPER WWTP, TOWN OF	03-01-53	0.397	0.054	2.626	958.42	0.283	103.16
NC0048861	CRESWELL WWTP, TOWN OF	03-01-53	0.299	0.041	0.607	221.40	0.270	98.72
						3185.03		284.95
NC0023027	VILLAS ASSOCIATION, INC.	03-01-55	0.267	0.012	0.065	23.78	0.062	22.56
NC0025313	KILL DEVIL HILLS WWTP, TOWN OF	03-01-55	0.275	0.027	3.299	1204.01	0.236	86.21
						1227.79		108.77

TABLE VII-2

EXPORT COEFFICIENTS USED IN CALCULATION OF NONPOINT SOURCE LOADS, BY LANDSAT CATEGORY (lb/ac/yr)

Code	LANDSAT Category	TP Export	TN Export
URBAN		0.95	6.71
3	Low Density Developed		
4	Medium Density Developed		
5	High Density Developed		
AGRICULTURE		0.88	8.74
6	Agriculture, Bare Soil and Grass		
12	Disturbed Land		
FOREST		0.12	2.08
7	Low Density Vegetation		
8	Pine Forest		
9	Bottomland Hardwoods		
10	Hardwood Forest		
11	Pine/Hardwood		
14	Riverine Swamp		
15	Evergreen Hardwood/Conifer		
16	Atlantic White Cedar		
17	Low Pocosin		
ATMOSPHERIC DEPOSITION		0.58	11.06
2	Open Water		
18	Low Marsh		
19	High Marsh		

Source: NC Division of Coastal Management

APPENDIX VIII

List of 303(d) Waters in the Pasquotank River Basin

APPENDIX VIII

List of 303(d) Waters in the Pasquotank River Basin

What is the 303(d) list?

Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or which have impaired uses. Waters may be excluded from the list if existing control strategies for point and nonpoint source pollution will achieve the standards or uses. Waterbodies which are listed must be prioritized, and a management strategy or total maximum daily load (TMDL) must subsequently be developed for all listed waters.

303(d) List Development

The 305(b) report was used as a basis for developing the 303(d) list. Section 305(b) of the CWA requires states to report biennially to the U.S. Environmental Protection Agency (EPA) on the quality of waters in their state. In general, the report describes the quality of the state's surface waters, groundwaters, and wetlands, and existing programs to protect water quality. Information on use support, likely causes (e.g., sediment, nutrients, etc.) and sources (point sources, agriculture, etc.) of impairment are also presented in the report.

Many types of information were used to make use support assessments and to determine causes and sources of use support impairment. Chemical, physical, and biological data were the primary sources of information used to make use support assessments. North Carolina has an extensive ambient and biological monitoring network throughout the state. Benthic macroinvertebrate data which indicate taxa richness of pollution intolerant groups are an important data source. North Carolina also collects fish tissue and fish community structure data and phytoplankton bloom data that are used in the assessments. In addition, shellfish closure data, information from other agencies, workshops, and reports, predictive modeling results, toxicity data, and self monitoring data is considered when making final use support determinations. Data from all readily available sources are used when the Division's standard operating procedures are followed when collecting and analyzing data. Where the list has no problem parameter listed, the use support rating was based on biological data, and available chemical data showed no impairment. It should be noted that where a problem parameter has been identified, the water quality standard for that parameter was exceeded. This parameter is a potential cause of the impairment, but there may be other unidentified causes contributing to the impairment as well.

Only those waterbodies whose use support rating were not supporting (NS) or partially supporting (PS) in the 305(b) report were considered as candidates for the 303(d) list. Of those waterbodies that showed impairment (PS or NS rating) only those waterbodies that had a use support rating based on monitoring data collected in the last five years were included on the 303(d) list. Since many changes can occur within a watershed in a five year period, conclusive information about a waterbody's use support cannot be made with older data. However, North Carolina will be collecting information on as many of these evaluated waterbodies as staffing and time permit for subsequent updates of the basin plans and 303(d) list. As more conclusive information on streams rated using older data or best professional judgment is obtained, evaluated waterbodies will be added to the list if the data indicate impairment. Finally, those waterbodies which were rated as NS or PS were then examined to determine if there were management strategies in place. If so, the streams were eliminated from the list. Management strategies that were considered included the following:

1. Miscellaneous nonpoint programs - Any waterbodies where DWQ was aware of nonpoint management studies (e.g. 319 or similar program) were eliminated if nonpoint sources were the only problem.

2. Point sources - All waters where point sources were the only problem were eliminated if the facility was under SOC, under schedule for removal, recently upgraded, or some other strategy was in place.

No waterbodies were removed from the Pasquotank River Basin 303(d) list for strategies cited above.

Changes in the Pasquotank River Basin's 303(d) list from earlier lists are based on updated chemical and biological monitoring results. If updated information indicated no impairment, a previously listed waterbody was removed. The Perquimans River was removed from the list since 1995 biological data resulted in a Good-Fair rating and is thus considered support-threatened. If previously supporting waterbodies had new data that indicated impairment, these waterbodies were added to the list. In addition, if no new data were collected on a given waterbody, and all available data were greater than 5 years old, the waterbody was excluded from the list. If future data indicate impairment, the stream will be added to the list. Bethel Creek was removed from the 303(d) list since no recent data are available on the creek. The freshwater portion of the Pasquotank River Basin 303(d) list is shown in Table 1.

The estuarine portion of the 303(d) list is organized by Division of Environmental Health area name as overall use support is determined in this manner (Table 2). Specific impaired areas can be viewed on the color use support maps included in Figure 4.18.

Fish consumption advisories are no longer considered when determining use support since the entire state was posted in June 1997 for the consumption of bowfin from mercury contamination. It should be noted that bowfin do not occur statewide; they are found primarily within the coastal plain. While DWQ considers fish consumption advisories as impairment, we did not want to mask other causes and sources of impairment by having the entire state listed as impaired due to advisories. Therefore, they are discussed in Chapter 3 and summarized on Figure 3.1.

Although fish consumption advisories are not considered when determining use support, the advisory information is considered when developing the state's 303(d) list. Albemarle Sound west of a line from Bull Bay is under a fish consumption advisory due to dioxin in fish. There are pulp and paper mills on both the Chowan and Roanoke Rivers upstream of the advisory area. Each of the facilities has eliminated dioxin in their discharge, but it will take time before use support is restored. Since no other management strategies are warranted in the basin to control dioxin, the waterbody is not included on the 303(d) list.

Phelps Lake has elevated mercury levels that have resulted in fish consumption advisories. The Division of Air Quality has initiated a study to assess atmospheric inputs of mercury in the Phelps Lake area. The study will focus on the measurement of ambient mercury levels around the lake as well as deposition rates of mercury through precipitation. Since a management strategy does not yet exist in the area, Phelps Lake has been included on the list. No other waters were included on the list due to mercury impairment since no other waters have been posted for anything other than bowfin (statewide advisory). Other waters will be added to the list if the State Health Director posts them for species other than bowfin. Listing all waters in the basin as a result of the bowfin advisory will only mask other areas of impairment. North Carolina will continue to work on the mercury problem, but developing allowable loads in all waterbodies for the parameter will not help solve the problem. Instead, North Carolina has implemented the Phelps Lake study to help determine sources.

The DWQ has formed a nonpoint source team in the Pasquotank River Basin, and Chapter 7 contains a list of the members. DWQ and the team will work as partners to identify, prioritize, and address the nonpoint source problems in the basin. DWQ believes that using these teams is the best way to manage many of the nonpoint source impacted areas of the state, since an understanding of the local resources and economy and support from local stakeholders will be fundamental to successfully manage nonpoint source pollution. Although there are some general management guidelines, there is no single technique for controlling nonpoint source pollution. The most efficient and effective nonpoint source strategies will be site specific. The number of waterbodies that can be addressed within a basin planning cycle will be dependent on available resources.

In order to provide some funds for the nonpoint source teams, the statewide NPS workgroup decided to allocate up to $100,000 to each basin's NPS team on a 5 year rotating schedule. The Pasquotank NPS team must submit a proposal by the end of March 1997 to be eligible for funds.

The Pasquotank NPS team has identified one impaired stream has a high priority: Kendricks Creek. Kendricks Creek has mainly agricultural land in its watershed and is in close proximity to the research station at Plymouth which may enable the team to do more with their resources.

The final requirement for 303(d) is to prioritize the list. The Clean Water Act requires that the prioritization be based in part on the degree of impairment (use support rating) and the uses to be made of the waterbody (stream classification). One waterbody, Burnt Mill Creek, was rated as not supporting while all other waters were rated as partially supporting. Therefore, initially it was rated higher than the other waters. The freshwater streams have identical uses while the saltwater areas are used for shellfishing and recreation. As such, the estuarine waters were considered for higher priority status than the freshwater streams. However, North Carolina does not have the technical tools at this time to review fecal coliform in the estuarine system. Finally, the NPS team has identified Kendrick Creek as a potential area in which to focus its efforts. Since local stakeholder support will significantly impact management strategy implementation success, it was given a higher priority. Based on this process, Kendrick Creek was rated as high, Burnt Mill Creek was rated as low, and all other waterbodies were rated as low. The amount of work that will be completed in time for the 2002 Pasquotank Basin Plan will depend on available resources. If the nonpoint source team is still reviewing waterbodies in the basin. If the NPS team chooses other priority watersheds, the priorities listed above may be revised.

Additional Guidance on Using the 303(d) List

The column headings in the 303(d) list refer to the following:

Class - The information in this column indicates the classification assigned to the particular waterbody. Stream classifications are based on the existing and anticipated best usage of the stream as determined through studies and information obtained at public hearings. The stream classifications are described in 15 A NCAC 2B .0300, and a copy of the pertinent pages of these regulations is attached in Appendix I.

Wtrbdy - The number in this column refers to the DWQ subbasin in which the waterbody is located. The NRCS 14 digit hydrologic units nest within the DWQ subbasins.

Problem Parameter - These are the causes of impairment as identified in the 305(b) report. Where no cause is listed, the rating was based on biological data, and available chemical data showed no impairment. These biological data may include benthic, fish habitat, and fish tissue information. It should also be noted that where a problem parameter is identified, the parameter listed exceeded the state's water quality standards for that substance. This parameter is a potential cause of the impaired stream, but there may be other, unidentified causes contributing to the impairment as well. Problem parameters included in the Pasquotank 303(d) list are outlined below:

Chla - chlorophyll-a
DO - dissolved oxygen
Fecal - fecal coliform

Rating - This column lists the overall use support rating. These values may be NS (not supporting) or PS (partially supporting). The 305(b) report describes these use support ratings further.

Major Sources (P,NP) - This column indicates whether point (P) or nonpoint (NP) sources are the major sources of impairment.

Subcategory - This column breaks the point and nonpoint sources down further. A list describing what each number means is provided after the list.

Table 1: 303(d) List for the Freshwater Portion of the Pasquotank River Basin.

Name of Stream	Description	Class	Wtrbdy	Problem Parameters	Overall Rating	Major Sources (P,NP)	Major Sources Subcategory	Priority
Burnt Mill Creek*	From source to Yeopim River	C Sw	30152		NS	NP	18,11,16	Medium
Little River*	From source to mouth of Halls Cr/Woodville	C Sw	30152	DO	PS	NP	11,18,32,65	Low
Kendrick Creek *	From source to U.S. Hwy. 64 at Roper	C Sw	30153	DO, pH	PS	NP,P	11,18,02	High
Main Canal *	From source to Kendrick Creek	C Sw	30153		PS	NP	16,18,11	Low
Scuppernong River	From source to mouth of Riders Creek	C Sw	30153	DO,pH	PS	NP,P	11,13,18,02	Low
Phelps Lake	Entire Lake	C Sw	30153	Mercury	PS	NP		Low

* DWQ believes the best way to management these waterbodies is through the NPS team process. Management strategies developed by these teams will be in lieu of a numeric TMDL. The number of waterbodies addressed during each basin cycle will depend on available resources. Kendrick Creek has been identified as a potential high priority waterbody by the Pasquotank NPS team.

Table 2: 303(d) List for the Pasquotank River Basin Estuary

Area Name	Total Acres	DEH AREA	Partial Support (acres)	Non-Support (acres)	Major Causes: Fecal (acres)	Major Causes: DO (acres)	Major Sources: Point	Major Sources: Nonpoint	Descriptions of Potential Sources of Pollution	Priority
Roanoke Sound	20,500	H1	1,950	0	1,950		500	1,450	WWTP, urban runoff, septic tanks, marinas	Low
Croatan Sound	42,500	H2	891	0	891			891	urban runoff, septic tanks, marinas	Low
Stumpy Sound	5,500	H3	265	0	265			265	septic tanks	Low
Hatteras	5,800	H4	625	0	625			625	urban runoff, septic tanks, marinas	Low
Outer Banks	66,800	H5	331	0	331			331	urban runoff, septic tanks, marinas	Low
Eastern Albemarle Sd	55,000	I2	800	0	800			800	septic tanks, urban runoff	Low
Little River	7,500	I6	1,125	0		1,125		1,125	ag,swamp	Low
Totals	203,600		5,987	0	4,862	1,125	500	5,487		
Percentages			2.9	0.0	81.21	18.79	8.4	91.6		

<u>Subcategory Codes</u>

0 Point Sources
- 01: Industrial
- 02: Municipal
- 03: Municipal Pretreatment (indirect dischargers)
- 04: Combined sewer overflows (end-of-pipe control)
- 05: Storm sewers (end-of-pipe control)
- 06: Schools
- 07: Other non-municipal

1 Nonpoint Sources

10 Agriculture
- 11: Non-irrigated crop production
- 12: Irrigated crop production
- 13: Specialty crop production (e.g., truck farming and orchards)
- 14: Pasture land
- 15: Range Lots
- 16: Feedlots - all types
- 17: Aquaculture
- 18: Animal holding/management areas

20 Silviculture
- 21: Harvesting, reforestation, residue management
- 22: Forest Management
- 23: Road Construction/maintenance

30 Construction
- 31: Highway road/bridge
- 32: Land Development

40 Urban Runoff
- 41: Storm Sewers (source control)
- 42: Combined sewers (source control)
- 43: Surface runoff
- 44: Finger Canals
- 45: Industrial

50 Resource Extraction/Exploration/Development
- 51: Surface mining
- 52: Subsurface mining
- 53: Placer mining
- 54: Dredge mining
- 55: Petroleum activities
- 56: Mill tailings
- 57: Mine tailings
- 58: Abandoned mines

60 Land Disposal / Runoff / Leachate From Permitted Areas)
- 61: Sludge
- 62: Wastewater
- 63: Landfills
- 64: Industrial land treatment
- 65: On-site wastewater systems (septic tanks, etc.)
- 66: Hazardous Waste

70 Hydrologic/Habitat Modification

- 71: Channelization
- 72: Dredging, sand dipping
- 73: Dam construction
- 74: Flow regulation
- 75: Bridge construction
- 76: Removal of riparian vegetation
- 77: Streambank modification/destabilization
- 78: Collapsed dam

80 Other

- 81: Atmospheric deposition
- 82: Waste storage/storage tank leaks
- 83: Highway maintenance and runoff
- 84: Spills
- 85: In-place contaminants
- 86: Natural
- 87: Marinas, harbors
- 88: Airport
- 89: Military activities (off road)

90 Source Unknown

- 91: General Erosion (road erosion)

References for Abbreviations

AQTox	Aquatic Toxicology Group (DWQ)
ARO	Asheville Regional Office (DWQ)
BMAN	Benthic Macroinvertebrate Survey (DWQ)
Comp	Compliance Group (DWQ)
DEM	Division of Environmental Management
DFR	Division of Forest Resources
DWQ	Division of Water Quality (formerly DEM)
DWR	Division of Water Resources
FAC	Food and Agriculture Committee
FRO	Fayetteville Regional Office (DWQ)
LQ	Division of Land Quality
Meck Co	Mecklenburg County
MRO	Mooresville Regional Office (DWQ)
NCFS	North Carolina Forest Services
RRO	Raleigh Regional Office (DWQ)
SCS	USDA Soil Conservation Service
SWCD	Soil and Water Conservation District
Topo	Topographic Map
WaRo	Washington Regional Office (DWQ)
WiRo	Wilmington Regional Office (DWQ)
WRC	Wildlife Resource Commission
WRRI	Water Resources Research Institute
WSR	Winston-Salem Regional Office (DWQ)
USGS	United States Geological Survey

APPENDIX IX

LIST OF NPDES PERMITTED DISCHARGES IN THE PASQUOTANK RIVER BASIN

Permitted Wastewater Discharges in the Pasquotank River Basin

Data as of 6/13/96 Permit Type	Permit #	Facility Name	Design Flow	Issued Date	Expiration Date	Basin	Pipe #	Receiving Stream Description
MAJOR MUNICIPAL	NC0079057	MANTEO WWTP, TOWN OF	0.6	93/04/27	98/02/28	30151	1	SHALLOWBAG BAY/PASQUOTANK RIVER BASN
MAJOR NON-MUNICIPAL	NC0025011	ELIZABETH CITY WWTP, CITY OF	2.5	95/03/28	98/02/28	30150	1	PASQUOTANK RIVER/PASQUOTANK RVR BASN
MINOR	NC0021849	HERTFORD WWTP, TOWN OF	0.4	93/04/30	98/02/28	30152	1	PERQUIMANS RIVER/PASQUOTANK RVR BASN
MUNICIPAL	NC0020443	COLUMBIA, TOWN OF	0.15	95/10/02	98/03/31	30153	1	SCUPPERNONG RIVER/PASQUOTANK RVR BSN
	NC0036315	ROPER WWTP, TOWN OF	0.085	93/04/30	98/03/31	30153	1	MAIN CANAL-KENDRICKS CRK/PASQUOTANK
	NC0048861	CRESWELL WWTP, TOWN OF	0.064	93/06/30	98/03/31	30153	1	SCUPPERNONG RIVER/PASQUOTANK RVR BSN
	NC0025313	KILL DEVIL HILLS WWTP, TOWN OF	0.06	93/01/20	98/03/31	30155	1	BUZZARD BAY/PASQUOTANK RIVER BASIN
MINOR	NC0007561	TRIANGLE PACIFIC CORP/IXL DIV.	0.018	93/07/26	98/02/28	30150	1	NEW BEGUN CRK/PASQUOTANK RIVER BASIN
NON-MUNICIPAL	NC0007561	TRIANGLE PACIFIC CORP/IXL DIV.	0.018	93/07/26	98/02/28	30150	2	NEW BEGUN CRK/PASQUOTANK RIVER BASIN
	NC0007978	SOUTH MILLS WATER ASSOC.,INC.	0	93/07/30	98/02/28	30150	1	DISMAL SWAMP CANAL/PASQUOTANK RVR BS
	NC0036447	ELIZABETH CITY WTP, TOWN OF	0	93/01/15	98/02/28	30150	1	KNOBBS CREEK/PASQUOTANK RIVER BASIN
	NC0037214	CAMDEN CO SCH-GRANDY ELEM	0.007	93/09/03	98/02/28	30150	1	SAWYERS CREEK/PASQUOTANK RIVER BASIN
	NC0043583	PASQUOTANK CO WTP	0	93/05/07	98/02/28	30150	1	UT NEW BEGUN CRK/PASQUOTANK RVR BASN
	NC0079499	U.S.COAST GUARD SUPPORT CENTER	0	93/06/28	98/02/28	30150	1	PASQUOTANK RIVER/PASQUOTANK RVR BASN
	NC0079499	U.S.COAST GUARD SUPPORT CENTER	0	93/06/28	98/02/28	30150	2	CANAL->PASQUOTANK RVR/PASQUOTANK R B
	NC0035670	DARE CO-REGIONAL WATER SUPPLY	0.05	93/04/30	98/02/28	30151	1	UT CROATAN SOUND/PASQUOTANK RVR BASN
	NC0049140	DARE CO-LANDFILL	0.16	92/10/30	97/10/31	30151	1	UT DEER CREEK/PASQUOTANK RIVER BASIN
	NC0056065	DOT-MARINE MAINTENANCE FAC.	0	93/03/12	98/02/28	30151	1	UT SPENCERS CRK/PASQUOTANK RIVER BSN
	NC0056065	DOT-MARINE MAINTENANCE FAC.	0	93/03/12	98/02/28	30151	2	UT SPENCER CREEK/PASQUOTANK RVR BSN
	NC0051373	PERQUIMANS COUNTY WTP # 2	0	93/08/19	98/02/28	30152	1	UT MILL CREEK/PASQUOTANK RIVER BASIN
	NC0068861	PERQUIMANS CO.WAT.DEPT./BETHEL	0	93/03/12	98/02/28	30152	1	BETHEL CREEK/ PASQUOTANK RIVER BASIN
	NC0080641	CHOWAN CO. WATER PLANT-YEOPIM	0	93/06/18	98/02/28	30152	1	UT BURNT MILL CREEK/PASQUOTANK RV BS
	NC0007510	COLUMBIA, TOWN OF	0	94/10/21	98/05/31	30153	1	UT SCUPPERNONG RIVER/CHOWAN RVR BASN
	NC0027600	CRESWELL WTP, TOWN OF	0	93/04/23	98/03/31	30153	1	UT SCUPPERNONG RVR/PASQUOTANK RVR BS
	NC0031925	ROPER WTP, TOWN OF	0	93/03/19	98/03/31	30153	1	UT MAIN CANAL/PASQUOTANK RIVER BASIN
	NC0072150	CURRITUCK CO. WTP	0	93/06/18	98/03/31	30154	1	UT EAST CREEK/CHOWAN RIVER BASIN
	NC0023027	VILLAS ASSOCIATION, INC.	0.06	92/12/04	97/12/31	30155	1	ROANOKE SOUND/PASQUOTANK RIVER BASIN
	NC0033103	CAPE HATTERAS WATER ASSOC.,INC	0	93/02/15	98/03/31	30155	1	PETER'S DITCH/PASQUOTANK RIVER BASIN
	NC0070157	DARE CO-REVERSE OSMOSIS	0	95/04/05	98/03/31	30155	1	DITCH TO ATLANTIC OCEAN/PASQUOTANK
	NC0070157	DARE CO-REVERSE OSMOSIS	0	95/04/05	98/03/31	30155	2	DITCH TO ATLANTIC OCEAN/PASQUOTANK
	NC0083909	DARE CO-	0	94/05/26	98/03/31	30155	1	BLACKMAR GUT/PASQUOTANK RIVER BASIN

APPENDIX X

SUMMARY OF COMMENTS RECEIVED AT PUBLIC WORKSHOPS

Summary of Comments Received at Workshops Held on the Pasquotank River Basin

July 25, 1996 3:00 p.m. to 6:00 p.m. - Elizabeth City, NC

GROUP 1

(Numbers in parentheses represent number of individuals in group voted that category a top priority during the prioritization process.)

Major Issues:

1. Nutrient loading/runoff (8)
2. Animal waste + septic tanks (8)
3. Education/outreach (5)
4. Decent WQ monitoring (4)
5. Sedimentation (3)
6. Coastal development (7) (balancing with water quality protection and stormwater control)
7. Loss of habitat/protection of resources (11)
   - -dredging
   - -freshwater discharge
   - -water quality
8. Identify prime resources (2)
   (nursery areas)
9. Maintain inlets for estuary access (1)

Local Projects, Efforts:

-Currituck -drainage ordinance
-Tulls Creek wetland
-Knob's Creek watershed (Pasquotank) planning proposed NRCS, DSW
-Bumper stickers for watersheds
-Ag cost share -animals
-BMP
-Odor
-No-till
-Animal operation review/permits/inspection plans (including poultry dry litter)
-Forestry BMP's
-Forestry research (agriculture + forestry) Kendrick's Creek
-Politics of permit reviews
-Certificates for restricted use pesticides
-C.E.S. fertilizer, rate trials crop management

What do State Agencies Need to Do?

-Document Problems
-State agency coordination
-Coordinate with citizen efforts
-State agencies develop consensus
-Check calendars
-Communication between State and public

Group 2

Major Issues:

-Growth - population
-Low density development w/septic tanks
-Alternative funding sources for land preservation and protection
i.e. impact fees
-Nutrient management
-Livestock operations (new & developing) - EIS needed
-Zoning/land-use/planning
-Better education for County Commissioners on these issues
-Better cost/benefit analysis (comparisons) for various types of development
-Bridge - secondary impacts to water quality
-Expansion of highway 17
-Hydrodynamics/flow modification >salt water intrusion
-Prioritize streams in the worst condition for improvement
- Satellite facilities for the basin D.W.Q. (too remote of an area for good management, research and monitoring)
-Secondary impacts from Va. Beach growth
-Better interstate communication
-Better monitoring - establish baseline data
-Get more D.W.Q. people out of Raleigh
-Utilize APES info for plan

Local Projects, Efforts:

-319 EPA projects - Tulls Creek (agriculture)
-Edenton (urban & agriculture) Manteo
-NRCS's - drainage improvement of agricultural land
-DEH - bring all septic tanks under management
-Public acquisition of wetlands/valuable resources
-Corps - canal #2 evaluation
-U.S.G.S. (Corps ?) gauges for navigational canals
-Elizabeth City WWTP upgrade
-Dr. Stan Riggs, ECU, identified sediment resuspension problem.
-DWQ - New regulations for concentrated animal facilities
-GIS use pilot Currituck Co./Coop. Ext.

What can the State do better?

-get out of Raleigh - field monitoring, satellite offices/labs in every basin
-re-evaluate citizen participation in APES process - don't make same mistake in non point source teams - they need to see results more quickly - take on smaller components
-Better consideration short comings or weaknesses in data when modeling the surface waters
-Public workshops like these are good
-Soil & water districts have done well with BMP's and training of landowners
-Division of Forest Resources - Workshops for loggers on water quality
-Define the real goals
-Land Quality BMP's

Group 3

Major Issues:

1. Growth/loss of Forest Heritage issues
2. Document - by Gordon Cashion documents wetland losses
3. Pest problems in forestry
   >creates pressure to log
4. Taking away buffers
5. Effects on water quality from Va.
6. Spend more time on implementation
7. NPS pollution
8. Need to protect designated spawning nursery areas
   -buffers
   -no direct discharges
   -no culverts
   -no dredging
   -habitat enhancement
9. Need for baseline monitoring
   >accountability -implementation
10. Waters not meeting classified uses
    >make a moratorium on new development
11. Educate everyone then they will volunteer
12. Suburban growth -pesticides, nutrients
    septic tanks
13. Cooperate with county health depts. DEH
14. Easements, buffers - have to compensate people for loss of land > that is some peoples pension plan
15. Trading of property rights "Environmental Architecture"
    Tax shelters
    Protect investment > water quality
    Leasing of hunting rights
16. Equitable enforcement
17. Broader planning perspective

Local Projects, Efforts:

1. Nature Conservancy
   Outer Banks - Nags head Woods wetland
   Kitty Hawk Woods wetland
   Buxton Woods maritime forest
   Currituck Reserve slough
   wetland reserves
   maintain drinking water for Outer Banks
2. Partnership for the Sound
   Environmental Education Program
   State - funded
3. Citizen Monitoring Program
4. USFWS got ACSP money for nutrient management in Dare Co.

July 26, 1996 9:00 a.m. to 12:00 p.m. - Manteo, NC

Group 1

Major Issues:

Turbidity - Fisheries - Economics
NPS
Agricultural Runoff
Coordinated Implementation APES CCMP
Education - We all Pollute
Balance Environment with Economics
Water Use - groundwater Recharge
Irrigation
Golf Course Development
Forestry - Misconceptions about its impact
Get Public to Care
Coastal Development
Protection of sensitive areas
Erosion/Sediment
Closed shell fisheries
Constant monitoring program
Stream buffers
Wetlands
Identify primary nursery areas
Septic systems
Interstate cooperation
Boating impacts: water quality, fisheries
Pumpout stations

Local Projects, Efforts:

Upgrade of paper mill (Union Camp)
Beneficial reuse - Wastewater on golf course (Currituck)
Dare Co. Monitoring (Clean Water Advisory)
Upgrade WWTP to nondischarge
Engelhard sewer to land application
Elizabeth City WWTP upgrade
Agricultural tour - No till - Aug. 7, 96 (Hyde, Tyrell)
Alligator Refuge - Wildlife habitat on drainage ditches
Pesticide Certification - training
Aquarium
Partnership for sounds
Nags Head - Manteo causeway
APES monitoring still ongoing
LuAnn Moore, Citizen Monitoring- Greenville

What can the State do better?
Enforce existing rules - reduce political influence
Monitor
Research to support education - application
Septic Maintenance districts

Understand Water movement in sounds
What rules do we need?
Aquarium - water quality oriented education
More education - interpretive
Ecotourism promotion
Research on Juvenile Recruitment
Address animal waste
- -rules
- -education
- -research (new tech.)

Human waste - technology

Group 2

Major Issues

1. Where do classifications come from? There (may be) are some bathing beaches classed "S C"
2. How do you reclassify waters?
3. Is there ocean water quality monitoring?
   (no evidence that it is necessary)
4. Shellfishing beds are closed if they are not monitored?
5. Bridges dump directly to sound >
   Should have retention area.
6. Golf courses - BMP's?
7. Dairy farms
8. Boats discharging into the Alligator River (Coast Guard jurisdiction)
9. Tried to get pumpout stations
   >Would they use them? Pay fee?
10. More enforcement
11. CAMA, Marine trade
12. Hydrogeological issue
13. Septic tank direct discharges
14. No mechanism for enforcing maintenance of septic tank's
15. Chesterfield Co. is looking into mandatory 5 year pumpouts.
16. Real Estate involvement
17. Hog farms - Camden Co.
18. Involve proposed regional council
19. Problems are lingering
20. APES - DWQ collaboration
    Let people know you are working together

Local Projects, Efforts:

1. Dare Co. -hired individual to do county-wide WQ program only 10 sites right now but plans to expand
   - -mobile lab
   - -raise public awareness
2. S. Shore - cit. monitoring program
3. Surf Rider foundation - monitoring
4. State needs to establish a protocol for testing
5. Get Eosat info.
   photographic data

What can the State do better?

1. Land use plans for SW control
2. Clear boat channels in Currituck sound
3. Recover energy from animal waste
   bamboo?

Group 3

Major Issues:

Aquatic Veg >for waterfowl
>milfoil <nuisance
vs.
bass habitat
Problems with dying masses of milfoil, loss of Oz Clostridia

Control of vegetation vs. elimination
-milfoil is moving south all the way to Roanoke Island
-still a dominant plant
-milfoil as habitat for variety of species
-loss of over-washes

Fisheries
-loss of abundance
-effect of upstream pollution on the sounds
High nitrogen & phosphorus
-limited circulation

Water Quality linked to Economic development

Land Use and Development
-loss of natural buffers
-development of industrial agriculture
-loss of maritime forest
-alteration of wetlands

Options for controlling wastes from confined animal operations
-land application
-activated sludge processing?

Stormwater controls

Cluster new development in less sensitive areas, preserve buffers

Look at all nonpoint sources of pollution for control urban runoff, agriculture, septic systems

Allow natural cuts through outer banks to remain open as an aid to circulation & flushing

Coordination w/ Virginia
-coordinate two EPA regions

End all wetland mitigation
mitigation programs that destroy wetland values

Healthy sounds lose to upstream interests

Flow regulation of waters in the Roanoke River basin

Educational efforts, beginning with children <Water Quality
Water Conservation

Technical assistance for agricultural cost share and BMP programs

Land acquisition for preservation

Local Projects, Efforts:

Land acquisition for preservation

Agricultural Programs
Blackland Farmers Association
Operator training & certification: animal operations
Forestry: incentives for good management

Citizen monitoring programs
-storm drain stenciling and monitoring

County level construction and development planning. State regs. are not sufficient

No-tillage practices are increasing in popularity in this region water quality benefit.

APPENDIX XI

Glossary

GLOSSARY

Legend of Acronyms, List of Abbreviations

7Q10- a value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. 7Q10 flow (in cfs) is used to allocate the discharge of toxic substances to streams.

AGPT-Algal Growth Potential Test.

AMS-Ambient Monitoring System.

BI(BIEPT)-Biotic Index, Biotic Index for EPT groups. A summary measure of the tolerance values of organisms found in the sample, relative to their abundance. Sometimes noted as the NCBI or NCBIEPT.

Bioclassification-Criteria have been developed to assign five bioclassifications (Poor, Fair, Good-Fair, Good, Excellent) to each benthic sample based on the number of taxa present in the intolerant groups (EPT) and the Biotic Index value.

BMAN-Biological Monitoring Ambient Network.

BODlt-Biochemical Oxygen Demand, long term.

cfs-Cubic feet per second, generally the unit in which stream flow is measured.

CHLA-Chlorophyll A.

ChV-Chronic Value. Of a toxicity test, defined as the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration.

DWQ-Division of Water Quality (became the Division of Water Quality on July 1, 1996)

DO-Dissolved Oxygen.

Ecoregion: An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, and soil type. Examples include mountains, piedmont, coastal plain, sandhills and slate belt.

EHNR-N.C. Dept. of Environment, Health, and Natural Resources.

EPT-The insect orders Ephemeroptera, Plecoptera, Trichoptera-as a whole the most intolerant insects present in the benthic community.

EPT N- The abundance of Ephemeroptera, Plecoptera, Trichoptera insects present, using values of 1 for Rare, 3 for Common and 10 for Abundant.

EPT S-Taxa richness of the orders Ephemeroptera, Plecoptera and Trichoptera. Higher taxa richness values are associated with better water quality.

HQW-High Quality Waters

IWC- Instream Waste Concentration. The percentage of a stream comprised of an effluent calculated using permitted flow of the effluent and 7Q10 of the receiving stream.

JOC-Judicial Order by Consent- An administrative order issued by an administrative law judge which in some way modifies limitations of an NPDES permit by consent of both parties which provides interim limitations and conditions.

LC50- The concentration of a toxicant or percentage dilution of an effluent that is predicted to be lethal to 50% of a test population of organisms.

LOEC-In a toxicity test, the Lowest Observed Effect Concentration.

NOEC-In a toxicity test, the No Observed Effect Concentration.

MGD-Million Gallons per Day, generally the unit in which effluent discharge flow is measured.

MSD-Metropolitan Sewerage District.

NPDES-National Pollutant Discharge Elimination System.

NCIBI-North Carolina Index of Biotic Integrity-a summary measure of the effects of factors influencing the fish community

NCTSI-North Carolina Trophic State Index.

NSW-Nutrient Sensitive Waters.

NTU-Nephelometric Turbidity Unit.

ORW-Outstanding Resource Water.

PF-Permitted flow, of an NPDES permit.

POTW-Publicly Owned Treatment Works.

Secchi- a standard measure of water transparency as determined by lowering of a black and white Secchi disk to the depth that the disk is no longer visible.

Total S-the number of different taxa present in a benthic macroinvertebrate sample

WTP-Water treatment plant

WWTP-Wastewater treatment plant