CAPE FEAR RIVER BASINWIDE WATER QUALITY MANAGEMENT PLAN

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This document was approved and endorsed by the North Carolina Environmental Management Commission on October 12, 1995 to be used as a guide by the NC Division of Water Quality in carrying out its water quality program responsibilities in the Cape Fear River Basin. It will be updated in 2000.

FORWARD

Clean water is critical to the health, economic well-being and quality of life of those living or working in the Cape Fear River basin. Most water users throughout the basin, including industry, agriculture and the basin's nearly 1.5 million residents, rely on surface water for basic needs such as water supply and/or disposal of treated wastewater. In addition, many businesses and residents of the Cape Fear basin rely directly or indirectly on the basin's lakes and 6300 miles of rivers and streams to meet their recreational needs and provide a source of living. To these groups and the public they serve, it is important that the basin's waters support viable fisheries, that the waters be relatively safe (low risk of contracting water-borne disease) and that they be aesthetically desirable (free of objectionable colors, odors and smells). Yet maintaining clean water becomes increasingly difficult and more expensive as the population grows, as land develops and as competition for its resources heighten.

The protection and restoration of surface waters in the Cape Fear Basin represents a tremendous challenge. Rising in the north central piedmont region of the state, near Greensboro and High Point, the Cape Fear is the largest river basin in North Carolina and one of just four basins located entirely within the state. It covers an area of over 9,000 square miles, and encompasses roughly 25% of the state's population including 114 municipalities and all or portions of 27 counties. The basin also includes one of the most concentrated turkey and hog producing regions in the country. On its way to the ocean, the Cape Fear flows through a series of three locks and dams and past such cities as Lillington, Fayetteville, Elizabethtown and Wilmington.

While 72% of the freshwater streams in the basin are considered to be supporting their designated uses, almost half of these streams are considered threatened; and over 1,100 miles, or approximately 18%, are considered impaired. Sedimentation is the most widespread cause of stream impairment in the basin, but other types of pollution which pose significant threats to water quality include oxygen-demanding wastes, nutrients and toxic substances. Urban stormwater, construction, agriculture and wastewater treatment plant discharges are the major pollution sources in the basin.

In the basin's estuarine waters, 27% percent of the waters are rated as use-impaired with low dissolved oxygen and closed shellfish waters (from fecal coliform bacteria contamination) being the primary causes. Statistics for the state's coastal waters have shown a slow but steady increase in shellfish water closures since the early 1980s which appears to be related to increased urbanization and stormwater runoff. Local government involvement will be needed if this trend is to be curtailed.

In addition, public water supply plans submitted to the state by local governments in the basin estimate that water usage by the year 2020 will double from 1992 levels. Water supply planning for the basin will be a critical need in the years ahead. This will need to be accompanied by both a greater emphasis to be placed on water conservation and reuse, and on expanded and improved waste treatment capacity.

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

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

EXECUTIVE SUMMARY

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

Basinwide management is a watershed-based water quality management initiative being implemented by the North Carolina Division of Water Quality (DWQ). The *Cape Fear River Basinwide Water Quality Management Plan* (Cape Fear Plan) is the seventh 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 Cape Fear River Basin.

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

The Cape Fear Plan was approved by the North Carolina Environmental Management Commission in October of 1995 and will be updated in the year 2000. Basinwide NPDES permitting was scheduled to commence in January 1996.

BASINWIDE GOALS

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

PUBLIC WORKSHOPS

Two public workshops were held in October 1994 in Elizabethtown and Pittsboro to familiarize stakeholders in the basin with DWQ's basinwide approach and to solicit their comments for the basin plan. The workshops, which had a combined total of 191 participants, were co-sponsored by the North Carolina Cooperative Extension Service (CES), DWQ and the North Carolina League of Municipalities. A summary of the workshop is provided in Appendix IV of the plan. Priority issues and recommended actions identified by two or more discussion groups included:

- Increase support for monitoring and enforcement
- Increase public education and involvement of local stakeholders
- Increase incentives and enforcement for nonpoint sources, including agriculture and forestry
- Promote regional land use and wastewater planning
- Consider economic implications of environmental protection
- improve monitoring data for a sound basis for regulations
- Identify and target critical areas of water quality concerns
- Coordinate local and state government programs to maximize effectiveness

- Address urban stormwater runoff through education and enforcement
- Evaluate nutrient trading for cost-effective pollutant reductions
- Consider impacts on wildlife habitat

CAPE FEAR BASIN OVERVIEW

The Cape Fear Basin is the largest river basin in the state covering 9,149 square miles. It is one of just four river basins in North Carolina located entirely within the state's boundaries and flows from the north central piedmont region near Greensboro to the Atlantic Ocean.

The Cape Fear River is formed at the confluence of the Haw and Deep Rivers on the border of Chatham and Lee Counties just below the Jordan Reservoir dam. From there the river flows across the coastal plain past Fayetteville and Wilmington, is fed by the Black and Northeast Cape Fear River watersheds (two major blackwater systems) and finally enters the Atlantic Ocean at Cape Fear.

There are 27 counties and 114 municipalities located in whole or in part in the basin. Based on 1990 census data, the population of the basin is just under 1.5 million people. The most densely populated areas are in and near the Triad area (Greensboro-High Point), the Durham-Chapel Hill area, and in and around Fayetteville. The overall population density is 160 persons per square mile versus a statewide average of 125 persons per square mile. The percent population growth over the past ten years (1980 - 1990) was 11.5 % versus a statewide average of 12.7%

Over half of the land in the river basin is forested. Statistics provided by the US Department of Agriculture, Natural Resources Conservation Service indicate that during the last decade there has been an increase in the amount of developed land and a decrease in the amount of cropland. Major industries in the basin include chemical manufacturing, textiles, silviculture and agriculture (hogs, poultry, soybeans and tobacco). North Carolina is the number one turkey- and number two hog-producing state in the country. The lower Cape Fear basin encompasses the most concentrated animal producing areas in the state in Sampson and Duplin counties.

The basin includes three coastal Outstanding Resource Waters (ORW) (Stump Sound, Middle and Topsail Sounds and Masonboro Sound) and one inland ORW (a portion of the Black River basin).

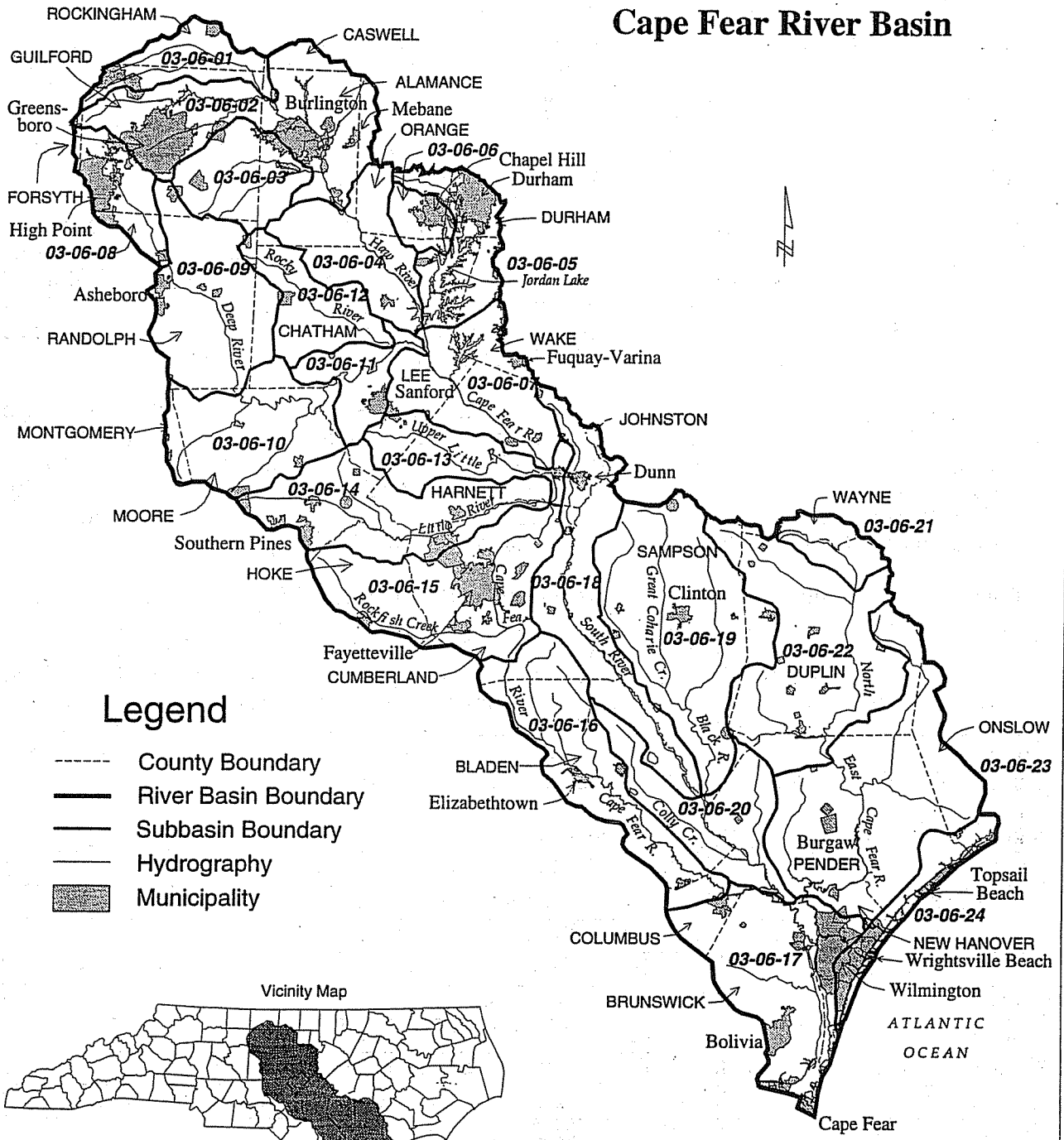
In the Cape Fear River Basin, there are 641 permitted NPDES dischargers, 336 of which are general permits or stormwater discharge permits. Of the total 641 dischargers, 54 are major facilities, 228 are domestic, 58 are municipalities and 212 are industries. The total permitted flow for all facilities is 397 million gallons per day (MGD).

Based on evaluation of water supply plans submitted to the North Carolina Division of Water Resources from 51 local governments in the basin, it is estimated that water usage in the year 2020 will be twice the reported usage by the governments in 1992. Review of interbasin transfer information for the basin indicates that there is a net increase of 13 million gallons per day coming into the Cape Fear basin from adjoining basins. This amount is expected to be reduced as Cary and Apex increase their withdrawals from Jordan Reservoir and discharge their wastewater into the Neuse River basin.

ASSESSMENT OF WATER QUALITY IN THE CAPE FEAR RIVER BASIN

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

General Map of the Cape Fear River Basin



Legend

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

Vicinity Map

Cape Fear River Basin

1:1,600,000

0 20 40 60 miles

DEHNR

Produced by: State Center for Health and Environmental Statistics
August, 1994

Summary of Biological Indicators

Benthic Macroinvertebrates - These are primarily bottom-dwelling aquatic insect larvae of species such as stoneflies, mayflies and caddisflies. Measurements of the number, types and diversity of these organisms at strategic sampling sites is an important means of assessing water quality.
In the Cape Fear River Basin, A total of 517 benthic macroinvertebrate samples have been collected from 295 monitoring locations from 1983 through 1993. The majority of these samples exhibited either Good/Fair (24%) or Fair (27%) bioclassifications, while only 8% of these samples noted Excellent bioclassifications. Bioclassifications were not given for 46 benthic macroinvertebrate samples collected from swamp-stream or euryhaline ecosystems within the Cape Fear River basin (this number also includes 4 very small streams). This is because bioclassification criteria have not been established for swamp-stream and euryhaline (brackish) ecosystems.

Ninety-four of the total monitoring locations have had data collected on two or more occasions, allowing for long-term data comparisons. Of these 94 monitoring locations, 58 (62%) had no long-term changes in bioclassification, 26 (28%) showed some improvement, and 10 (10%) noted a decline in bioclassification. Many of the improvements noted in bioclassifications were from monitoring sites in the Deep River watershed although this watershed continues to experience water quality problems associated with nutrients, toxicity and low dissolved oxygen.

Fish Community Evaluations - Fish community evaluations were performed at 47 sites in the Cape Fear River Basin. These individual site assessments should not be interpreted as representative samplings of either the entire basin or an entire subbasin. Constraints in both sampling methodology and resources prevent the monitoring of a sufficient number of fish community locations to clearly evaluate the ecological health of the entire basin. Therefore evaluations of the fish community structure analysis should be limited to a site specific interpretation.

Of the forty-seven sites sampled, twelve were rated as Poor or Poor-Fair, 17 rated as Fair or Fair-Good, and 18 rated as Good or Good-Excellent. Grays Branch, Stinking Quarter Creek, Bear Creek, and Grove Creek each received ratings in the Good-Excellent category. Those sites which were rated as Poor or Poor-Fair and reasons for these ratings are presented in the table, below. Some of the sites which were rated Poor or Poor-Fair have already had remedial action taken or planned. The Cherokee Brick Quarry which drains into a tributary of Gulf Creek is currently applying for a stormwater permit, BMPs are being initiated in the Herring Marsh drainage, and the Burgaw WWTP has been upgraded since our sampling date in 1985.

Cape Fear Basin Fish Community Structure Sites which rated Poor or Poor-Fair

SITE	SUBBASIN	REASONS FOR RATINGS
Troublesome Cr at SR-1001	03-06-01	nutrient enrichment
South Buffalo Cr at SR-2821	03-06-02	below WWTP and urban runoff
North Buffalo Cr at SR-2770	03-06-02	below two WWTP's, urban runoff, and poor habitat
Third Cr at NC-751	03-06-05	urban runoff and low flows
Northeast Cr at SR-1100	03-06-05	below WWTP and urban runoff
Kenneth Branch at SR-1441	03-06-07	nutrient enrichment and sedimentation
Gulf Cr trib at SR-1924	03-06-07	sedimentation, nutrient enrichment and low flow
Gulf Cr off SR-1916	03-06-07	sedimentation
Little Coharie Cr at SR-1214	03-06-19	unclear
Herring Marsh at SR-1306	03-06-22	unclear
Burgaw Cr at US-117	03-06-23	below WWTP and sedimentation
Burgaw Cr at SR-1216	03-06-23	below WWTP and sedimentation

Fish Tissue Analyses - Analysis of fish tissues for organic chemicals and metals 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 the Cape Fear Basin, 618 fish tissue samples from 51 locations have been analyzed from 1980 through 1994. EPA screening criteria for organic chemicals and metals (mercury) were equaled or exceeded in 52 samples at 16 sites. The FDA limit of 1.0 ppm for mercury was exceeded in ten samples at seven sites. Organic chemicals found in the tissues included: Dieldrin, DDT, Chlordane, Heptachlor epoxide, Heptachlor, Endrin, PCB and Lindane. None of these organic substances was found to exceed applicable FDA limits.

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. 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 that 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 Cape Fear River basin, described more fully in Chapter 4, are summarized below for freshwater streams and lakes.

Freshwater Streams and Rivers - Of the 6204 miles of freshwater streams and rivers in the Cape Fear basin, use support ratings were determined for 90% or 5601 miles. Of this total, 72% were rated as supporting their uses, 18% were considered impaired and 10% were not evaluated. Of those waters rated as Supporting their uses, approximately half (or 34% of all streams) were considered threatened.

SUPPORTING 72%
- Fully supporting (38%)
- Support-threatened (34%)

IMPAIRED 18%
- Partially supporting (15%)
- Not supporting (3%)

NOT EVALUATED: 10%

Sediment was the most widespread cause of f*reshwater* stream use-support impairment throughout the basin, followed by turbidity, pH, metals, fecal coliform bacteria and ammonia. Information on sources of impairment for stream miles rated partially or not supporting indicated that 870 stream miles were thought to be impaired by nonpoint sources, and 181 stream miles were thought to be impaired by point sources. Agriculture was thought to be the most widespread nonpoint source, followed by urban runoff and construction. It should be noted that most of the use support information is based on older monitored data or best professional judgement of nonpoint source workshop participants in the 1980s. As this information is updated, it is expected that the numbers of stream miles thought to be impaired as a result of agricultural-related sedimentation will change. NRCS data have shown reductions in cropland sediment runoff from 1982 to 1992 (results of federal Farm Bill programs?) which may not be accurately reflected in the use support data.

Oxygen-demanding wastes from point source discharges and nutrients from both point and nonpoint sources are also very important causes of pollution that need to be addressed in

freshwater streams in the Cape Fear Basin. These appear to be the causes for many freshwater streams being support-threatened, and control of these substances is needed to prevent degradation of water quality below standards that could result in impairment of water uses.

Lakes

Thirty-four of the thirty-six lakes assessed in the basin were rated as fully supporting their designated uses. Sixteen of those lakes are listed as threatened which identifies some cause for concern if precautions are not taken. In virtually of these cases, the cause for concern is tied to elevated levels of nutrients. One lake, Greenfield Lake, is designated as not supporting its uses as indicated in the table below. This lake has had ongoing problems with nuisance filamentous algal blooms, fish kills and aquatic macrophytes. To improve the lake's condition, dredging, application of herbicides, and lowering of the lake's water level have been performed. Known contributions of nutrients to the lake include stormwater runoff from the residential watershed.

Threatened and Not Supporting Lakes in the Cape Fear River Basin

LAKE	STATUS	CAUSES
Pittsboro Lake	Support-threatened	Algal blooms, Aquatic weeds, Elevated D.O.
Jordan Reservoir	Support-threatened	Elevated nutrients (TP 0.07MG/L, TN 0.58MG/L)
Upper Moccasin Lake	Support-threatened	Elevated nutrients (TP 0.12 MG/L, TN 0.92 MG/L)
Sandy Creek Res.	Support-threatened	Elevated nutrients (TP 0.07 MG/L, TN 0.77 MG/L)
Carthage City Lake	Support-threatened	Aquatic Weeds
Rocky River Res.	Support-threatened	Elevated nutrients (TP 0.095 MG/L, TN 1.01 MG/L)
Bonnie Doone Lake	Support-threatened	Elevated nutrients (TP 0.12 MG/L, TN 1.07 MG/L)
Mintz Pond	Support-threatened	Elevated nutrients (TP 0.08 MG/L, TN 0.58 MG/L)
Glenville Lake	Support-threatened	Elevated nutrients (TP 0.07 MG/L, TN 0.67 MG/L)
Greenfield Lake	Not Supporting	Algal blooms, Fish kills, Aquatic Weeds
University Lake	Support-threatened	Elevated nutrients (TP 0.065 MG/L, TN 0.66 MG/L)
Lower Moccasin Lake	Support-threatened	Elevated nutrients (TP 0.06 MG/L, TN 0.61 MG/L)
Lake Burlington	Support-threatened	Elevated nutrients (TP 0.065 MG/L, TN 0.56 MG/L)
Kornbow Lake	Support-threatened	Elevated nutrients (TP 0.05 MG/L, TN 0.78 MG/L)
Oak Hollow Lake	Support-threatened	Algal blooms
Harris Lake	Support-threatened	Elevated nutrients (TN 0.61 MG/L)
Burlington Lake	Support-threatened	Elevated nutrients (TN 1.51 MG/L)
Bay Tree Lake	Partially Supporting	Mercury fish consumption advisory

One lake was rated as partially supporting its uses because of fish consumption advisory due to elevated mercury levels found in tissues of fish caught in that lake.

Estuarine Waters

Use support determinations were made for all of the 39,200 acres of estuarine waters in the Cape Fear Basin. Approximately 73 percent of these waters were rated as fully supporting and the remaining 27 percent were rated partially supporting.

Low dissolved oxygen was the most widespread probable cause of impairment in waters downstream of Lock and Dam #1 causing an estimated 5,010 acres to be rated as partially supporting. Point source discharges are considered to be a significant contributor to this problem.

An additional 4,900 acres of shellfish (SA) waters were closed to harvesting due to elevated levels of fecal coliform bacteria. It is noted that the total acreage of estuarine waters in the basin closed to shellfish harvesting by the NC Division of Environmental Health (DEH) Shellfish Sanitation Branch is 18,732 acres. However, only approximately 4,900 acres of these waters have been classified by DWQ for shellfish harvesting, thus only this 4,900 acres are rated as impaired. Another 18,500 acres of estuarine waters are open to shellfish harvesting, based on DEH surveys, although they may be temporarily closed from several days to several weeks after heavy rains or high river flows. Waters are reopened when DEH surveys show fecal coliforms concentrations returning to safe levels.

Nonpoint source pollution is estimated to be the primary pollution source in 77% of the impaired waters (primarily those waters impaired based on shellfish water closures), with the remaining 23% impaired due to point sources (those waters impaired by low dissolved oxygen).

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, the number of users potentially affected, and the threat to water quality degradation posed by certain pollutants. Those issues considered most significant on a basinwide scale are presented below along with recommended corrective or research actions. These include: A. Oxygen-consuming wastes, B. Nutrients, C. Toxic Substances, D. Erosion and Sedimentation E. Urban Stormwater, F. Color, G. Fecal Coliform Bacteria, and H. Protection of High Resource Value Waters through reclassifications.

A. MANAGEMENT OF OXYGEN-CONSUMING WASTES FROM DISCHARGE FACILITIES

The Division of Water Quality has the responsibility of ensuring that the waste limits in NPDES discharge permits are established to protect dissolved oxygen (DO) standards in receiving waters. The standard for all waters in the Cape Fear River basin, except for waters supplementally classified as swamp waters, is 5.0 mg/l (daily average with instantaneous measurements not to fall below 4.0 mg/l). Swamp waters, which are prevalent in the lower portion of the basin, may have naturally lower levels of dissolved oxygen, and the acceptable dissolved oxygen level can vary from stream to stream. For example, the natural dissolved oxygen concentration in the Black River would be expected to vary considerably from that portion of the mainstem of the lower Cape Fear River below Lock and Dam 1 that is classified as swamp waters because they are two very different river systems.

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

- Buffalo Creek watershed
- Deep River watershed
- Upper Haw River

- Jordan Reservoir watershed
- Kenneth Creek
- Cape Fear River Mainstem from Buckhorn Dam to the mouth

The strategies for each of these waterbodies are presented in section 6.3 of Chapter 6. TMDLs are based on observed water quality data and predictive computer modeling that take into account water quality data, stream flow and physical conditions, waste loading and waste assimilative capacity. Calibrated QUAL2E models were developed for Buffalo Creek and the Cape Fear River during this basin planning process. Calibrated models have been developed in the past for the Rocky River and several tributaries of Jordan Lake.

The most significant dissolved oxygen issues in the basin are summarized below. These strategies are given emphasis based on severity of water quality problems, completion of intensive studies by DWQ, and importance to basinwide water quality.

Buffalo Creek Watershed

North and South Buffalo Creeks, from their headwaters to their confluence at Buffalo Creek/Reedy Fork, are low flow streams dominated by the two City of Greensboro WWTPs and Cone Mills' discharges. Both streams also receive urban and agricultural runoff. These creeks as well as Buffalo Creek and Reedy Fork are on the state's impaired waters list. DWQ and facility self-monitoring data show severely low dissolved oxygen concentrations (less than 2 mg/l) in North and South Buffalo Creek below the WWTPs during summer conditions.

In light of the extremely limited assimilative capacity for oxygen-consuming wastes in Buffalo Creek and its tributaries, no new wastewater outfalls should be constructed within the modeled area. The existing municipal facilities should serve as regional treatment facilities to handle future wastewater needs. Any proposed expansion of the existing regional facilities will be thoroughly evaluated to ensure no additional degradation will occur, and if technically feasible, ensure improvements to water quality. All remaining permitted facilities should conduct an engineering alternatives and economic analysis including the feasibility of connecting to municipal sewer service. If there are no feasible alternatives, limits of BOD_5=5 mg/l, NH_3-N=2 mg/l, and DO=6 mg/l will be recommended and a schedule for implementation developed. Future wastewater expansions may require environmental assessments.

Before approving new and expanding discharges to tributaries outside the modeled area, an empirical (desktop) model should be run to ensure that wastewater is fully assimilated prior to confluence with the mainstem area.

Deep River

The Deep River is one of two headwater tributaries of the Cape Fear River. In the upper reaches the Deep River is shallow and rocky as it flows through the rolling hills of the Piedmont, while the lower, easternmost reaches are flatter, with greater depths and slower velocities. Seventeen dams create impoundments which slow flow and trap pollutants. Dissolved oxygen standard violations have been observed at a number of ambient sites, with most violations occurring downstream of Carbonton Dam in the lower reaches of the Deep River.

Due to the predominance of wastewater in this system during low flow conditions it is recommended that all new and expanding major facilities in the Deep River basin between

High Point Reservoir and Carbonton dam be issued advanced tertiary limits (BOD_5 = 5 mg/l and NH_3-N = 2 mg/l). For new and expanding discharges between High Point Lake and Carbonton dam with flows less than 1 million gallons per day (MGD), regionalization of wastewater treatment is encouraged. If discharge to a regional WWTP is not feasible, new and expanding discharges should prepare an alternatives analysis to evaluate all practicable alternatives to surface water discharge. Where discharge is the most feasible option, permit limits no less stringent than BOD_5 = 15 mg/l and NH_3-N = 4 mg/l are recommended. Additionally, because low dissolved oxygen levels in the Deep River are strongly linked to algae growth, nutrient limits are recommended in this section of the basin.

In the section of the Deep River from Carbonton dam to the Haw River, the assimilative capacity is nearly exhausted and new discharges should not be permitted. Expansion requests by Sanford WWTP due to further regionalization will be thoroughly evaluated to insure no additional water quality degradation will result.

Cape Fear River

The Cape Fear River mainstem is a complex system which can be broken into three distinct segments:

1) Confluence of the Haw and Deep Rivers to Lock & Dam 3,
2) Lock & Dam 3 to Lock & Dam 1 and
3) Lock & Dam 1 to the ocean.

From the Deep River to Erwin, there is significant slope to the river and the dissolved oxygen standard for freshwater is met. Below Erwin, the river becomes flat and there is limited reaeration. In addition, the river receives significant point and nonpoint source pollution loadings resulting in cumulative impacts to the river. Ambient monitoring data collected by DWQ indicate lower dissolved oxygen levels at the stations between Erwin and Lock & Dam 3 than above Erwin. The series of locks and dams slows the river down and creates lake-like conditions under prolonged low flow events. Though the monthly ambient data indicate no dissolved oxygen violations, special studies and facility self-monitoring data indicate that there are pronounced dissolved oxygen sags behind each dam with dissolved oxygen violations occurring under summer conditions. Below Lock & Dam 1, dissolved oxygen levels are influenced by additional point source loads, swamp water from the Black River and tidal influences. Minimum dissolved oxygen levels drop below 5 mg/l downstream of Lock & Dam 1 to as low as 2.6 mg/l near Wilmington.

Field-calibrated predictive models have been developed for much of the Cape Fear River from Buckhorn Dam to Wilmington to examine the impacts of wastewater discharges on dissolved oxygen in the river during low-flow summer conditions. Modeling results indicate that the daily average dissolved oxygen standard of 5 mg/l is not protected under current permitted loading. Instream data support the modeling conclusion that the assimilative capacity of the river for oxygen-consuming wastes is very limited. In order to protect the dissolved oxygen standard in the mainstem of the river, it is recommended that alternatives to discharging to the river be considered for new expanding discharges. Where such alternatives are not feasible, the following recommendations would recommended for new and expanding NPDES discharge permits.

Type	New	Expanding
Domestics < 1 MGD	BOD5=12 & NH3-N =2	BOD5=12 & NH3-N =2
Domestics > 1 MGD	BOD5=5 & NH3-N =2	BOD5=5 & NH3-N =2
Industrial	BOD5=5 & NH3-N =2	Best Available Technology or BOD5=5 & NH3-N =2

Technology-based limits for expanding industrial dischargers will be determined on a case-by-case basis by DWQ, following a review of information submitted by the permittee. The strategies for each of these waterbodies are presented in section 6.3 of Chapter 6. These strategies are based on observed water quality data and predictive computer modeling that take into account water quality data, stream flow and physical conditions, waste loading and waste assimilative capacity. Calibrated QUAL2E models were developed for Buffalo Creek and the Cape Fear River during this basin planning process. Calibrated models have been developed in the past for the Rocky River and several tributaries of Jordan Reservoir.

Other streams in the basin for which recommended NPDES management strategies are recommended include: Little Troublesome Creek, Reedy Fork, Moadams Creek, Back Creek, Haw Creek, Alamance Creek, Robeson Creek, New Hope Creek, Northeast Creek, Kenneth Creek, Utley Creek, Richland Creek, Hasketts Creek, Cotton Creek, Loves Creek, Lower Little River, Northeast Cape Fear River, South River, Black River, Barlow Branch, Panther Branch, Burgaw Creek, and Osgood Canal.

B. NUTRIENTS

Control of two major plant nutrients, phosphorus and nitrogen, is necessary to limit the excessive growth of algae and other aquatic plants in lakes and some slow-moving streams in the Cape Fear River basin. Sources of nutrients include animal operations, cropland, urban stormwater and wastewater treatment plants. Strategies for limiting nutrients have been recommended by DWQ for the Jordan Reservoir watershed and the Deep River watershed (Section 6.4 of Chapter 6). In addition, development and implementation of nutrient management strategies for protection of lakes throughout the basin should be given consideration by local stakeholders. Of the 36 lakes assessed in this document, 16 were considered threatened and one not supporting based nutrient-related problems.

Jordan Reservoir NSW Strategy All surface waters in the watershed of Jordan Reservoir, including the Haw River watershed, have been classified as nutrient sensitive waters (NSW). In addition to the NSW classification, more stringent limits on total phosphorus (TP), as well as possible establishment of limits on total nitrogen (TN), have been necessary in localized areas including a number of tributaries to Jordan Reservoir. Control strategies for nutrients (TP and TN) have been developed for tributaries including Morgan Creek, New Hope Creek and Northeast Creek. A study plan for re-evaluation of the NSW strategy is currently under development to determine the sources and relative contributions of point and nonpoint source nutrient loading to Jordan Reservoir.

Deep River Nutrients The Deep River has severe nutrient problems, and the Deep River and many of its tributaries have been listed as impaired waters. Three factors: impoundments which affect stream velocity, point source nutrient loading, and nonpoint source loadings, play a significant role in the control of eutrophication and DO standards violations in the Deep River. A three-tiered management strategy which includes maintenance of stream velocity and control of point and nonpoint sources of nutrients is

recommended for reduction of eutrophication in the Deep River. This includes recommended nutrient limits of 0.5 mg/l of phosphorus and 6.0 mg/l of nitrogen for the High Point Eastside Wastewater Treatment Plant.

C. TOXIC SUBSTANCES

Point source discharges will be allocated chemical specific toxics limits and monitoring requirements based on a mass balance technique discussed in the Instream Assessment Unit's Standard Operating Procedures manual and in Appendix III of this report. Any available data are used at permit renewal to determine which toxic parameters need to be limited in the NPDES permit. Whole effluent toxicity limits are also assigned to all major discharges and any discharger of complex wastewater. Strategies have been recommended to address point source-related toxicity problems on the following streams. Pollution prevention efforts may be particularly applicable to addressing toxicity problems, especially at industrial facilities. Keeping toxic substances out of the waste stream in the first place is can be a very cost-effective approach to solving the problem.

The following is a list of streams which have not been meeting instream water quality standards or action levels and where specific strategies have been recommended.

Subbasin 01:	Little Troublesome Creek
Subbasin 02:	North Buffalo Cr
	South Buffalo Cr
	Haw River near Burlington
	Richland Creek/Deep River
Subbasin 17	Cape Fear River estuary
Subbasin 21	Northeast Cape Fear River tributaries:
	- Barlow Branch
	- Panther Branch

Nonpoint source strategies to be implemented through the municipal and industrial NPDES stormwater program should also be helpful in reducing toxic substance loading to surface waters. Industries are being required to control runoff from their sites and to cover stockpiles of toxic materials that could pose a threat to water quality. Greensboro, Fayetteville, and Cumberland County will also be implementing stormwater programs that will include identifying and removing illicit discharges to storm drain systems.

D. SEDIMENTATION

Sedimentation is the most widespread cause of water quality use support impairment in the Cape Fear River Basin as it is throughout most of the state. Data, based mostly on best professional judgment of field personnel from several agencies that was presented at nonpoint source workshops held in the mid to late 1980s revealed that 613 miles of streams in the Cape Fear River Basin were thought to be impaired by sediment. It should be noted, however, that data compiled by the USDA Natural Resources Conservation Service have indicated an overall reduction in soil loss per acre from agricultural cropland across the state between 1982 and 1992. Tons of soil lost per crop acre has dropped from 1.4 tons per acre to 1.1 tons per acre.

The major sources of sediment in the Cape Fear Basin include construction, urban development, agriculture, forestry and mining. There are 19 programs administered by various local, state and federal agencies which have been developed to control sediment from these activities (Table 6.13 of Chapter 6). Improvements in several of these programs since 1989 are presented in Chapter 5. Eleven of the 24 subbasins in the basin had 20 or more miles of streams thought to be impaired by sediment based on the earlier

information. Each of these subbasins and their respective miles of sediment-impaired streams is listed below by major watershed areas.

Haw River Watershed: subbasins 01 (26 miles), 02 (31 miles), 03 (23 miles) and 05 (38 miles)
Deep River Watershed: Subbasin 11 (58 miles)
Upper Cape Fear River Watershed: subbasins 07 (44 miles) and 15 (50 miles)
Lower Cape Fear River and Coastal Waters: subbasins 16 (54 miles) and 17 (52 miles)
Black River Watershed: subbasin 18 (31 miles) and 19 (27 miles)
Northeast Cape Fear: subbasin 22 (68 miles) and 23 (35 miles)

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

Recommendations for Improving Erosion and Sediment Control

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

E. COLOR

The discharge of color is to be regulated such that only those amounts as will not render the waters injurious to public health, secondary recreation, or to aquatic life and the wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses. Though no waters in the Cape Fear Basin have been listed as impaired due to color, there are a number of streams in the Cape Fear Basin where color is a concern and where discharges have been identified for participation in future color monitoring pending the outcome of a pilot study in the Catawba River Basin.

Subbasin 01: Little Troublesome Creek
Subbasin 02: North Buffalo Creek
Haw River
Subbasin 08: Richland Creek and Cotton Creek
Subbasin 15: Little Rockfish Creek
Subbasin 22: NE Cape Fear River

F. RUNOFF FROM URBAN STORMWATER AND DEVELOPMENT

Water quality impairment from urbanization is a major concern in the Cape Fear River Basin. Virtually every urban stream sampled by DWQ biologists is found to be impaired, and as land is developed, more streams are impaired. The impacts result from a combination of sedimentation from construction, increased streamflow from more impervious surface areas, and decreased quality of runoff water that contains lawn care products, automobile-related pollutants, fecal coliform bacteria from animals and more.

There are 200 miles of streams in the Cape Fear River Basin that are thought to be impaired by urban stormwater and, based on past experience, the number of miles could have been longer had more streams been sampled. Several streams identified as being at least partially impaired from urban runoff based on DWQ's most recent biological monitoring are listed below.

Subbasin 01: Little Troublesome Creek (Reidsville)
Subbasin 02: South Buffalo Creek, Horsepen Creek, UT Horsepen Creek, Mile Run Creek (Greensboro)
Subbasin 05: Northeast Creek, Burdens Cr (Durham)
Subbasin 06: Morgan Creek, Bolin Creek, Little Creek, Meeting of Waters Creek (Chapel Hill)
Subbasin 08: UT East Fork Deep River, E Fk Deep River, Richland Creek (High Point)
Hasketts Creek (Asheboro)
Subbasin 11: Big Buffalo Creek, Little Buffalo Creek (Sanford)
Subbasin 15: Cross Creek (Fayetteville)
Subbasin 17: Greenfield Lake (Wilmington)

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

In the Cape Fear River basin, three municipalities are required to develop urban stormwater programs under the NPDES stormwater requirements because their population exceeds 100,000. These include Greensboro, Durham and Fayetteville/Cumberland County. These programs would cover much of the watershed areas of those seven streams listed above in subbasins 02, 05 and 15. Also, at least two other local governments in the basin have undertaken voluntary stormwater programs including High Point and Chapel Hill.

For other local governments that are not required to develop stormwater programs but where urban stormwater impacts have been identified and/or where urban water quality is of concern to local citizens, there are several basic steps, listed below, that could be undertaken at relatively low cost to help control urban stormwater pollution.

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

DWQ's urban stormwater staff have recently completed a series of stormwater workshops across the state for the benefit of local governments and others on addressing urban stormwater pollution. DWQ can provide additional information to interested local governments or can provide references of other local governments in the state that are undertaking programs on their own. Section 5.3.2 in Chapter 5 lists important accomplishments in the urban stormwater program since 1989.

G. FECAL COLIFORM BACTERIA

Fecal coliforms are bacteria typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of disease-causing bacteria and viruses. They enter surface waters from a number of sources including failing onsite wastewater systems, broken sewer lines, improperly treated discharges of domestic wastewater, pump station overflows, and runoff carrying livestock and wildlife wastes.

Based on evaluation of fecal coliform data from 69 ambient water quality monitoring sites throughout the basin (monitoring stations sampled by DWQ once a month), 10 sites were found to have bacteria counts where the geometric mean of all samples (minimum of 10 samples) over the last five years exceeded the state standard of 200/100 ml. These sites include:

Subbasin 01:	Little Troublesome Creek at SR 2600 near Reidsville (Rockingham County)
Subbasin 02:	Reedy Fork at Ossipee (Alamance County)
"	Haw River at Haw River (Alamance County)
"	Town Branch at SR 2109 near Graham (Alamance County)
"	North Buffalo Creek near Greensboro (Guilford County)
Subbasin 05:	New Hope Creek near Blands (Durham County)
"	Northeast Creek near Nelson (Durham County)
Subbasin 08:	East Fork Deep River at SR 1541 near High Point (Guilford County)
"	Muddy Creek at SR 1936 near New Market (Randolph County)
Subbasin 09:	Deep River at SR 2128 at Worthville (Randolph County)

In coastal waters, the NC Division of Environmental Health's Shellfish Sanitation Branch has recommended closure of 18,700 acres of open water for shellfish harvesting due to

elevated levels of bacteria. The fecal coliform bacteria standard for shellfish waters is 14/100 ml while the standard for swimming is 200/100 ml. Approximately 4,900 acres of the closed waters have been classified for shellfish water harvesting (SA) by the Division of Water Quality. Nonpoint sources are reported to be the pollution source for 78% of the impaired estuarine waters with point sources accounting for the remaining 22%. Probable sources of the fecal coliform contamination include urban runoff, failing septic tanks, agriculture, marinas and improperly operating wastewater treatment plants.

Several general recommendations for addressing fecal coliform contamination in both fresh and estuarine waters include:

- Proper maintenance of onsite waste disposal systems (such as septic tanks).
- Maintenance and repair of sanitary sewer lines by WWTP authorities.
- Elimination of direct unpermitted discharges of domestic sewage wastes (also known as "straight pipes") from homes and businesses to streams or stormwater systems.
- Proper management of livestock to keep wastes from reaching surface waters.
- Encouragement of local health departments to routinely monitor waters known to be used for body contact recreation (e.g., swimming and tubing). DWQ has classified 272 miles of streams for primary water contact.

DWQ has targeted several fecal-coliform impaired coastal water bodies in the Cape Fear Basin in which localized watershed-based planning will be needed to begin to effectively address the problems.

- Bradley Creek
- Howe Creek
- Pages Creek
- Futch Creek
- Virginia Creek
- Mill Creek.

It is DWQ's intent, in updating this plan over the next five years, to work cooperatively with the NC Division of Environmental Health, the NC Division of Coastal Management, local governments having jurisdiction over the watersheds of these creeks, UNC-W and other members of the basin nonpoint source pollution team to examine the causes and sources of impairment in these waters, to examine the feasibility of restoration (reopening them) and, where feasible, to recommend actions that would lead to reopening.

One possible avenue for accomplishing these efforts would through reclassifying these waters as URW. DWQ is working on development of a new supplemental water classification called use restoration waters (URW). URW would be assigned to the watersheds of waters that are not supporting their uses such as those listed above. If adopted, reclassification of waters to URW would follow the same formal procedures as for other surface water reclassifications. The reclassification would include preparation of a watershed plan that would stipulate specific BMPs that would need to be implemented to restore uses to the impaired waters.

A second aid in studying and restoring these waters could be federal nonpoint source funding under Section 319 of the Clean Water Act. Because these streams have been assigned a high priority rating for Section 319 funding by DWQ in Table 6.2 of Chapter 6, 319 nonpoint source grant proposals by local governments, university researchers and others would receive a high priority for funding.

A third means of restoring or protecting these waters is recommendation that the local governments having jurisdiction over the watersheds of these waters, and that are required to prepare local land use plans under requirements of the Coastal Area Management Act, consider including provisions that minimize further impacts to these and other shellfish waters along the coast from stormwater runoff from new development.

One local effort for reopening closed shellfish waters, that is already underway, is the Futch Creek Demonstration Project. This project entails dredging two channels through the shoals at the mouth of the creek in order to increase tidal flushing, increase salinity and hopefully decrease fecal coliform counts. The project is being funded through the NC Agricultural Cost Share Program and the Northeast New Hanover Conservancy. Other sponsors include Pender Watch and Conservancy and New Hanover County. Water quality effects of the project are being monitored by UNC-W scientists.

H. RECLASSIFICATION OF HIGH RESOURCE VALUE WATERS

Waters considered to be biologically sensitive or of high resource value may be afforded protection through reclassification to HQW (high quality waters), ORW (outstanding resource waters) or WS (water supply), or they may be protected through more stringent NPDES permit conditions. Waters eligible for reclassification to HQW or ORW may include those designated as native trout waters, critical habitat for threatened or endangered species (as designated by the NC Wildlife Resources Commission), waters having Excellent water quality, or waters used for domestic water supply purposes and classified WS I or II. Portions of the following streams and their tributaries have been identified as potential candidates for reclassification to HQW or ORW. These streams will be evaluated for reclassification during the next basin schedule.

One potential ORW/HQW candidate stream in the Cape Fear basin, based on preliminary water quality assessments is the Cape Fear River at Erwin. DWQ has reviewed this and determined that additional sampling will be necessary before any formal action can be taken to pursue reclassification of this segment.

A portion of the Lower Cape Fear River below Lock and Dam No.1 was being considered for HQW status, but the proposed reclassification was postponed pending additional monitoring data to be collected by the University of North Carolina at Wilmington. The Marine Science Center at UNC-W is currently seeking funding to complete additional monitoring through the proposed Cape Fear River Program. This program represents a unique partnership including industry, local , state, and federal governments, state regulatory agencies, citizens' groups, and the university community collectively working together to preserve and improve the important natural resources of the Cape Fear River Basin while maintaining the economic vitality and well-being of the region. DWQ supports this effort and looks forward to working with UNC-W, Cape Fear River Assembly and dischargers in the Cape Fear Basin on establishing a discharger monitoring network from the Haw and Deep Rivers downstream to the coast.

I. FUTURE INITIATIVES IN THE CAPE FEAR BASIN

NONPOINT SOURCE (NPS) BASIN TEAMS

Nonpoint source pollution has been identified in the plan as the major source of stream impairment. There many programs being administered by numerous agencies at the state, local and federal levels to address the different types of nonpoint source pollution. DWQ is in the process of establishing nonpoint source basin teams for each of the state's major basins in order to improve communication between the various agencies, improve

effectiveness in implementing the programs, and target available resources to address problems in watersheds prioritized by team members.

A team will be formed in the Cape Fear Basin prior to updating the Cape Fear Plan in 2000. The teams will consist of representatives of the lead nonpoint agencies familiar with or working within each basin. Subgroups are formed for each category to include other participants as needed such as industry, producers, special interest groups and other state, federal and local government agencies. The individual members of these subgroups change to reflect the particular basin being considered. The NPS Basin Teams responsibilities include:

- Providing general program and activity descriptions by NPS category and/or pollutant,
- Conducting specific assessments of NPS controls in targeted watersheds driven by water quality data and the basinwide process,
- Develop five year action plans of NPS categories/pollutants (Identify the challenge, schedule for completion, estimated costs, expected pollutant reductions and responsible parties) and,
- Develop Section 319 project proposals for targeted watersheds to be submitted to the NPS Workgroup.

SPECIFIC AREAS IN NEED OF MANAGEMENT STRATEGIES

There are a number of areas within the Cape Fear River Basin in need of future management strategy development that are elaborated on in Chapter 7. The Division of Water Quality has identified areas it would like to target for study during the next basin planning cycle. These areas may be modified based on comments received from the public on the basin plan. In addition, this list contains a number of items that would require much staff time to adequately evaluate, and therefore some of these issues will probably not be addressed in the next basin plan. The Division would anticipate holding meetings approximately three years prior to the due date of the second Cape Fear Basin Plan to inform the public of any changes in priorities in the basin and to obtain feedback on them. The following areas are tentatively prioritized:

- Cape Fear River Below Lock and Dam 1 and Northeast Cape Fear River Below Castle Hayne and the mainstem Cape Fear River - a TMDL for biochemical oxygen-demanding (BOD) wastes is needed for dischargers.
- Jordan Lake NSW Strategy - the existing NSW
- Deep River - need to manage toxicity and nutrients and provide protection of proposed Randleman Reservoir
- Haw River - Lack of BOD assimilative capacity in North and South Buffalo Creeks
- Toxicity Limits in the Cape Fear Estuary
- Reopening and protection of shellfish waters

WATER SUPPLY PLANNING

A water supply plan for the Jordan Reservoir and the Cape Fear River needs to developed. Water quantity in the basin needs to be managed in order to ensure an adequate and clean supply of water and healthy ecosystem while providing adequate waste assimilative capacity for dischargers. As noted in Chapter 2, public water supply users are predicting a doubling of their water supply needs by the year 2020. This is a critical and ongoing issue that needs to be addressed in future updates of the plan. It is anticipated that the Division of Water Resources will take the lead in developing a plan and that it will include input from water authorities, local governments and other basin stakeholders.

GENERAL NPDES PROGRAM INITIATIVES

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

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

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

FUTURE MONITORING PRIORITIES

Monitoring of the chemical and biological status of receiving waters will provide critical feedback on the success of the basin management strategy. As discussed in Chapter 4, monitoring data will be collected from (1) ambient water chemistry, (2) sediment chemistry, (3) biological communities, (4) contaminant concentrations in fish and other biota, (5) ambient toxicity, and (6) facility self-monitoring data. This should also include review of data collected by others including The specific parameters measured will relate directly to the long-term water quality goals and objectives defined within the basinwide management strategy.

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. DWQ would like to develop a model that can be used in channelized swamps that have some degree of slope to allow for one dimensional flow. Work has begun on reviewing swamp models. In addition, DWQ will begin determining which swamp systems may be modelable. Most likely, early analyses will be limited to black water river systems. The Northeast Cape Fear River may be a good river to study in the Cape Fear River basin.

USE OF DISCHARGER SELF-MONITORING DATA

NCDWQ will explore the pros and cons of using discharger self-monitoring data to a greater degree to augment the data it collects through the programs described in Chapter 4. Quality assurance, timing and consistency of data from plant to plant would have to be addressed. Also, a system would need to be developed to enter the data into a computerized database for later analysis. One method of data collection that is currently being explored includes developing a comprehensive list of monitoring sites for the basin that would be monitored by an Association of NPDES dischargers with data input to STORET. A basinwide sampling program has been established for dischargers in the Neuse River Basin and to date appears to be successful.

PROMOTION OF NON-DISCHARGE ALTERNATIVES/REGIONALIZATION

NCDWQ requires all new and expanding dischargers to submit an alternatives analysis as part of its NPDES permit application. Non-discharge alternatives, including tying on to an existing WWTP or land-applying wastes are preferred from an environmental standpoint.

If the Division determines that there is no economically reasonable alternative to a discharge, DWQ may recommend issuance of the NPDES permit.

DWQ is also encouraging establishment of regional wastewater facilities. Under this concept, smaller dischargers are encouraged to connect to large municipal systems which would be considered regional facilities. There are a number of benefits to these approach including better plant and effluent monitoring and a more consistent and higher quality effluent. However, before this concept is formalized, impacts on the future expansion potential of the regional plants needs to addressed. The concept must provide an equitable balance between water quality protection and the needs of the prospective regional facilities.

IMPROVED DATA MANAGEMENT AND EXPANDED USE OF GEOGRAPHIC INFORMATION SYSTEM (GIS) COMPUTER CAPABILITIES

INTEGRATE WETLANDS, GROUNDWATER AND ATMOSPHERIC DEPOSITION INTO BASINWIDE PLANNING IN THE CAPE FEAR BASIN

Research is being conducted in other basins to assess the impacts of groundwater and atmospheric deposition of nutrients on water quality. The prime concern is nitrogen loading to lakes and estuaries. Livestock operations are a potential source for both atmospheric and groundwater nutrient loading.

On wetlands, the general assembly passed a bill in 1996 calling for developing of basinwide wetland restoration plans beginning in 1997. As the program develops, its findings will be applied to future updates of the basin plan.

INCREASING PUBLIC PARTICIPATION AND STAKEHOLDER INVOLVEMENT IN THE BASINWIDE PLANNING PROCESS

Protection and enhancement of water quality is a shared need and a responsibility of all those who work, reside or recreate in the basin. Communication of ideas, conducting research, sharing information, solving problems cost-effectively with minimal regulation, and balancing the needs of various stakeholder groups are all necessary for long-term success. Basinwide planning can assist in meeting these needs but the planning process and products will need to be improved. Below are several recommended improvements to be undertaken during the next basinwide planning cycle for the Cape Fear basin.

- More clearly define the role for citizen participation in basinwide planning
- Ensure active interaction between DWQ staff and other stakeholder groups including UNC-Wilmington, discharger associations, citizen organizations such as the Haw River Assembly and others.
- Increase state staff involved in public outreach so as to provide better opportunities for communication between stakeholders and the state.
- Produce more user-friendly basin plans and associated reports in order to enhance public interest and understanding in water quality protection.

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CHAPTER 1
INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The purpose the Cape Fear River 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 will be used as a guide by the Division of Water Quality in carrying out its water quality program responsibilities in the Cape Fear River Basin. Section 1.2 provides an overview of the plan format to assist in the use and understanding of the document. It is one of a series of basinwide water quality management plans that are being prepared by the Water Quality Section of the North Carolina Division of Water Quality (DWQ). Plans will be prepared for all seventeen of the state's major river basins over the next five years as shown in Figure 1.1. An introduction to the basinwide management approach and a statewide basinwide permitting schedule are presented in Section 1.3.

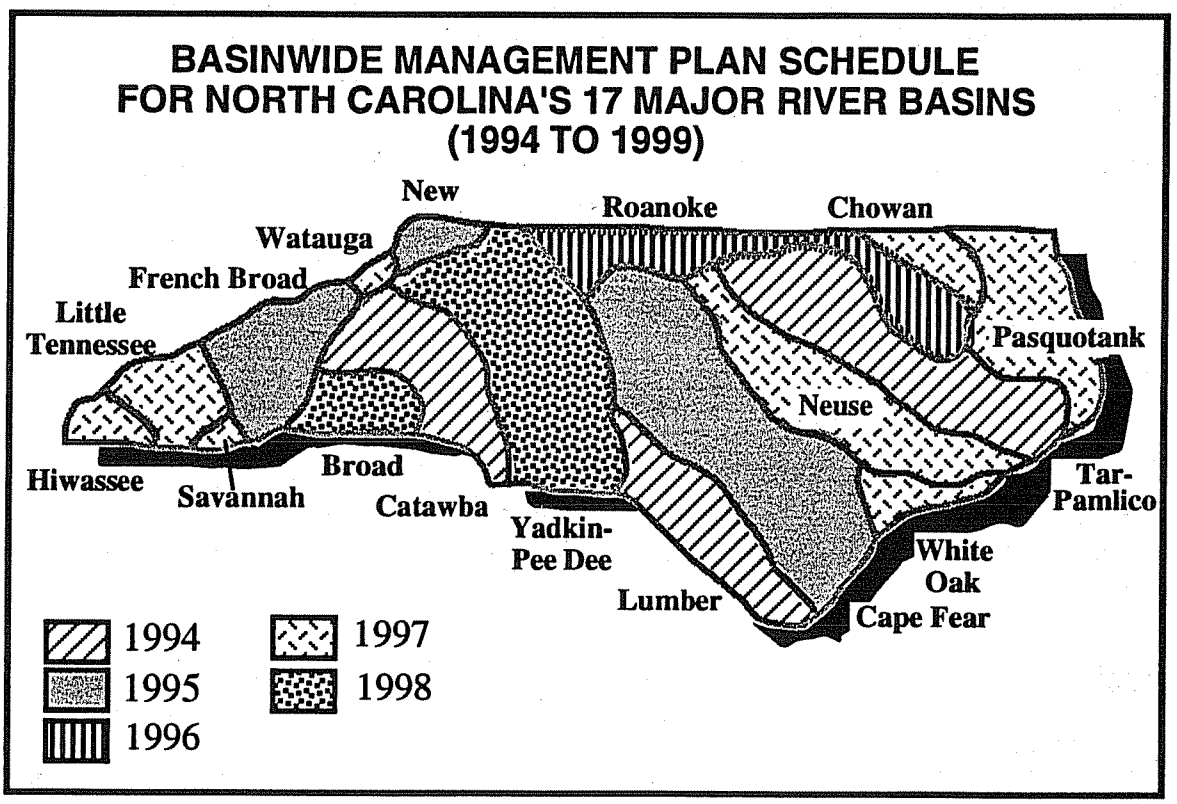


Figure 1.1 Basinwide Management Plan Schedule (1994 to 1998)

1.2 GUIDE TO USE OF THIS DOCUMENT

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

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

- an overview of the major features such as location, rainfall, population, physiography, etc.
- hydrology of the basin and its 24 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 Soil Conservation Service.
- population growth trends and densities by subbasin using 1970, '80 and '90 census data.
- numbers of farm animals and registered operations
- major water uses in the basin and DWQ's program of water quality classifications and standards.
- a summary of water supply uses prepared by the Division of Water Resources

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

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

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

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

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

1.3 NORTH CAROLINA'S BASINWIDE MANAGEMENT APPROACH

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

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

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

DWQ began formulating the idea of basinwide management in the late 1980s, established a basin permitting schedule and 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, *increased fficiency* 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 on 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 (1993 through 1998).

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

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

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

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

Year	Activity
1 to 3	Water Quality Data Collection/Identification of Goals and Issues: Year 1 entails identifying sampling needs and canvassing for information. It also entails coordinating with other agencies, the academic community and local interest groups to begin establishing goals and objectives and identifying and prioritizing problems and issues. Biomonitoring, fish community and tissue analyses, special

studies and other water quality sampling activities are conducted in Years 2 and 3 by DWQ's Environmental Sciences Branch (ESB). These studies provide information for assessing water quality status and trends throughout the basin and provide data for computer modeling.

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

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

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

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

Table 1.2 Subbasin NPDES Permit Schedule for the Cape Fear Basin

Subbasin No.	Month/Year	Subbasin No.	Month/Year
030601	January, 1996	**030613**	May, 1996
030602	January, 1996	**030614**	May, 1996
030603	Febraury, 1996	**030615**	May, 1996
030604	February, 1996	**030616**	May, 1996
030605	February, 1996	**030617**	June, 1996
030606	March, 1996	**030618**	July, 1996
030607	March, 1996	**030619**	July, 1996
030608	March, 1996	**030620**	July, 1996
030609	April, 1996	**030621**	July, 1996
030610	April, 1996	**030622**	July, 1996
030611	April, 1996	**030623**	July, 1996
030612	April, 1996	**030624**	July, 1996

Basinwide NPDES permitting in the Cape Fear River basin will occur during time intervals between January, 1996 and July, 1996. Table 1.2 lists each subbasin and the month in which permitting will occur for that subbasin.

1.4 BASINWIDE RESPONSIBILITIES WITHIN THE DWQ WATER QUALITY SECTION

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

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

The Central office is divided into four branches, with each branch being subdivided into two units. The Planning Branch is responsible for developing water quality standards and classifications, program planning and evaluation, and implementation of new water quality protection programs. The *Water Quality Planning and Assessment Unit* handles surface water reclassifications, development of water quality standards, coordination of the state's nonpoint source program and development of the stormwater runoff program. The *Basinwide Assessment Unit* administers implementation of the basinwide management program and includes technical staff to assist in modeling nonpoint pollution sources, developing use support ratings and improving section's GIS capabilities. It also coordinates EPA water quality planning grants, state environmental policy act responsibilities and development of wetlands rules and regulations.

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

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

The Environmental Sciences Branch is responsible for water quality monitoring, toxicity testing, biological laboratory certifications and the wetlands 401 Water Quality Certification program. The branch is divided into the Ecosystems Analysis Unit and the Aquatic Survey and Toxicology Unit Some of the major functions of the *Ecosystems Analysis Unit* include biological water quality monitoring and evaluation, evaluating reclassification requests, algal analyses, benthic macroinvertebrate monitoring (biomonitoring), fish tissue and fish communities studies and

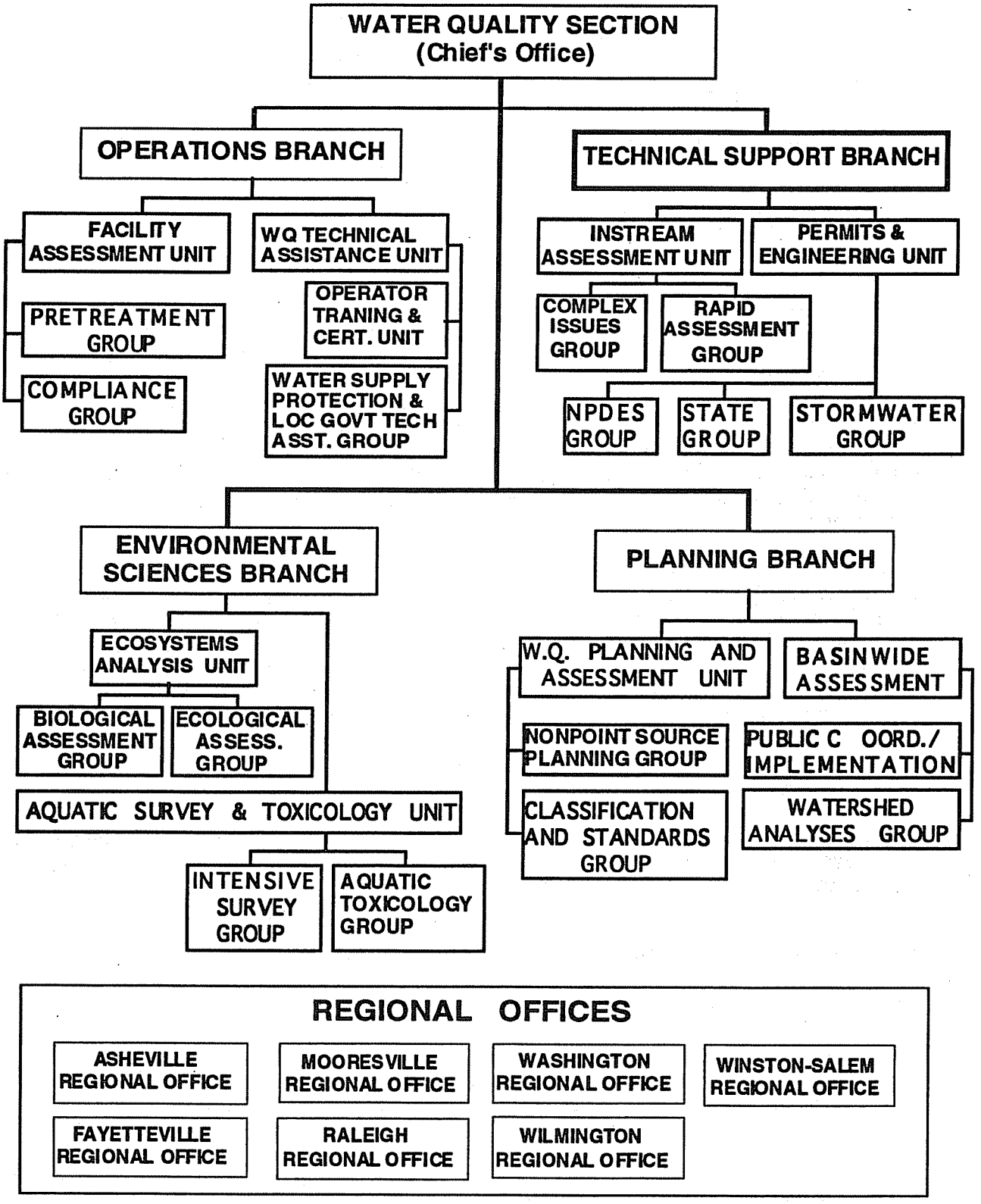


Figure 1.2 Organizational Structure of the DWQ Water Quality Section

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

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

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

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

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

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

1.5.1 Federal Authorities for NC's Water Quality Program

- **Section 301** - Prohibits the discharge of pollutants into surface waters unless permitted by EPA (see Section 402, below).
- **Section 303(c)** - States are responsible for reviewing, establishing and revising water quality standards for all surface waters.
- **Section 303(d)** - Each state shall identify those waters within its boundaries for which the effluent limits required by section 301(b)(1) A and B are not stringent enough to protect any water quality standards applicable to such waters.
- **Section 305(b)** - Each state is required to submit a biennial report to the EPA describing the status of surface waters in that state.
- **Section 319** - Each state is required to develop and implement a nonpoint source pollution management program.

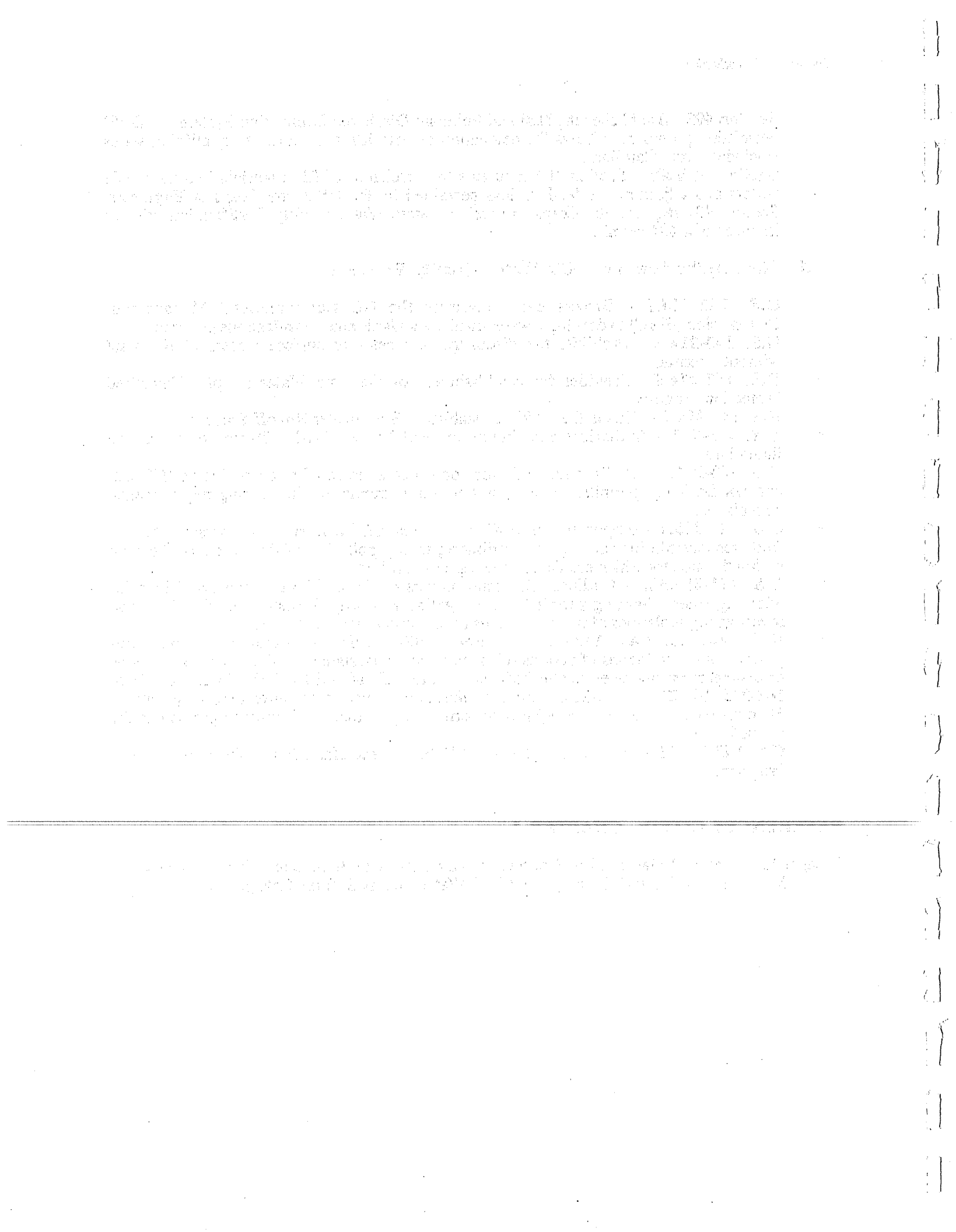
- **Section 402** - Establishes the National Pollutant Discharge Elimination System (NPDES) permitting program. Allows for delegation of permitting authority to qualifying states (includes North Carolina).
- **Section 404/401** - Section 404 regulates the discharge of fill materials into navigable waters 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.

1.5.2 State Authorities for NC's Water Quality Program

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

REFERENCES CITED: CHAPTER 1

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



CHAPTER 2

GENERAL BASIN DESCRIPTION WITH WATER QUALITY STANDARDS AND CLASSIFICATIONS

2.1 CAPE FEAR RIVER BASIN OVERVIEW

The Cape Fear River Basin is the largest river basin in the state covering 9,149 square miles. It is one of just four basins located entirely within the state's boundaries. It flows southeast from the north central piedmont region of the state, near Greensboro, to the Atlantic Ocean. (Figure 2.1)

The Cape Fear River is formed at the confluence of the Haw and Deep Rivers on the border of Chatham and Lee Counties, just below the B. Everett Jordan Reservoir dam. From there, the river flows across the coastal plain past Fayetteville, through three locks and dams, and past Wilmington before entering the Atlantic Ocean near Cape Fear. Along the way it is fed by the Black and Northeast Cape Fear Rivers (two major blackwater systems) (Figures 2.2 to 2.4).

There are 27 counties and 114 municipalities located in whole or in part in the basin . Based on 1990 census data, the population of the basin was 1,467,984 people. The most populated areas are in and near the Triad area (Greensboro-Burlington-High Point), the Durham-Chapel Hill area and in and around Fayetteville. The overall population density is 160 persons per square mile versus a statewide average of 123 persons per square mile. The percent population growth over the ten-year period from 1980 to 1990 was 11.5 % versus a statewide increase of 12.7%

Over half of the land in the river basin is forested. Statistics provided by the US Department of Agriculture, Natural Resources Conservation Service (NRCS) indicate that during the 10-year period from 1982 to 1992, there had been an increase in the amount of developed land and a decrease in the amount of cropland. Major industries in the basin include silviculture and agriculture (hog farms, poultry, soybeans, sweet potatoes, tobacco).

The basin includes three coastal Outstanding Resource Waters (Stump Sound, Middle and Topsail Sounds and Masonboro Sound) and one inland ORW (a portion of the Black River basin).

2.2 Basin Hydrology

The Cape Fear River Basin is the largest river basin in North Carolina and its watershed is contained entirely within the state. The mainstem of the river is formed by the confluence of the Deep and Haw Rivers just downstream of the B. Everett Jordan Reservoir Dam. The Deep River originates near High Point, and the Haw originates near Greensboro. The mainstem of the river flows in a generally southeastern direction until it empties into the Atlantic Ocean at Cape Fear, south of Wilmington.

The watershed is divided into 6 major hydrologic areas (*8-digit hydrologic units*) by the U.S. Water Resources Council and the U.S. Geologic Survey (USGS). These include the Haw River/Jordan Reservoir watershed, the Deep River, the Upper Cape Fear, the Black River, the Northeast Cape Fear and the lower Cape Fear and coastal waters. These major hydrologic areas are further subdivided by DWQ for management purposes into 24 subbasins denoted by 6-digit numbers (03-06-01 to 03-06-24) as shown in figure 2.2. Table 2.1 shows the breakdown of USGS hydrologic units and DWQ's corresponding subbasins.

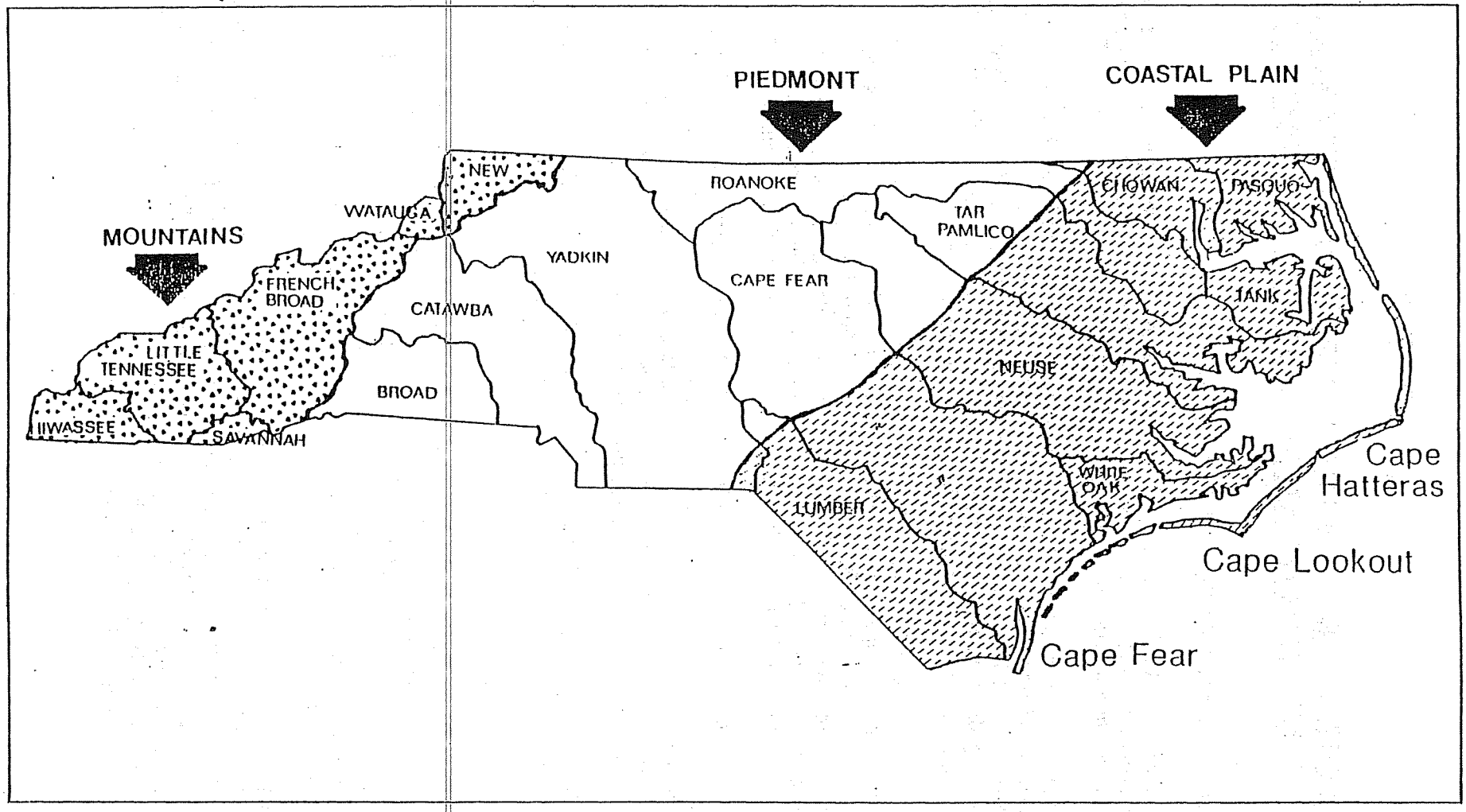
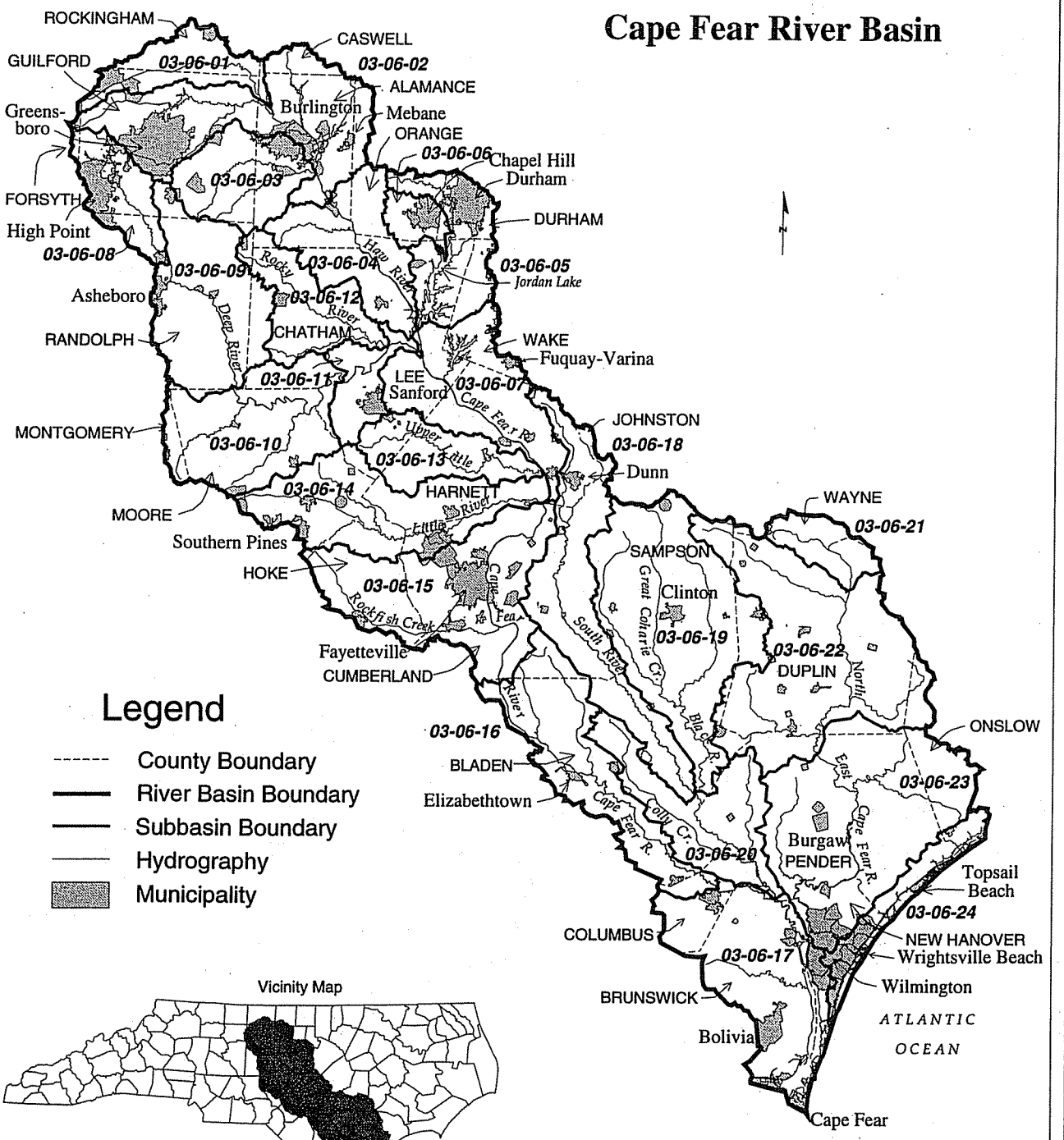


Figure 2.1 Physiographic Regions and Major River Basins in North Carolina

General Map of the Cape Fear River Basin



Legend

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

Vicinity Map

DEHNR

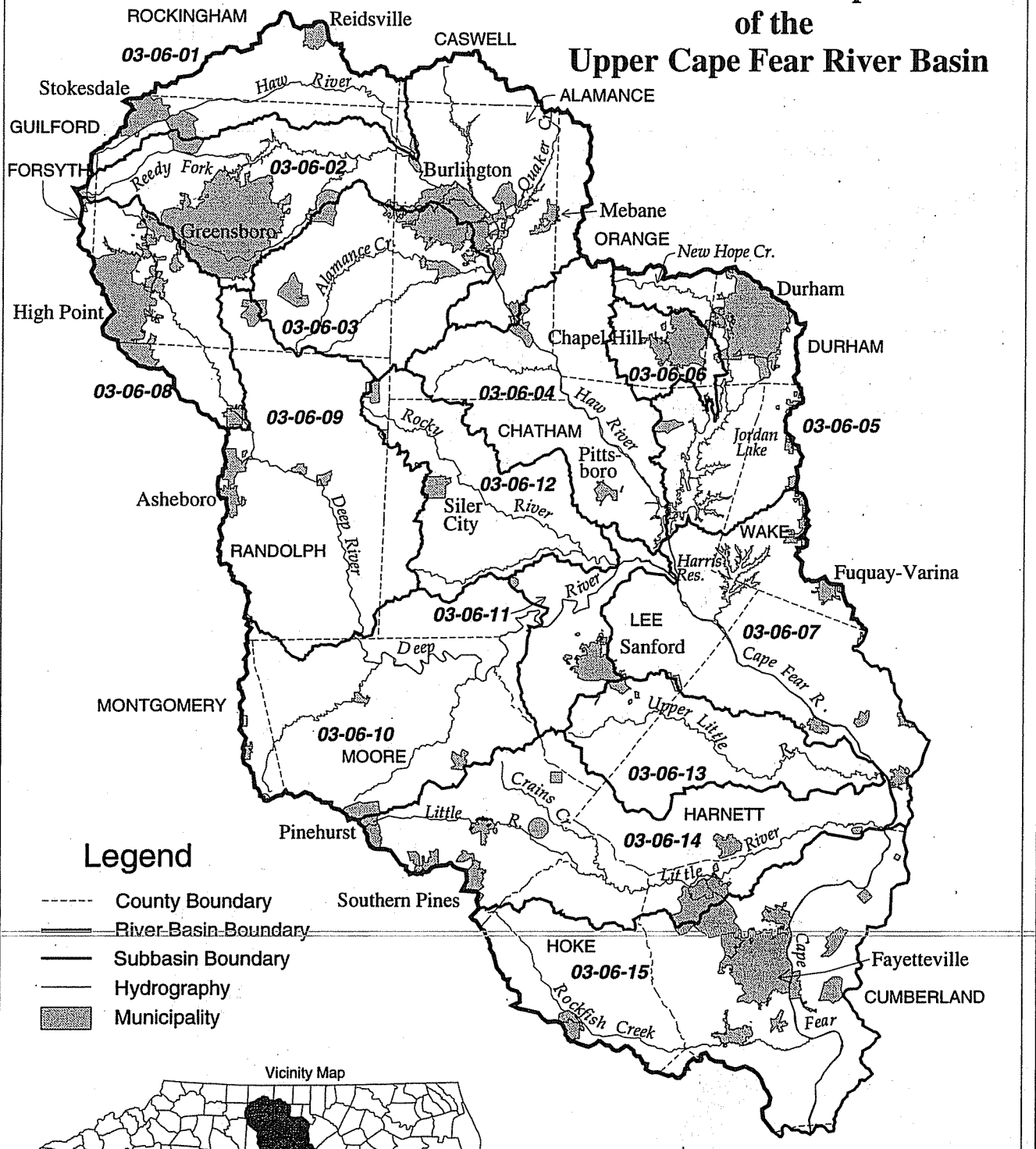
Produced by: State Center for Health and Environmental Statistics
April, 1995

Cape Fear River Basin

1:1,600,000

0 20 40 60 miles

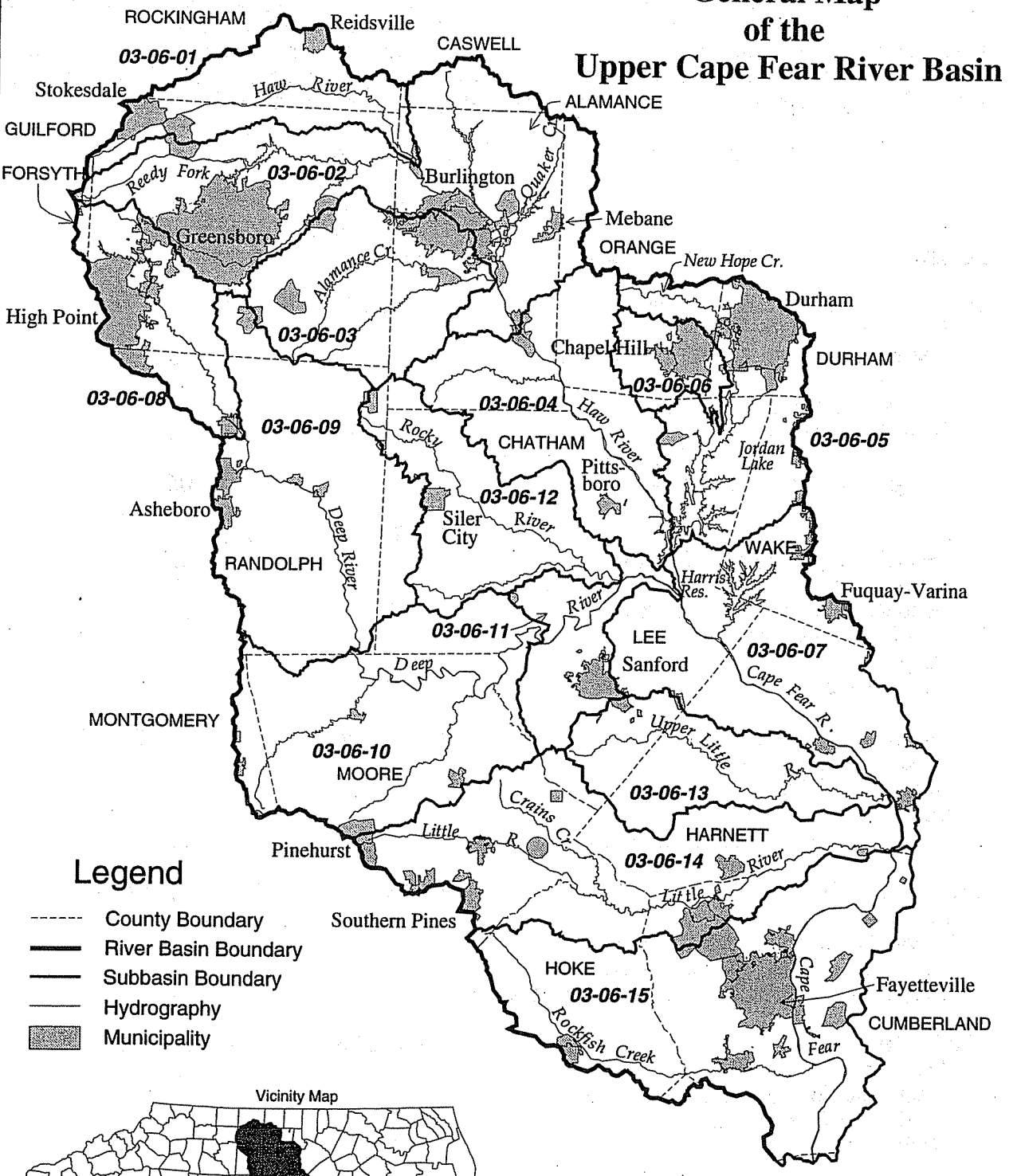
General Map of the Upper Cape Fear River Basin



DEHNR

Produced by: State Center for Health and Environmental Statistics
April, 1995

General Map of the Upper Cape Fear River Basin



DEHNR

Produced by: State Center for Health and Environmental Statistics
April, 1995

There are 36 lakes in the Cape Fear River Basin that are monitored by DWQ, only five of which are natural. Over half of the total number of lakes are located in the upper portion of the basin (subbasins 01 through 08). These artificial impoundments serve as water supplies for communities in the piedmont such as Greensboro, Burlington, Durham and Chapel Hill. The natural lakes are Carolina bays that are concentrated in the lower portion of the basin.

Table 2.1 Hydrologic Divisions in the Cape Fear River Basin

Watershed Name and Major Tributaries	USGS 8-digit Hydrologic Units Figure 2.2	DWQ Subbasin 6-digit codes Figure 2.3
Haw River and Jordan Reservoir	**03030002**	**030601 - 06**
Upper Haw River	"	01
Reedy Fork, Stony Creek, and Haw River (middle)	"	02
Big and Little Alamance Creeks	"	03
Haw River (lower)	"	04
New Hope Creek and Jordan Reservoir	"	05
Morgan Creek and University Lake	"	06
Deep River	**03030003**	**030608 - 12**
Deep River (upper) and Muddy Creek	"	08
Deep River (middle) and Richland Creek	"	09
Deep River (middle), Cabin Creek and McLendons Creek	"	10
Deep River (lower)	"	11
Rocky River	"	12
Upper Cape Fear River	**03030004**	**030607, 13-15**
Cape Fear River (upper)	"	07
Upper Little River	"	13
Little River	"	14
Rockfish Creek and Cape Fear River	"	15
Lower Cape Fear River	**03030005**	**030616, 17, 24**
Cape Fear River	"	16
Town Creek, Brunswick River and Cape Fear River (extreme lower)	"	17
Topsail, Middle, Masonboro and Stump Sounds	"	24
Black River	**03030006**	**030618 - 20**
South River	"	18
Great Coharie Creek, Six Runs Creek and upper Black River	"	19
Black River	"	20
Northeast Cape Fear River	**03030007**	**030621 - 23**
upper Northeast Cape Fear River	"	21
middle Northeast Cape Fear River, Goshen Swamp, Rockfish Creek	"	22
lower Northeast Cape Fear River	"	23

The Cape Fear River Basin, which has a total land area of 9,149 square miles and 6,282 stream miles, has an average drainage area of 1.5 square miles per stream mile. A variety of aquatic systems are represented in the basin as the terrain changes from the piedmont to the coastal plain, including large freshwater rivers, blackwater swamps and estuaries.

2.3 LOCAL GOVERNMENT AND PLANNING JURISDICTIONS

The basin encompasses all or part of the following 27 counties and 114 municipalities presented in Table 2.2. Also included in the table are abbreviations for the Lead Regional Organizations (Councils of Government) and Districts of the North Carolina League of Municipalities.

Table 2.2 Local Governments and Local Planning Units within the Cape Fear River Basin

County	*% of county in basin	Region	League District	Municipality
Alamance	100%	G	VI	Alamance Burlington Elon College Gibsonville Graham Green Level Haw River Mebane
Bladen	70%	N	III	Dublin East Arcadia Elizabethtown Tar Heel White Lake
Brunswick	40%	O	III	Bald Head Is. Belville Boiling Spring Lk Caswell Beach Leland Long Beach Navassa Sandy Creek Southport Yaupon Beach
Caswell	15%	G	VI	
Chatham	100%	J	VI	Goldston Pittsboro Siler City
Columbus	15	O	III	
Cumberland	98%	M	VII	Falcon Spring Lake Fayetteville Stedman Godwin Wade Hope Mills Linden

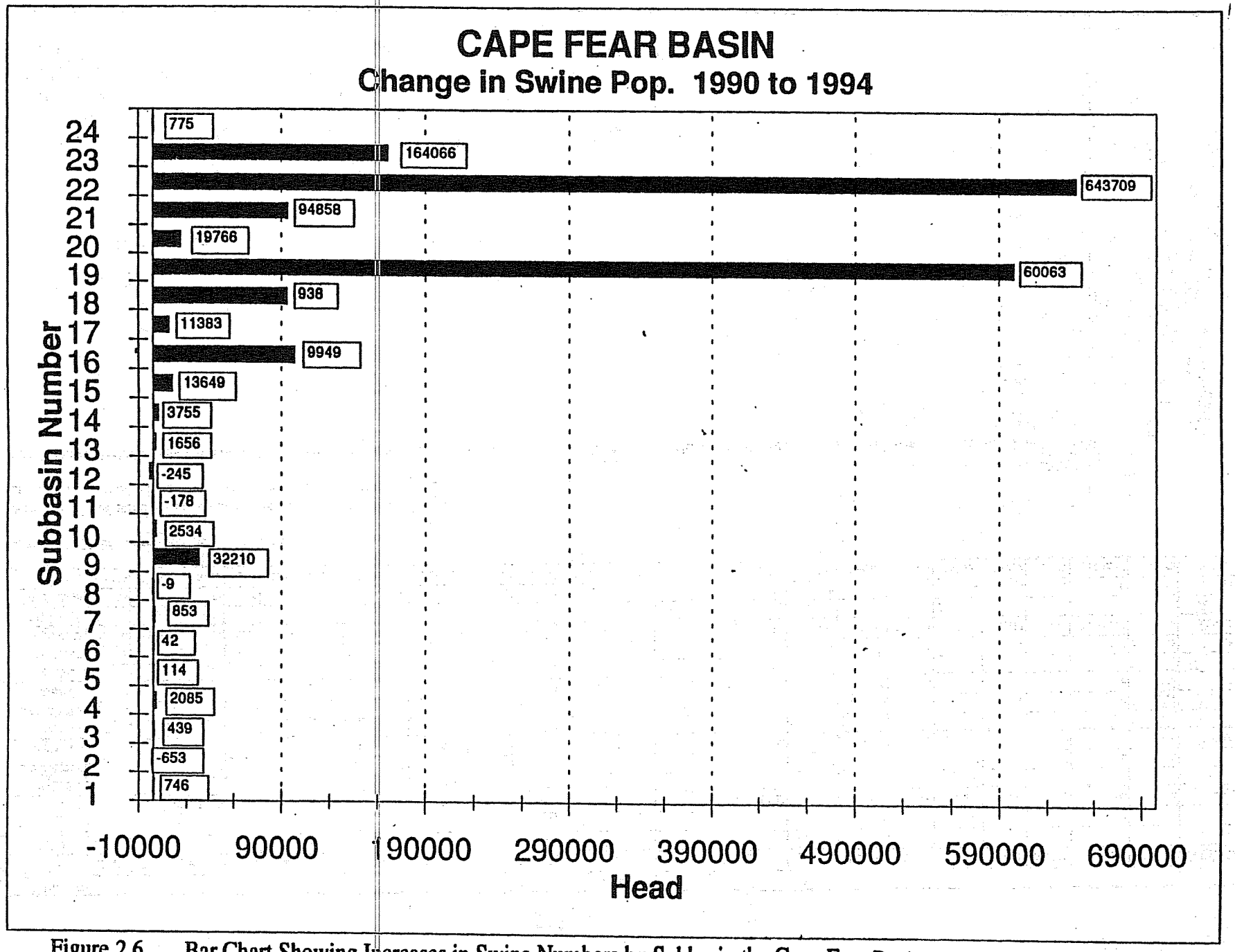


Figure 2.6 Bar Chart Showing Increases in Swine Numbers by Subbasin the Cape Fear Basin from 1990 to 1994

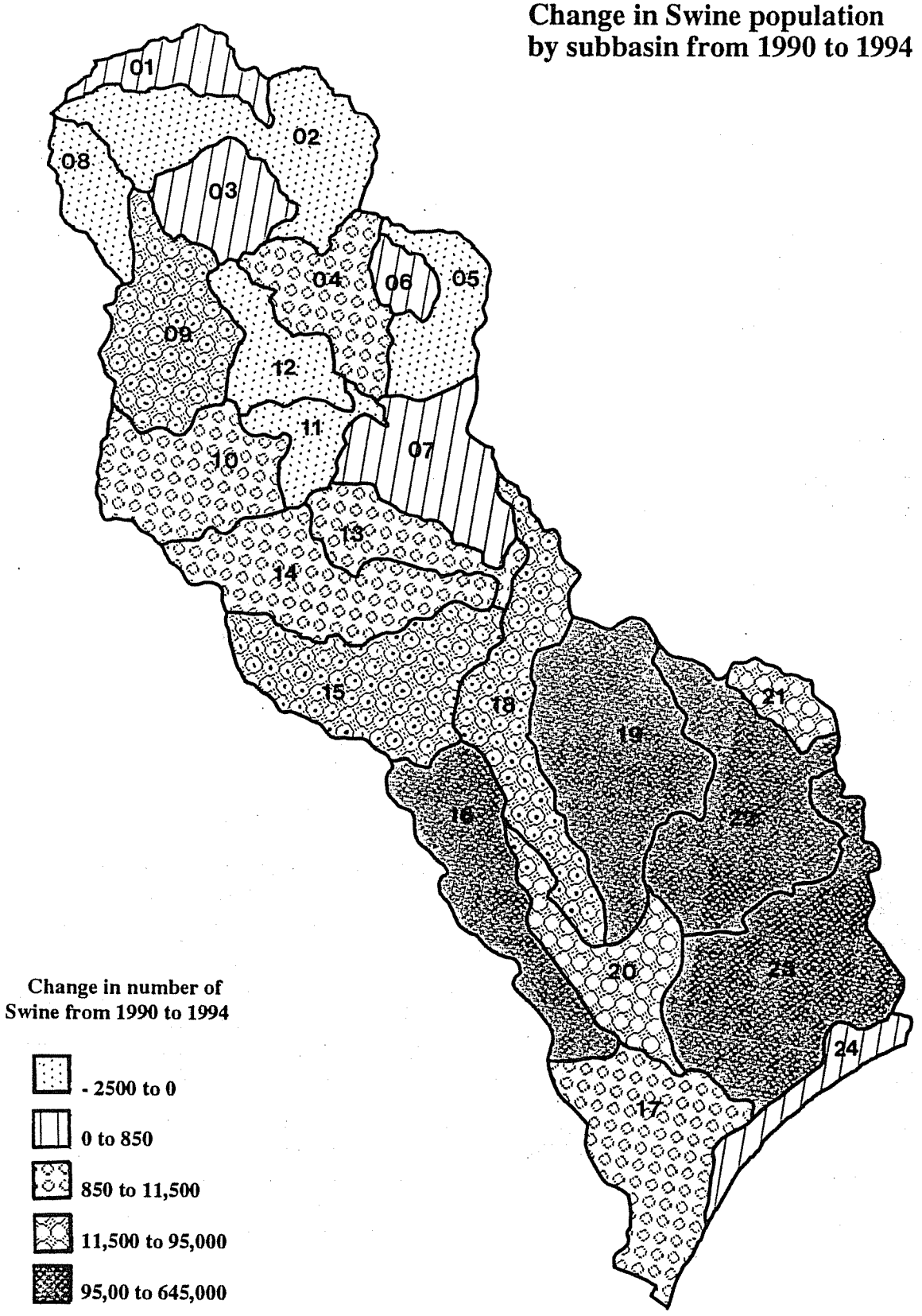


Figure 2.7 Map of Swine Population Increases by Subbasin from 1990 to 1994

2.6 THREATENED AND ENDANGERED AQUATIC FAUNAL SPECIES

The Cape Fear River Basin provides habitat for seven, state and/or federally listed, threatened and endangered freshwater mussel species. In addition, the state and federally listed Cape Fear Shiner and Shortnose Sturgeon occur in this basin. There are also seven fish species of special concern: the Highfin Carpsucker, the Carolina Darter, the Least Killifish, the Thinlip Chub, the Bluefin Killifish, the Broadtail Madtom, and the Sandhills Chub (Wilson, 1994). Table 2.7 lists the endangered and threatened mussel and fish species along with the subbasins where they are found and their listing status. Factors in their continued survival at these locations would appear to be the minimal amount of urban development that has occurred in these subbasins and the relatively low number of wastewater treatment plants.

Table 2.7 Threatened and Endangered Freshwater Mussel and Fish Species in the Cape Fear River Basin (Source: NC Wildlife Resources Commission)

Common Name	Scientific Name	Subbasins where found	Listing Status: State	Federal
Triangle Floater	(Alasmidonta undulata)	12	T	
Atlantic Pigtoe	(Fusconia masoni)	18, 19, 20	T	(E)
Yellow Lamp Mussel	(Lampsilis cariosa)	07, 09, 10, 11 13, 15, 18, 19, 20	T	(E)
Squawfoot Mussel	(Strophitus undulatus)	04, 09, 10, 11 12	T	
Cape Fear Shiner	(Notropis mekistocholas)	07, 09, 10, 11 12	E	E
Brook Floater	(Alasmidonta varicosa)	12	T	
Magnificent Rams-horn	(Planorbella magnifica)	17	E	
Savannah Lilliput	(Toxolasma pullus)	06	T	
Shortnose Sturgeon	(Acipenser brevirostrum)	17	E	E

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

There are three specific watersheds in the Cape Fear River Basin that are of particular importance to threatened and endangered species (Alderman, 1995). The Deep River upstream of its confluence with the Haw River contains good populations of the federally listed Cape Fear Shiner. This area also contains a variety of listed mussel species, although they are not strong populations.

The Black River watershed contains the only good populations of the Atlantic Pigtoe in the state. While found elsewhere in the state, it is almost extirpated in the other areas. Another important characteristic of the Black River watershed with regard to mussels is the abundance of the organisms found. The watershed has a relatively large number of a variety of animals.

Finally, Town Creek near Wilmington contains a generally good variety and number of threatened species. A freshwater mussel species that was once believed to be extinct was also recently rediscovered in this creek and is called the Greenfield Rams-horn. (Alderman, 1995).

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.

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

Table 2.8 Primary and Supplemental Classifications Applicable to the Cape Fear River Basin (Primary classifications beginning with an "S" are assigned to salt waters)

PRIMARY FRESHWATER AND SALTWATER CLASSIFICATIONS

Class	Best Uses
C and SC	Aquatic life propagation/protection and secondary recreation
B and SB	Primary recreation and class C uses
WS	Water Supply watershed and class C uses. There are five WS classes, I through V. WS classifications are assigned to watersheds based on land use characteristics of the area. Each water supply classification has a set of management strategies to protect the surface water supply. A Critical Area (CA) designation is also listed for watershed areas within a half-mile and draining to the water supply intake or reservoir where an intake is located.

SUPPLEMENTAL CLASSIFICATIONS

Class	Best Uses
Sw	Swamp Waters: recognizes waters that will naturally be more acidic (have lower pH values) and have lower levels of dissolved oxygen
HQW	High Quality Waters: waters possessing special qualities including excellent water quality, Native or Special Native Trout Waters, Critical Habitat areas, or WS-I and WS-II water supplies
ORW	Outstanding Resource Waters: unique and special surface waters which are unimpacted by pollution and have some outstanding resource values.
NSW	Nutrient Sensitive Waters: areas with water quality problems associated with nutrient enrichment.

Some of the classifications, particularly for HQW, ORW and WS waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. These strategies are summarized in Appendix I and are discussed briefly below.

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).

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). For freshwater ORWs, 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. In saltwater ORWs, new development must comply with the low density option specified in the coastal stormwater rules (15A NCAC 2H .1000), new non-discharge permits must meet reduced loading rates and increased buffer zones, dredging in areas with significant shellfish or submerged aquatic vegetation is not allowed unless it is maintenance dredging, and a public hearing is required for any proposed wastewater discharges. All ORWs may be subject to unique management strategies developed on a case-by-case basis. These strategies are listed in the ORW rule.

The requirements for WS waters vary significantly from WS-I to WS-V, and these are often a reflection of the level of development within the watershed of a water intake. See Appendix I for further details. The WS-I classification carries the most stringent requirements for dischargers and surrounding land use activities while WS-V carries the least. A WS-1 water supply requires a completely undeveloped watershed. There are few of these in the state and all are located in the mountains (none in the Cape Fear Basin). There are a number of waters classified as WS-11 in the Cape Fear Basin including Cane Creek Reservoir. These are listed in Table 6.1b in Chapter 6. WS-IV and V watersheds are typically established for run-of-the-river water supply intakes for water intakes in mutlti-use reservoir such as Jordan Reservoir.

2.7.3 Surface Water Classifications in the Cape Fear River Basin

Table 2.9 presents statistics for classifications found in the Cape Fear River Basin. Some classifications in Table 2.9 show both mileages and acreages. Acreage figures for water supplies (WS-II through WS-V), HQW and ORW waters include the watershed land areas draining to these waters that are subject to protection regulations. The figures for acres that are in ***italics,*** represent open water areas.

The waters of the Cape Fear River Basin have a variety of surface water quality classifications applied to them. The upper portion of the basin has been designated Nutrient Sensitive Waters in order to control nutrient input into Jordan Reservoir, one of the most eutrophic lakes in North Carolina. Isolated areas throughout the basin have been classified High Quality Waters where Excellent water quality has been identified. Stump Sound, Masonboro Sound and Topsail and Middle Sound are saltwaters that have been designated as Outstanding Resource Waters. A lower portion of the Black River basin was recently designated Outstanding Resource Waters. There are several classified water supplies in the basin that are used to serve the more populated areas.

Table 2.9 Water Quality Classification Statistics for the Cape Fear River Basin

PRIMARY CLASSIFICATIONS

Class	C	B	SC	SB	SA	WS-II	WS-III	WS-IV	WS-V
Miles	8,060	272	68	0	70	266	1,092	1,639	100
% of Miles	70	2	1	0	1	2	9	14	1
Acres	NA	NA	*14,767*	*806*	*17,050*	147,910	500,136	750,576	NA
% of Acres	NA	NA	NA	NA	NA	2	8	13	NA

SUPPLEMENTAL CLASSIFICATIONS

Class	Sw	NSW	HQW*	ORW
Miles	4,127	2,186	313	243
% of Miles	36	19	3	2
Acres (land)	NA	1,087,456	168,389	150,500
Acres (water)			*389*	*3,727*
% of Acres	NA	18	4	<1

* Calculations for HQW miles and acres of water includes only those waters assigned an HQW classification in the schedule of classifications. It does not include waters that are classified as WS-II and SA, although these waters are HQW by definition.

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 Cape Fear River Basin". Figure 2.8 depicts the locations of WS, HQW and ORW waters throughout for the basin as a whole. Figures 2.9, 2.10 and 2.11 depict the locations and major water body names of WS, HQW and ORW waters for the upper, middle and coastal portions of the basin. Figure 2.12 depicts that general extent of swamp and salt waters in the basin. It also shows the area of the basin classified as NSW (Jordan Reservoir watershed). Figure 2.13 depicts primary nursery areas and closed shellfish waters in the coastal portion of the basin.

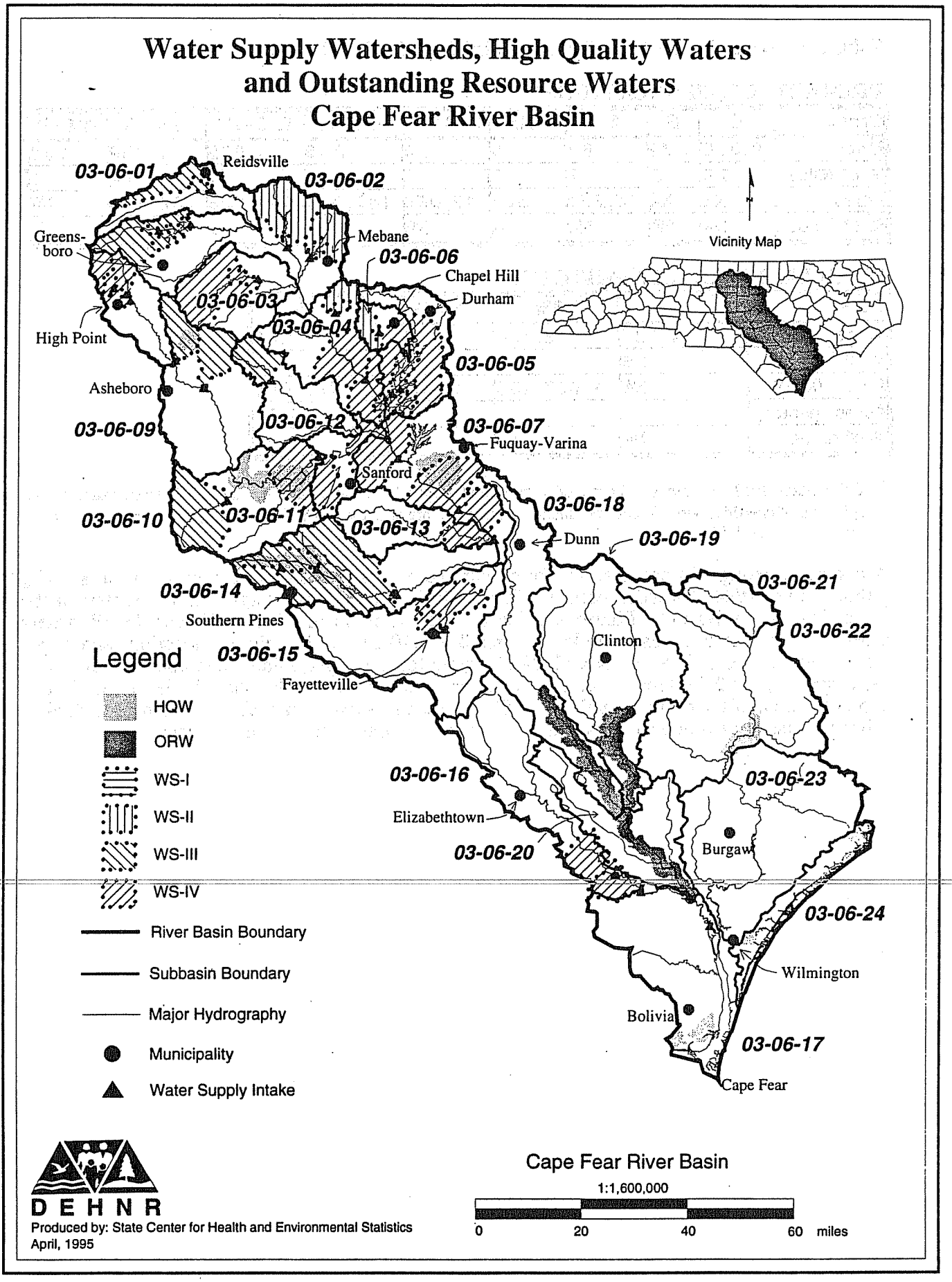


Figure 2.8 Water Supply Watersheds, High Quality Waters and Outstanding Resource Waters in the Cape Fear River Basin

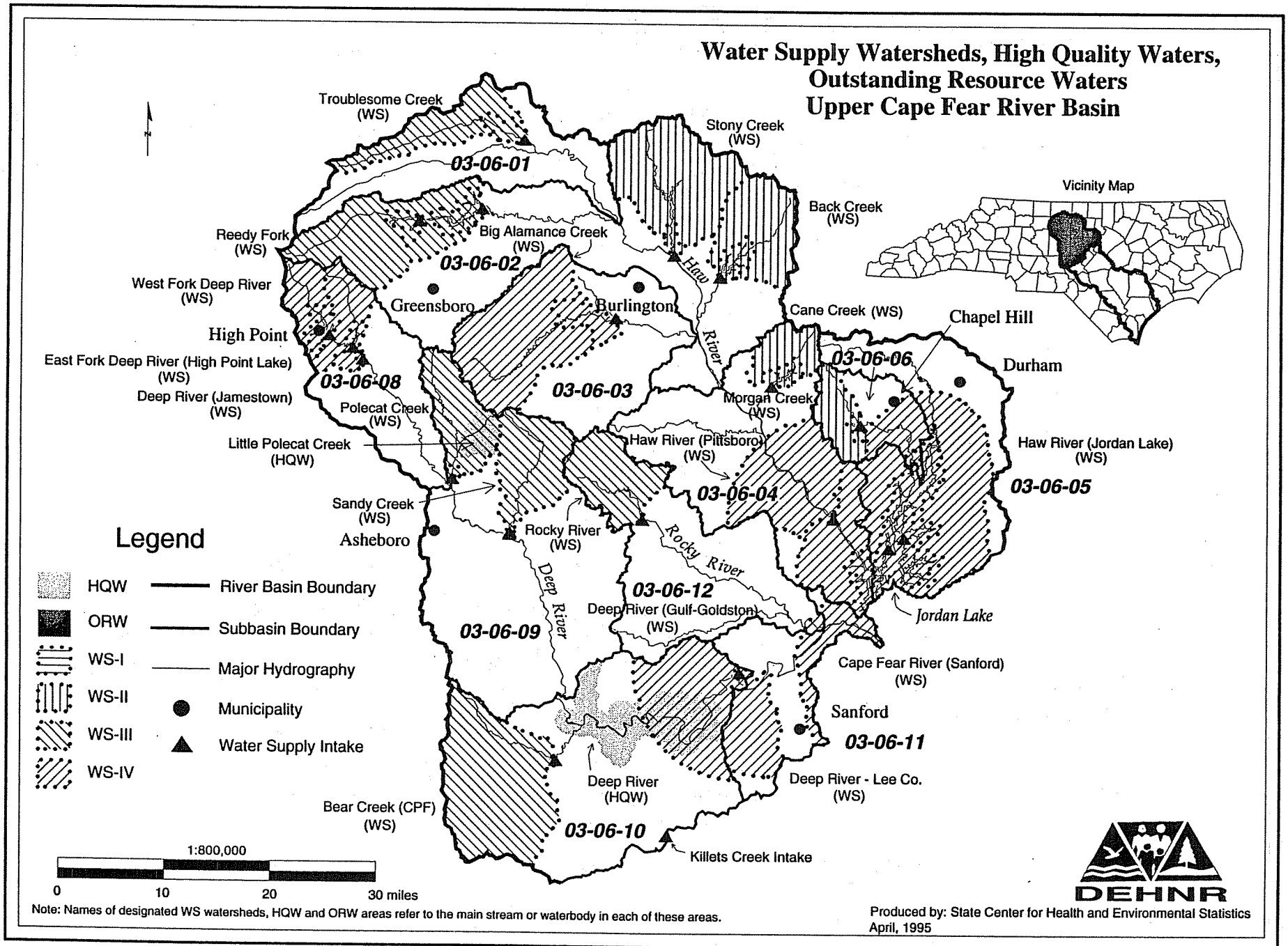


Figure 2.9 Water Supply Watersheds, High Quality Waters (HQW) and Outstanding Resource Waters (ORW) in the Upper Cape Fear River Basin

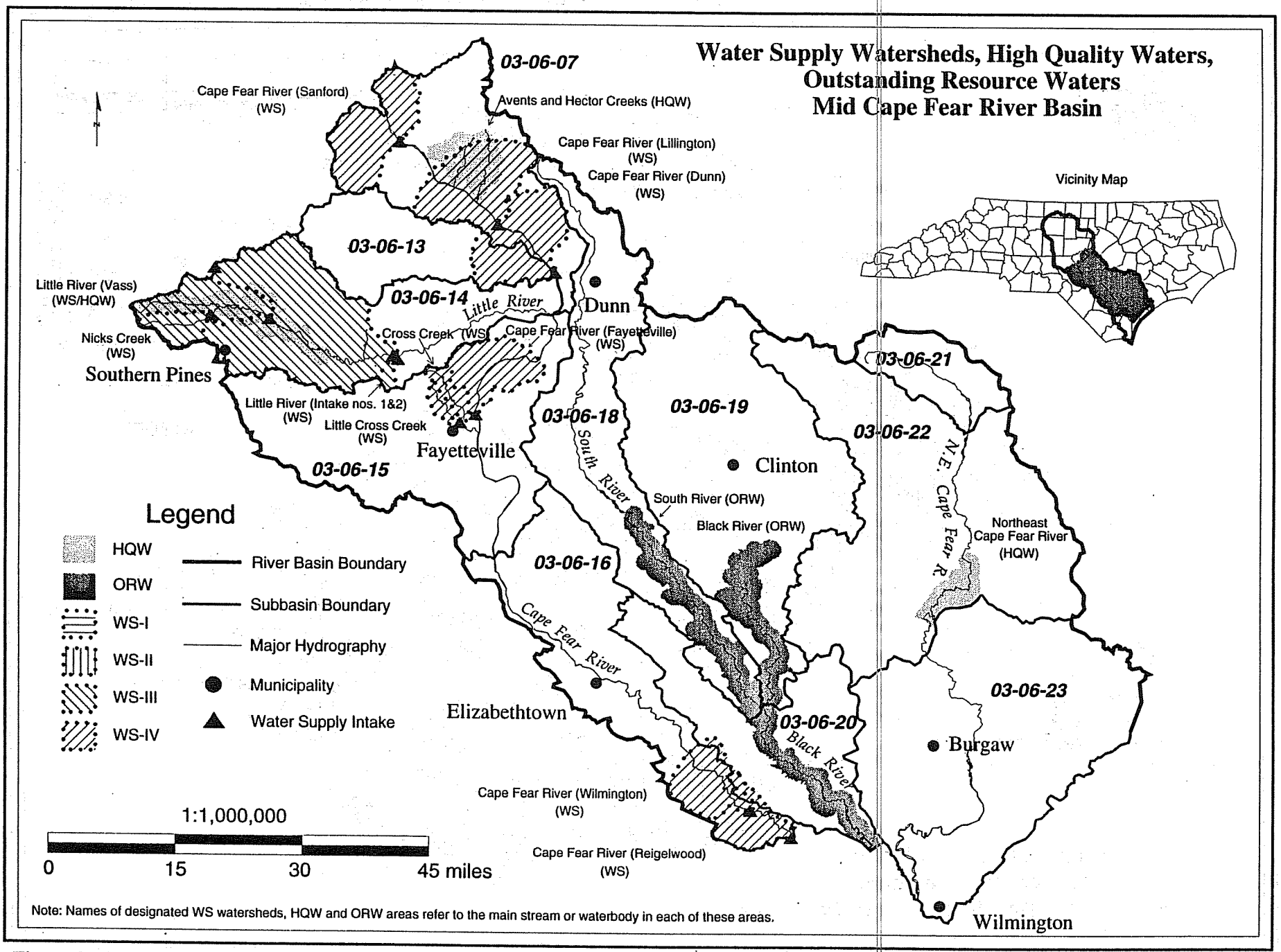


Figure 2.10 Water Supply Watersheds and HQW/ORW Waters in the Mid Cape Fear River Basin

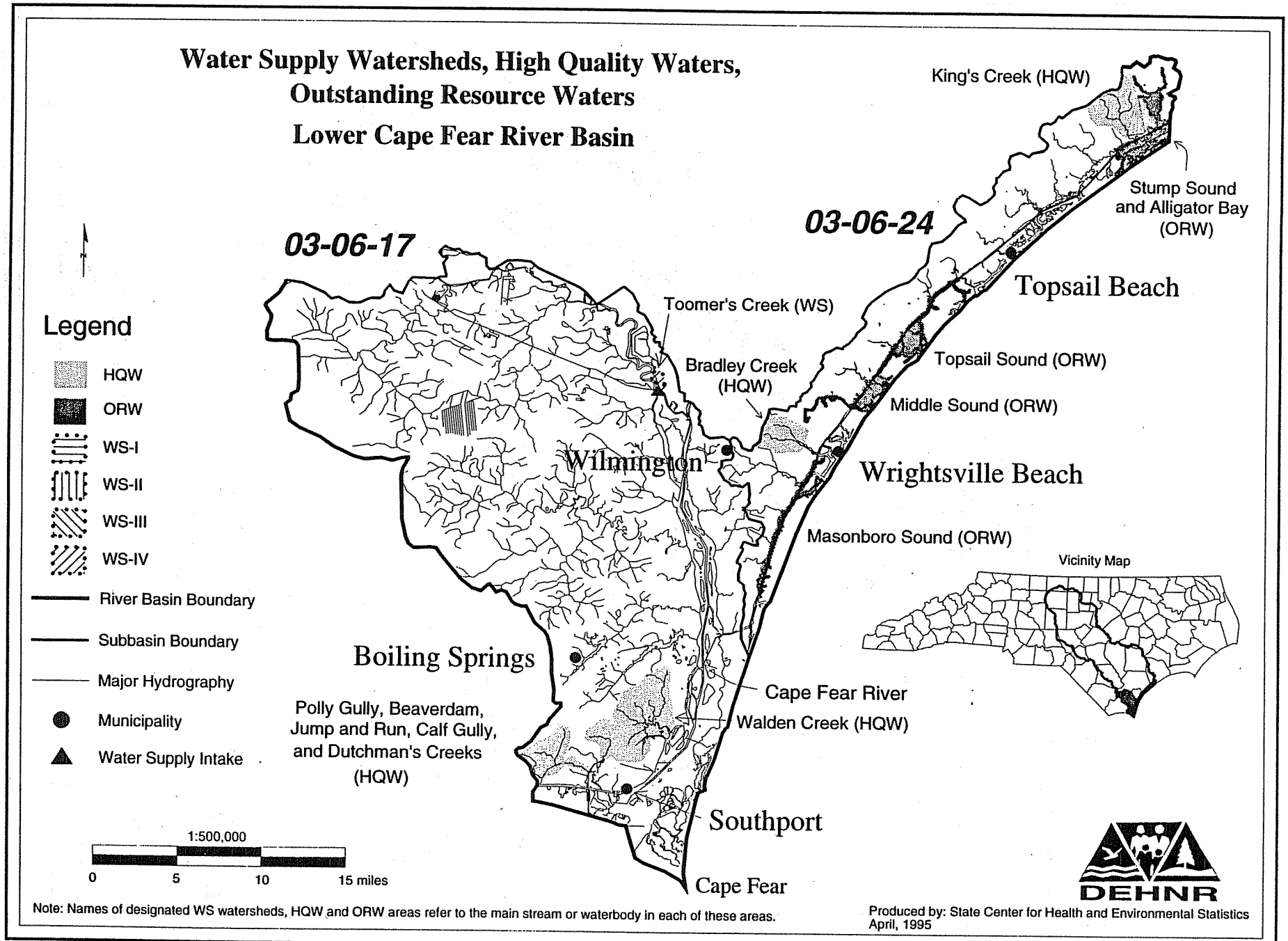


Figure 2.11 Water Supply Watersheds and HQW/ORW Waters in the Coastal Portion of the Cape Fear River Watershed

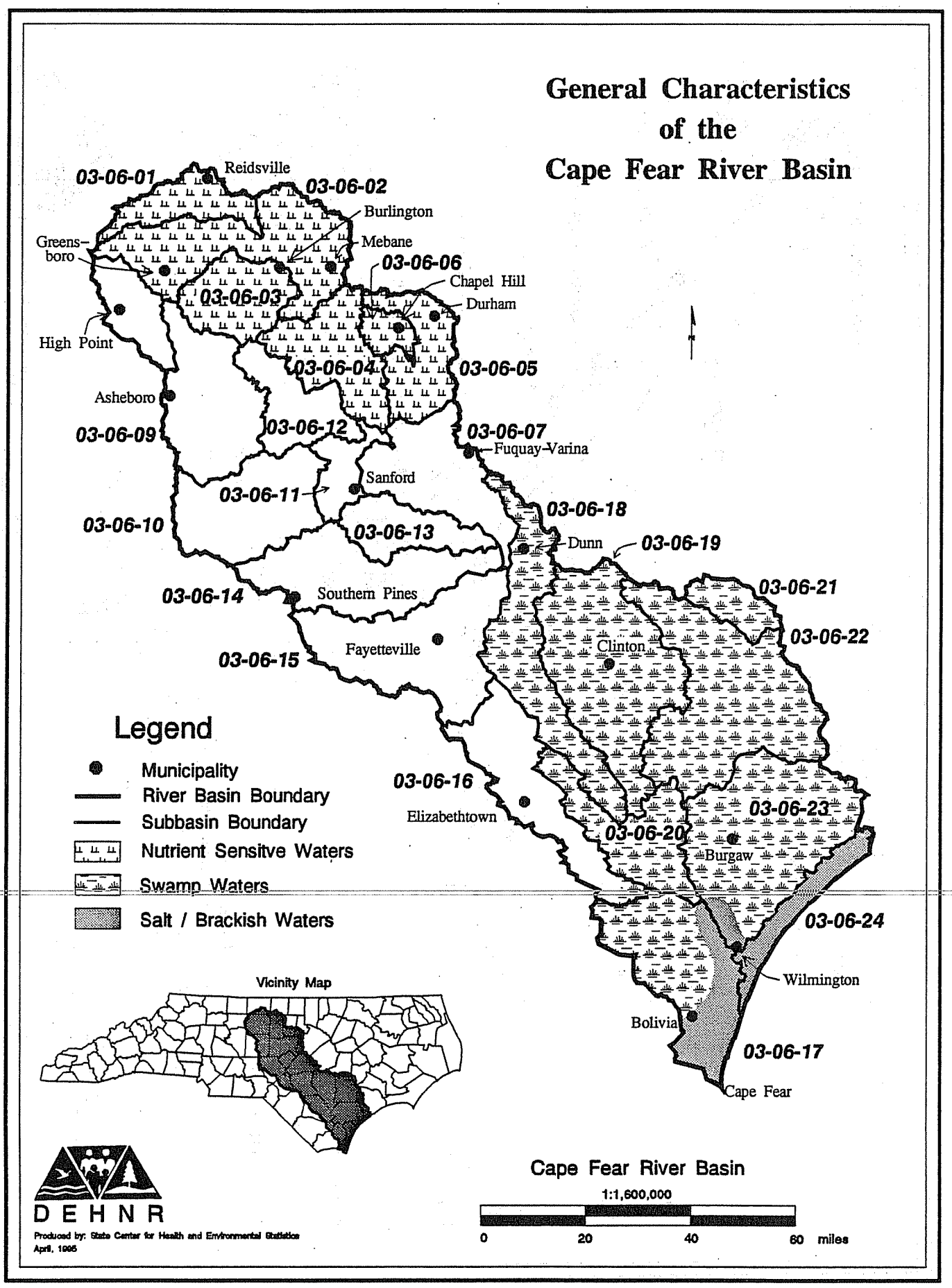


Figure 2.12 Swamp, Salt and Nutrient Sensitive Waters in the Cape Fear Basin

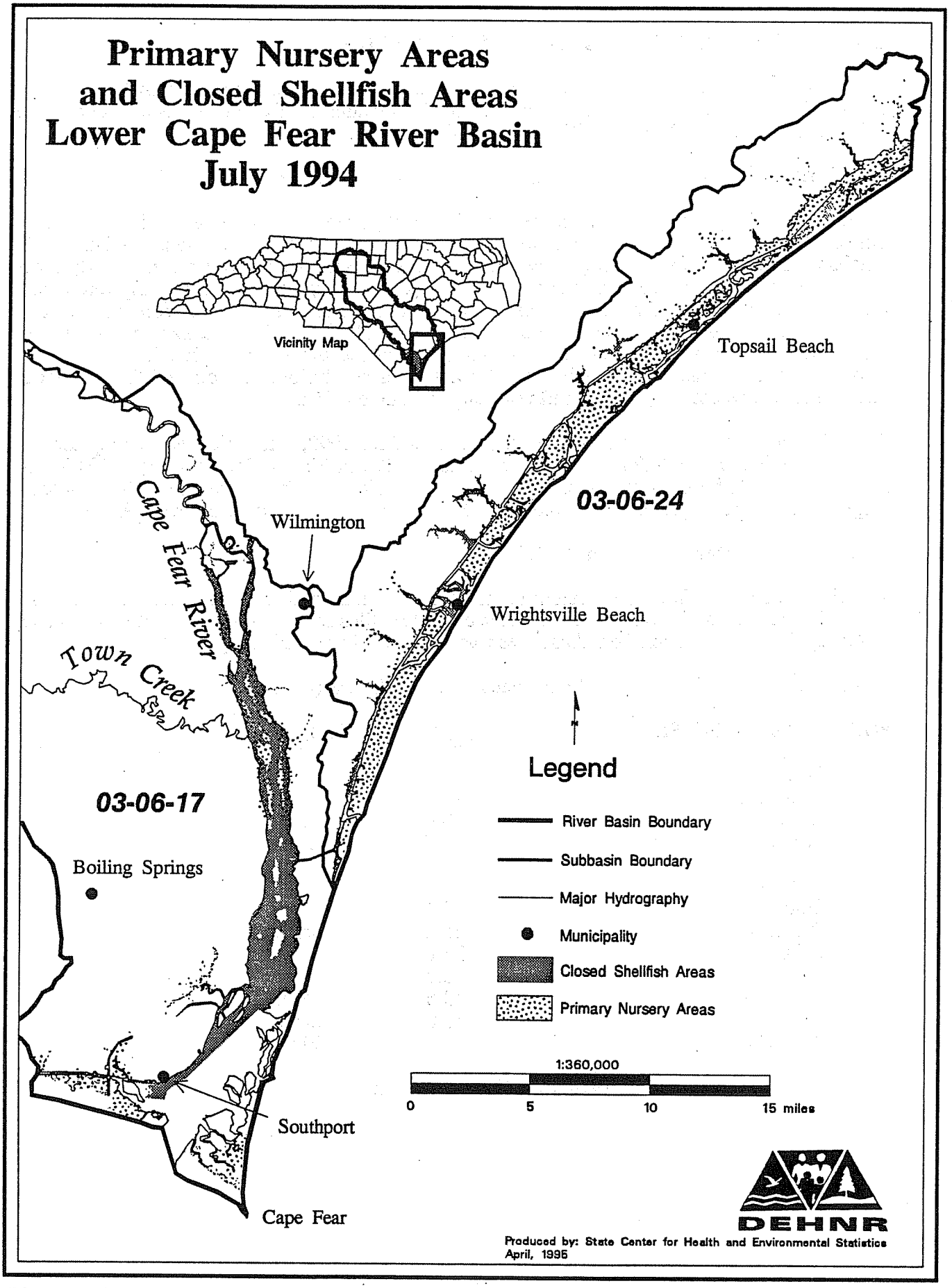


Figure 2.13 Primary Nursery Waters and Closed Shellfish Waters in the Cape Fear Basin

2.8 WATER USE IN THE CAPE FEAR RIVER BASIN

Maintaining an adequate supply of clean water will be critical to future economic growth and maintaining a healthy and productive environment. Information in this section was provided by the NC Division of Water Resources (Kuchen and Watts, 1995).

2.8.1 1992 Water Use Reported by Local Governments in the Cape Fear Basin

DWR is compiling water use data as reported by local governments in their local water supply plans. This data will be used in the development of the State Water Supply Plan. To date, DWR database contains (among others) present and projected water use information from fifty local governments located in the Cape Fear River basin (Table 2.10). An additional fifty-three draft plans have been submitted by local governments within the basin. The information in these draft plans are subject to verification and are not considered official until DWR has determined the information is reasonable and meets the requirements of the water supply planning law and the local government has approved its plan by a formal resolution. A total of thirteen local governments have not submitted a draft water supply plan to DWR.

According to Water Supply System Reports submitted for 1992, these fifty systems represent a service population of 981,702. A total water use of 125 million gallons per day (MGD) was reported for 1992 by these systems. Total water use projections for the year 2020 is 262 MGD (Figure 2.14). The projected use for the year 2020 represents a 110% increase over 1992 use.

2.8.2 1990 Water Use from USGS

The U.S. Geological Survey (Terziotti et. al., 1994) summarized water use from 1990 (Table 2.11). USGS staff reviewed reported water use in DWR files for agriculture, industry and public water supplies. Information from those files was further analyzed and interpolated.

Table 2.11 1990 Surface and Groundwater Use from USGS (MGD)

PUBLIC WATER SUPPLY	MGD	PERCENT
Domestic	72.6	3%
Commercial	31.9	1%
Industrial	79.5	4%
Other	0.4	<1%
Subtotal	**184.4**	**9 %**
SELF-SUPPLIED		
Commercial	2.3	<1%
Domestic	15.2	<1%
Industrial	97.6	4.6%
Mining	3.2	<1%
Agriculture	43.5	8 %
Power	1,781.0	84 %
Subtotal	**1,942.8**	**91%**
Total Water Use in 1990	**2,127.2**	**100%**

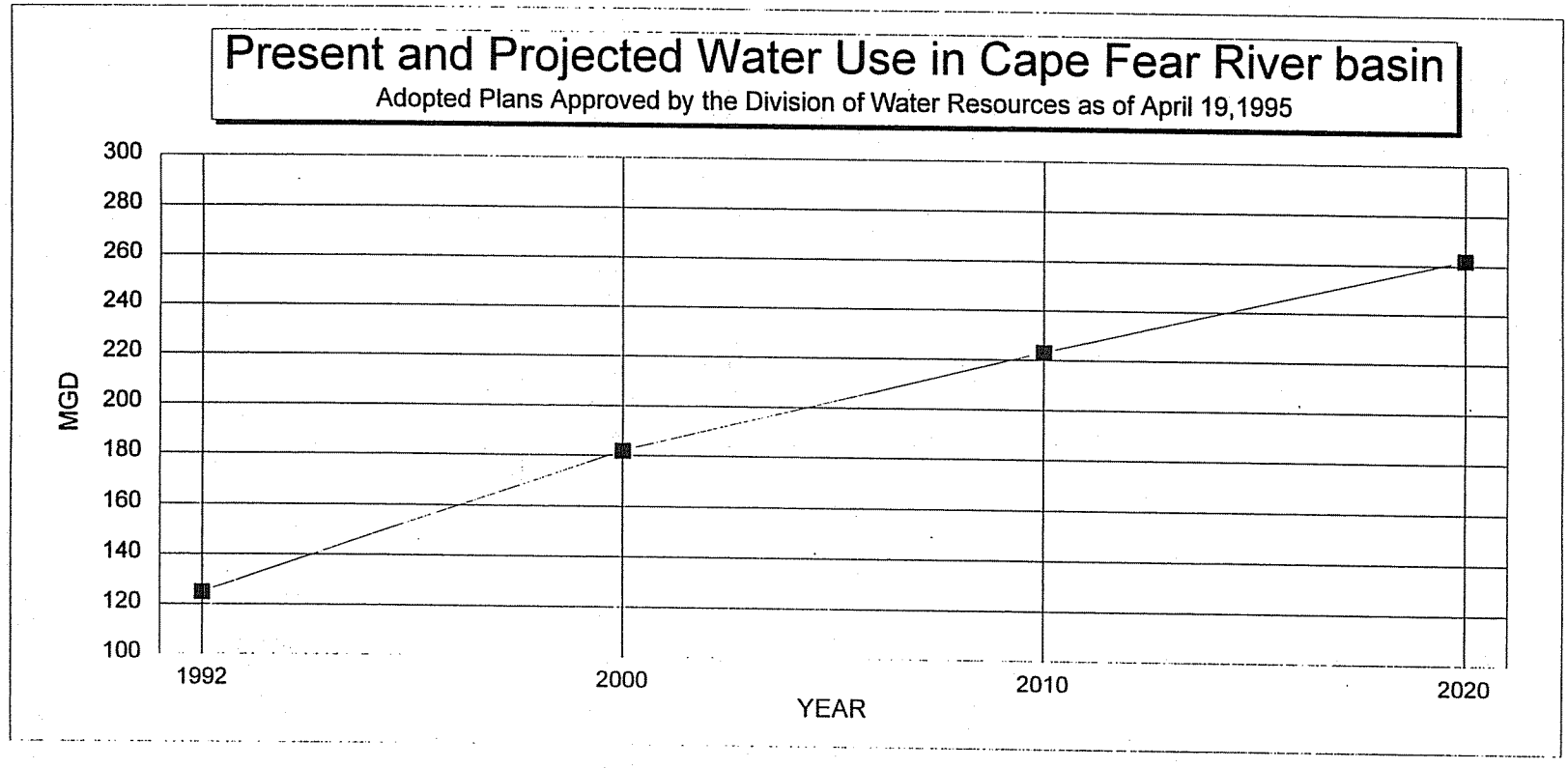


Figure 2.14 Present and Projected Water Use in the Cape Fear River Basin

Table 2.10 Present and Projected Water Use of Local Governments in the Cape Fear River basin (Adopted Plans Approved by the Division of Water Resources as of April 19, 1995).

PWSID	BASIN	SYSTEM NAME	USE				POPULATION				TOTAL USE
			1992 MGD	2000 MGD	2010 MGD	2020 MGD	1992	2000	2010	2020	
03-82-045	CAPE FEAR (2-3)	AUTRYVILLE	0.025	0.023	0.022	0.020	314	287	271	253	
04-10-045	CAPE FEAR (2-3)	BRUNSWICK CO	8.600	13.710	15.983	18.436	45748	67791	77452	88910	3147.490
04-10-055	CAPE FEAR (2-3)	CASWELL BEACH	0.101	0.294	0.350	0.400	500	980	1167	1332	36.970
03-43-020	CAPE FEAR (2-3)	COATS	0.146	0.176	0.210	0.252	1958	2346	2811	3368	53.570
03-09-010	CAPE FEAR (2-3)	ELIZABETHTOWN	0.805	1.746	1.851	1.972	4000	4260	4899	5633	284.625
03-26-010	CAPE FEAR (2-3)	FAYETTEVILLE	21.552	25.000	33.000	40.000	130000	154000	185000	213000	7866.000
03-92-055	CAPE FEAR (2-3)	FUQUAY-VARINA	0.542	1.320	2.220	3.090	4300	9153	14133	19319	
03-43-045	CAPE FEAR (2-3)	HARNETT CO	2.505	6.275	7.807	9.460	26000	40981	58676	73671	925.779
02-01-020	CAPE FEAR (2-3)	HAW RIVER	0.836	0.864	0.883	0.902	1928	2204	2297	2385	306.020
03-47-035	CAPE FEAR (2-3)	HOKE CO. AIRPORT	0.061	0.816	1.023	1.224	1112	8880	9642	10318	
03-26-025	CAPE FEAR (2-3)	HOPE MILLS	0.666	0.857	1.156	1.480	8809	11348	15316	19599	243.690
04-10-070	CAPE FEAR (2-3)	LELAND SD	0.393	0.471	0.561	0.617	3464	4200	5000	5500	143.788
03-26-045	CAPE FEAR (2-3)	LINDEN	0.028	0.036	0.040	0.047	465	575	640	750	
04-10-015	CAPE FEAR (2-3)	LONG BEACH	0.544	0.890	1.130	1.410	3280	5419	6797	8526	199.200
04-65-999	CAPE FEAR (2-3)	LOWER CAPE FEAR	7.820	26.000	41.000	56.000	292178	310320	346618	358512	
04-65-510	CAPE FEAR (2-3)	NEW HANOVER AIRPORT	0.019	0.020	0.024	0.029	0	0	0	0	
03-47-030	CAPE FEAR (2-3)	ROCKFISH	0.030	0.292	0.408	0.523	733	2565	2774	2968	
03-26-020	CAPE FEAR (2-3)	SPRING LAKE	0.783	0.937	1.167	1.517	10500	11660	12600	13600	
03-26-040	CAPE FEAR (2-3)	WADE	0.027	0.035	0.064	0.164	438	448	479	507	9.990
04-65-010	CAPE FEAR (2-3)	WILMINGTON	9.610	19.300	19.400	19.700	57213	84500	85000	86500	
04-10-020	CAPE FEAR (2-3)	YAUPON BEACH	0.105	0.107	0.109	0.111	785	800	815	830	38.399
02-76-030	DEEP (2-2)	ARCHDALE	0.663	0.900	1.430	1.900	7100	8500	10200	12250	242.658
03-83-025	DEEP (2-2)	CARTHAGE	0.201	0.256	0.271	0.000	1810	1900	2200	2400	73.377
02-41-020	DEEP (2-2)	HIGH POINT	11.290	12.160	13.040	14.210	70258	76492	80113	83155	4134.640
02-41-030	DEEP (2-2)	JAMESTOWN	0.370	0.445	0.625	0.700	3000	3600	4300	5000	135.381
02-76-020	DEEP (2-2)	RAMSEUR	0.476	0.622	0.650	0.676	2300	2680	2970	3240	173.800
02-76-015	DEEP (2-2)	RANDLEMAN	0.980	1.036	1.077	1.116	3200	3484	3857	4209	358.718
03-83-150	DEEP (2-2)	ROBBINS	0.686	2.000	3.000	0.000	1400	2300	3500	0	250.330
03-53-010	DEEP (2-2) CAPE FEAR (2-3)	SANFORD	4.563	4.980	5.330	5.630	17540	20173	21585	22880	
02-01-010	HAW (2-1)	BURLINGTON	11.088	12.600	13.300	14.200	40369	46000	49000	52200	4058.300
02-01-030	HAW (2-1)	GREEN LEVEL	0.107	0.114	0.119	0.124	1536	1636	1705	1770	39.218
02-41-010	HAW (2-1)	GREENSBORO	30.620	34.750	41.140	49.330	194300	204000	214000	222000	
03-68-020	HAW (2-1)	ORANGE-ALAMANCE WTR. SYS.	0.722	0.910	1.201	1.599	11000	13800	17300	20800	264.360
03-19-015	HAW (2-1)	PITTSBORO	0.610	1.080	1.540	2.000	2200	2350	2500	2660	222.500
02-79-020	HAW (2-1)	REIDSVILLE	3.289	4.500	4.900	5.400	14011	14825	15200	15400	1201.650
04-71-020	NEW (2-6)	TOPSAIL BEACH	0.150	0.190	0.230	0.270	8000	9876	10000	10000	56.000
04-31-999	NORTHEAST CAPE FEAR (2-5)	DUPLIN CO WATER DIST G	0.000	0.196	0.269	0.258	0	1879	2573	2471	0.000
04-31-995	NORTHEAST CAPE FEAR (2-5)	DUPLIN CO WATER DIST B	0.000	0.357	0.430	0.413	0	1275	1536	1475	0.000
04-31-996	NORTHEAST CAPE FEAR (2-5)	DUPLIN CO WATER DIST D	0.000	0.325	0.510	0.490	0	3106	4885	4690	0.000
04-31-997	NORTHEAST CAPE FEAR (2-5)	DUPLIN CO WATER DIST E	0.000	0.286	0.412	0.396	0	2742	3945	3787	0.000
04-31-998	NORTHEAST CAPE FEAR (2-5)	DUPLIN CO WATER DIST F	0.000	0.318	0.382	0.366	0	3045	3653	3505	0.000
04-65-191	NORTHEAST CAPE FEAR (2-5)	FLEMINGTON	0.210	0.217	0.258	0.308	108	110	114	118	
04-31-030	NORTHEAST CAPE FEAR (2-5)	KENANSVILLE	0.189	0.271	0.230	0.259	861	814	787	756	
04-31-035	NORTHEAST CAPE FEAR (2-5)	MAGNOLIA	0.070	0.075	0.078	0.080	747	800	825	850	25.695
04-31-010	NORTHEAST CAPE FEAR (2-5)	WALLACE	2.810	3.030	3.360	3.680	3304	3437	3683	3951	1027.200
03-43-015	SOUTH (2-4)	ANGIER	0.231	0.242	0.271	0.302	2265	2283	2504	2711	84.960
03-82-025	SOUTH (2-4)	SALEMBURG	0.100	0.097	0.094	0.091	650	610	576	539	36.756
03-26-035	SOUTH (2-4)	FALCON	0.050	0.053	0.057	0.061	695	747	797	845	
03-82-020	SOUTH (2-4)	GARLAND	0.075	0.128	0.193	0.261	746	789	842	895	
03-26-030	SOUTH (2-4)	STEDMAN	0.085	0.940	0.100	0.108	777	896	957	1014	
		TOTAL -	124.833	182.247	222.905	261.582	981702				

2.8.3 Allocations for Jordan Reservoir and Proposed Randleman Reservoir

Jordan Reservoir Allocation
Thirty-three percent of Jordan Reservoir's water supply storage is allocated to four systems. Originally, Hillsborough and Orange-Alamance also requested allocations, but they have since dropped their requests. If growth exceeds projections, applicants may request additional allocations at 5-year intervals. Allocation amounts are included in Table 2.12

Table 2.12 Summary of Jordan Reservoir Allocations (MGD)

Applicant	LEVEL 1	LEVEL 2
Cary-Apex Joint Request	16.0	0.0
Chatham Co.	4.0	2.0
Orange Water and Sewer Authority		10.0
Orange County		1.0
Totals	**20.0**	**13.0**

* These figures, while expressed in terms of water supply yield, actually represent the percentage of the water supply pool allocated. For example, a 12 MGD allocation means that the applicant would purchase 12 percent of the total water supply storage pool.

Randleman Reservoir (Proposed)
Randleman Lake is a proposed 3,000-acre reservoir with a 200-foot protective buffer strip around it that will provide 48 MGD of water supply. The reservoir will serve as a regional water supply for the Piedmont Triad Water Authority, which consists of Greensboro, High Point, Randolph County, Randleman, Jamestown and Archdale. The current raw water allocations are shown in Table 2.13. The project should be completed in 1998 and operational by the year 2000.

The Authority in 1988 requested certification for an interbasin transfer and for the power of eminent domain from the Environmental Management Commission. In late 1991, the EMC approved the certificates in a close vote. Landowners appealed the EMC decision in Superior Court, which ruled in the landowners' favor. The EMC appealed that decision to the N.C. Court of Appeals, and a decision has not yet been made. This fall, a draft Environmental Impact Statement is planned for release as part of the application procedure for the 404 permit from the U.S. Army Corps of Engineers.

Table 2.13 Current Raw Water Allocations for Randleman Lake

	Yield (MGD)	Percent
Greensboro	28.512	59.4
High Point	10.08	21.0
Randolph County	6.0	12.5
Randleman	1.008	2.1
Jamestown	1.2	2.5
Archdale	1.2	2.5
Totals	**48.0**	**100.0**

2.8.4 Interbasin Transfers Between the Cape Fear and Adjoining Basins

Water systems in North Carolina are required to register their water withdrawals and transfers with the Division of Water Resources if the amount is one million gallons per day or more, according to G.S. 143-215.22H. Under this law, the major Cape Fear River Basin is comprised of the

following smaller basins: Haw River, Deep River, Cape Fear River, South River, Northeast Cape Fear River, and New River (see Figure 2.15). (Note: the New River is not considered part of the Cape Fear River Basin under the basinwide management approach which utilizes basin definitions adopted by the Department of Water and Air Resources in 1974. The New River will be addressed as part of the White Oak Basin in 1996).

In addition, any unit of local government that supplies water is required to prepare a local water supply plan that documents its current (1992) and projected water use and supplies, plus much other water supply planning information. All of the registered interbasin transfers either into or out of the Cape Fear River Basin are listed below in Table 2.14. The average annual 1992 transfer amount and the projected average annual 2010 transfer amount are based on information provided in each system's local water supply plan unless otherwise noted.

Table 2.14 Registered Interbasin Transfers (as of March 1, 1992) in Millions of Gallons per Day (MGD)

FACILITY	RIVER BASIN FROM	>	TO	1992 TRANSFER (MGD)	PROJECTED 2010 TRANSFER (MGD)	
Transfers out of Cape Fear Basin:						
High Point	Deep		Yadkin	3.47	4.00	
Cary-Apex	Haw		Neuse	0.00	12.38	(*)
Benson	South		Neuse	0.968	1.230	
Total Transfer Out:				**4.438**	**17.610**	
Transfer into Cape Fear Basin						
Durham (**)	Neuse		Haw	11.640	20.800	(***)
Asheboro	Uwharrie		Deep	4.655	11.500	
Montgomery County	Yadkin		Deep	0.927	1.050	
Total Transfer In:				**17.222**	**33.350**	

* Source: Cary Public Works (2/12/96)

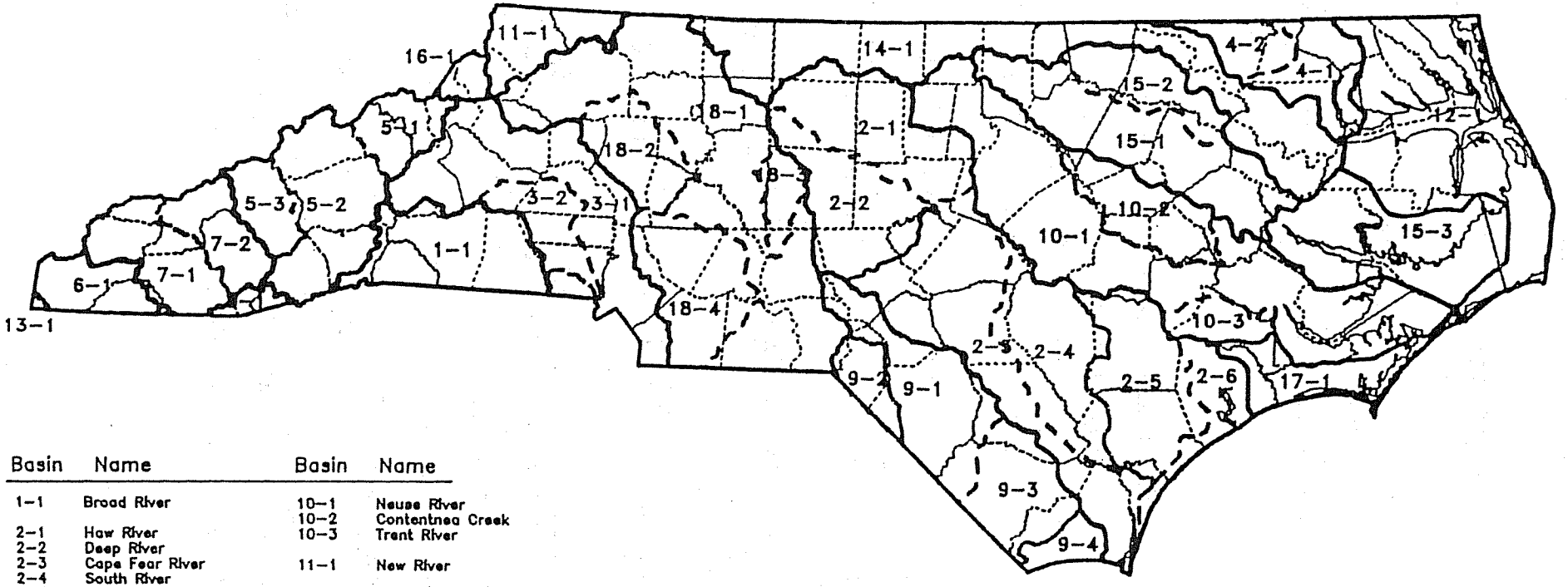
** Includes Durham County's wastewater discharge

*** Sources: Durham Dept. of Water Resources; Durham County Env. Eng. Dept. - Utilities Div. (2/12/96)

Based on the above information, there was a net transfer of 12.784 MGD *into* the Cape Fear River Basin in 1992. For 2010, the projected transfer amounts result in a *net* transfer of 15.74 MGD *into* the Cape Fear River Basin. This assumes that Cary-Apex's current 16 MGD Jordan Reservoir allocation is increased to meet its estimated 2010 demand of 24.55 MGD and that the West Cary WWTP is on-line and discharging 12.17 MGD back into the Cape Fear River Basin. (These projections are based on the current plans of the Cary Public Works Department). Neither the Cary-Apex withdrawal from Jordan Reservoir nor their transfer out of the Cape Fear River Basin can exceed 16 MGD without prior approval by the Environmental Management Commission.) The 2010 transfer estimate for Durham includes a 14.8 MGD wastewater discharge to the Cape Fear River Basin by the City of Durham (Durham Department of Water Resources) and an estimated 6 MGD discharge to the basin by Durham County (Durham County Environmental Engineering Department -Utilities Division).

A 1995 approximation of transfer amounts has also been made, since the 1993 amounts do not adequately represent Cary-Apex's current situation. This is because Cary-Apex's water use has increased significantly over 1992 levels and, in 1992, Cary-Apex had not yet begun using its

Figure 2.15 Map Defining River Basin and Subbasins for Purposes of Regulating Interbasin Transfers in North Carolina



Basin	Name	Basin	Name
1-1	Broad River	10-1	Neuse River
		10-2	Contentnea Creek
2-1	Haw River	10-3	Trent River
2-2	Deep River		
2-3	Cape Fear River	11-1	New River
2-4	South River		
2-5	Northeast Cape Fear River	12-1	Albemarle Sound
2-6	New River		
		13-1	Ocoee River
3-1	Catawba River		
3-2	South Fork Catawba River	14-1	Roanoke River
4-1	Chowan River	15-1	Tar River
4-2	Meherrin River	15-1	Fishing Creek
		15-3	Pamlico River & Sound
5-1	Nolichucky River		
		16-1	Watauga River
5-2	French Broad River		
5-3	Pigeon River	17-1	White Oak River
6-1	Hiwassee River	18-1	Yadkin River
		18-2	South Yadkin River
7-1	Little Tennessee River	18-3	Uwharrie River
7-2	Tuskasegee River	18-4	Rocky River
8-1	Savannah River		
9-1	Lumber River		
9-2	Big Shoe Heel Creek		
9-3	Waccamaw River		
9-4	Shallotte River		

Jordan Reservoir allocation. Pumping records indicate that Cary-Apex transferred an average of about 10.27 MGD in 1995. By assuming 1992 levels for the other systems, this results in a net transfer *into* the basin of approximately 2.5 MGD for 1995.

Since transfers less than one MGD are not required to be registered with the Division of Water Resources, there are a few systems not listed here that nod have minor transfers involving the Cape Fear River Basin. Also, there are some systems, such as the Orange Water and Sewer Authority, that have only emergency or supplemental connections that involve a transfer, making it difficult to project these uses. Both of these would affect the transfer amounts slightly. The Division of Water Resources is in the process of better documenting these additional transfers.

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CHAPTER 3

CAUSES AND SOURCES OF WATER POLLUTION IN THE CAPE FEAR RIVER BASIN

3.1 INTRODUCTION

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

3.2 CAUSES OF POLLUTION

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

3.2.1 Oxygen-Consuming Wastes

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

The concentration of dissolved oxygen (DO) in a water body is one indicator of the general health of an aquatic ecosystem. The United States Environmental Protection Agency (EPA) states that 3.0 milligrams per liter (mg/l) is the threshold dissolved oxygen concentration needed for many species' survival (EPA, 1986). North Carolina has adopted a water quality standard of 5.0 mg/l (daily average with minimum instantaneous measurements not permissible below 4.0 mg/l) in order to protect the majority of its waters. Higher concentrations are needed to promote propagation and growth of a diversity of aquatic life in North Carolina's surface waters. Exceptions to this standard exist for waters supplementally classified as *trout waters* (not found in the Cape Fear River Basin) and those supplementally classified as *swamp*. Trout waters have a dissolved oxygen standard of 6.0 mg/l due to the higher sensitivity of trout to low dissolved oxygen levels. Swamp waters often have naturally low levels of dissolved oxygen, and aquatic life typically found in these waters are adapted to the lower dissolved oxygen levels. Sluggish swamp waters in the Coastal Plain portion of the state may have natural dissolved oxygen levels of 3.0 to 4.0 mg/l or less at times. Therefore, the dissolved oxygen standard for swamp waters may be less than 5.0 mg/l if that lower level is judged to be the result of natural conditions. Many of the freshwater streams in the Coastal Plain portion of the basin are supplementally classified by the state as swamp waters (see section 2.5 for further discussion on standards and classifications).

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

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

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

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

Oxygen-Consuming Wastes in the Cape Fear River Basin

The protection of dissolved oxygen through management of the discharge of oxygen-consuming wastes into waters of the Cape Fear River basin continues to be a high priority. Efforts to limit the discharge of these wastes from NPDES discharge facilities have been largely successful over the past two decades. The total daily loading of biochemical oxygen demanding wastes (BOD) from NPDES (National Pollutant Discharge Elimination System) municipal dischargers in the Cape Fear River Basin in 1993 is estimated to be significantly lower than it was 20 years ago despite a large increase in the total volume of treated wastewater. As depicted in Figure 3.1a, the total loading of BOD has decreased from approximately 33 tons per day in the mid-1970s to approximately 9.7 tons per day in 1993 while the total daily volume of effluent discharged increased by 38% from 173.3 MGD in the mid 1970s to 239.1 MGD in 1993 (Figure 3.1b). This reduction in BOD loading is the result of several factors including 1) more stringent point source pollution control requirements mandated by the federal Clean Water Act, 2) management actions implemented through the state's NPDES program and 3) major efforts by municipalities, industries and others, in the form of wastewater treatment plant upgrades and improved plant operation, to meet these requirements for water quality protection.

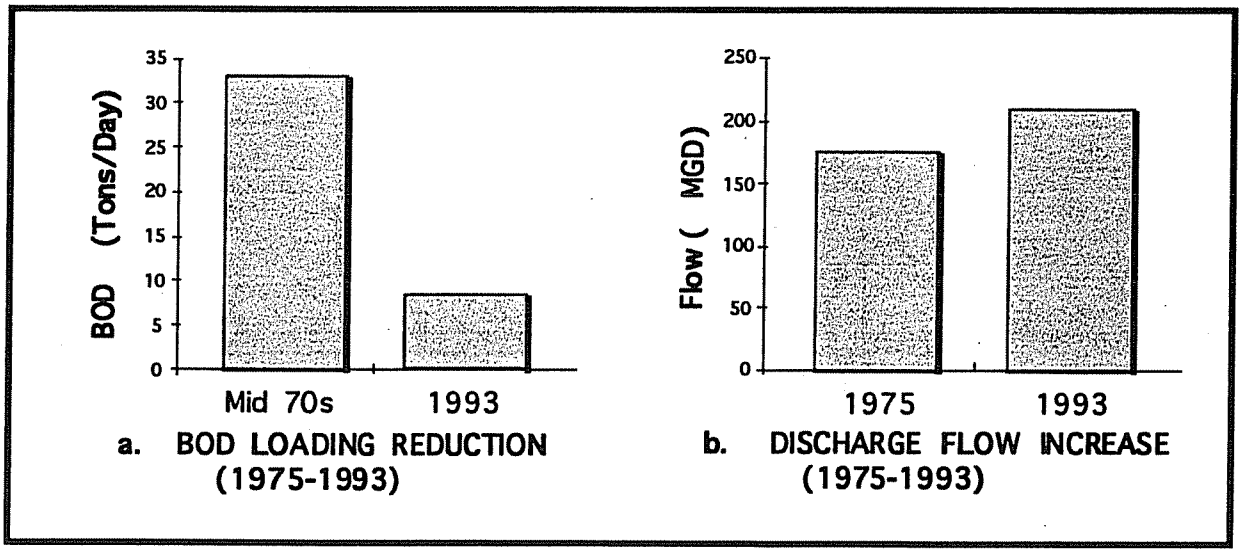


Figure 3.1 Comparison of (a) Total BOD Loading and (b) Effluent Flows from Municipal NPDES dischargers in the Cape Fear River Basin Between Mid-1970s and 1993

In general, while water quality standards for dissolved oxygen are being met throughout most of the basin, modeling studies have indicated that the BOD assimilative capacity is either limited or has been exhausted in some waters in the basin. Also, treatment of BOD will need to continue to improve in order to maintain water quality standards in the face of future plant expansions. Recommended strategies for addressing BOD are presented in Section 6.3 of Chapter 6.

3.2.2 Nutrients

The term *nutrients* in this document refers to the substances phosphorus and nitrogen, two common components of plant fertilizers, animal and human wastes, vegetation and some industrial processes. Nutrients in surface waters come from both point and nonpoint sources. While nutrients can be beneficial to aquatic life in small amounts, in overabundance and under favorable conditions, they can stimulate the occurrence of algal blooms and excessive plant growth in quiet waters such as ponds, lakes, reservoirs and estuaries.

Algal blooms, through respiration and decomposition, deplete the water column of dissolved oxygen and can contribute to serious water quality problems. Nutrient overenrichment and the resultant problems of low dissolved oxygen are called *eutrophication.* In addition to problems with low dissolved oxygen, the blooms are aesthetically undesirable, impair recreational use, impede commercial fishing and pose difficulties in water treatment at water supply reservoirs. Excessive growth of larger plants, or macrophytes, such as milfoil, alligator weed and Hydrilla, can also be a problem. These plants, in overabundance, can reduce or eliminate swimming, boating and fishing in infested waters.

Agricultural runoff and wastewater treatment plants along with urban stormwater, forestry and atmospheric deposition are the main sources of nutrients. Nutrients in nonpoint source runoff come mostly from fertilizer and animal wastes (See Section 3.4.1). Nutrients in point source discharges are from human wastes, food residues, some cleaning agents and industrial processes. A statewide phosphorus detergent ban implemented in 1988 significantly reduced the amount of phosphorus reaching and being discharged into surface waters from wastewater treatment plants. A report was prepared by the North Carolina Department of Environment, Health, and Natural Resources in 1991 to evaluate the effects of the ban. (NCDEHNR, 1991).

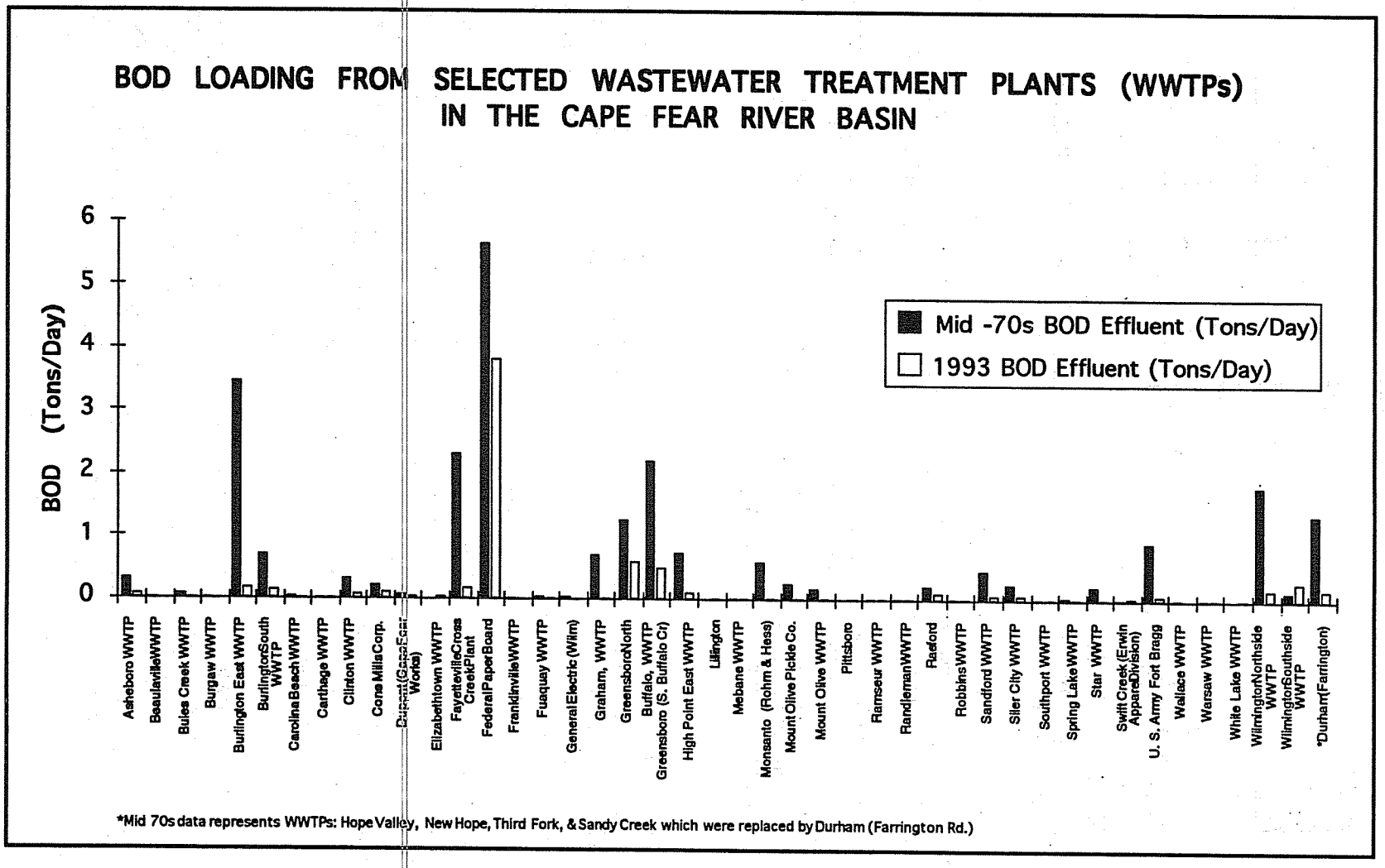


Figure 3.2 Comparison of Permitted BOD (Biochemical oxygen demand) Loadings from Selected NPDES Dischargers in the Cape Fear River Basin Between the Mid-1970s and 1993

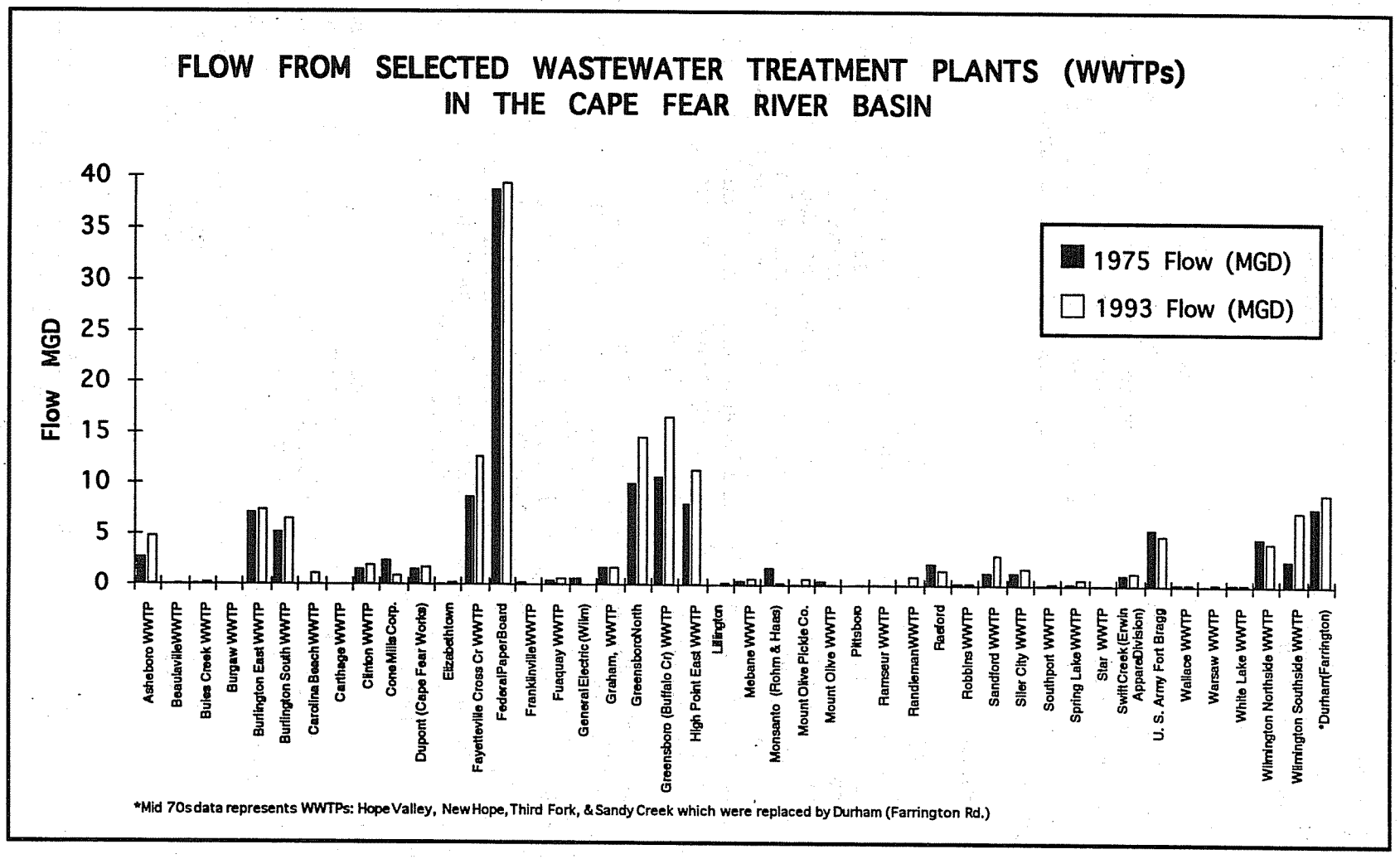


Figure 3.3 Comparison of Permitted Flows from Selected NPDES Dischargers in the Cape Fear River Basin Between the Mid-1970s and 1993

At this time, North Carolina has no numeric instream standards for total phosphorus (TP) and total nitrogen (TN), but analysis is underway, and standards or instream criteria may be developed for these parameters in the future. In addition, the State has a standard of 40 ug/l (micrograms per liter or parts per billion) for chlorophyll *a* . Chlorophyll *a* is a constituent of most algae (it gives algae its green color). A chlorophyll *a* reading above the 40 ug/l standard is indicative of excessive algal growth and portends bloom conditions.

Nutrients in the Cape Fear Basin

The control of nutrients, especially phosphorus, is an important water quality concern in the Cape Fear River Basin. There are 16 lakes in the basin, including Jordan Reservoir, which are rated as threatened due to nutrient overenrichment (see Figure 4.3 in Chapter 4). Greenfield Lake in New Hanover County is considered hypereutrophic and not supporting its uses because of excessive nutrients and noxious aquatic weed growth. Nutrients are also a major concern in the upper Deep River watershed in the vicinity of the proposed Randleman Reservoir because of the potential for eutrophication occurring in the lake (Section 6.4.3 in Chapter 6). Nutrient management strategies for the basin, overall, are presented in Section 6.4.

3.2.3 Toxic Substances

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

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

Whole effluent toxicity (WET) testing is required on a quarterly basis for major dischargers and any discharger containing complex (industrial) wastewater. There are 119 such dischargers in the Cape Fear River Basin. A complete listing of these facilities is included in Appendix II. 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 Sections 4.2.4 and 5.2.5 of Chapters 4 and 5, respectively. Strategies to address toxicity problems associated with dischargers are presented in Section 6.5 of the Chapter 6.

Metals

According to Table 4.13 in Chapter 4, 55 miles of streams in the basin are estimated to be impaired by metals. In addition, 10 fish tissue samples at seven sampling locations in the basin had mercury concentrations that exceeded the federal Food and Drug Administration limit of 1.0 parts per

million (Section 4.2.2). Municipal and industrial dischargers along with urban runoff, and possibly atmospheric deposition, are the main sources of metals contamination in surface water. North Carolina has stream standards for many heavy metals, but the most common ones in municipal permits are cadmium, chromium, nickel, lead, mercury, silver and zinc. Each of these, with the exception of silver, is also monitored at the 69 ambient monitoring stations in the basin along with aluminum and arsenic. Point source discharges of metals are controlled through the NPDES permit process. Mass balance models (Appendix III) are employed to determine appropriate limits. Municipalities with significant industrial users discharging wastes to their treatment facilities limit the heavy metals coming to them from their industries through their *pretreatment program.* Source reduction and wastewater recycling at WWTPs also reduces the amount of metals being discharged to a stream. Nonpoint sources of pollution are controlled through best management practices. The new urban stormwater NPDES program described in Chapter 5 and in Section 6.7 of Chapter 6 should help address nonpoint source metals loading in the Greensboro and Fayetteville areas.

Chlorine

Chlorine is commonly used as a disinfectant at NPDES discharge facilities which have a domestic (i.e., human) component. These discharges are a major source of chlorine in the State's surface waters. Chlorine dissipates fairly rapidly once it enters the water, but it can have significant toxic effects on sensitive aquatic life such as trout and mussels. North Carolina has adopted a freshwater action level of 17 ug/l (micrograms per liter) to protect against chronic toxicity. It is recommended that new and expanding discharges provide dechlorination or alternate disinfection of wastewater. A total residual chlorine limits is assigned based on the freshwater action level of 17 ug/l (13 ug/l for salt water) or a maximum concentration of 28 ug/l for protection against acute effects in the mixing zone. In 1993, letters were sent to existing facilities with chlorine monitoring requirements. These letters encouraged permittees to examine their effluent chlorine levels and noted that limits may be implemented in the future. At this time, the State is not requiring chlorine limits at existing treatment facilities.

Ammonia (NH_3)

According to Table 4.13 in Chapter 4, 24 miles of streams in the basin are estimated to be impaired by ammonia. Point source dischargers are one of the major sources of ammonia. In addition, decaying organisms which may come from nonpoint source runoff and bacterial decomposition of animal waste products also contribute to the level of ammonia in a waterbody. At this time, there is no numeric standard for ammonia in North Carolina.

3.2.4 Erosion and Sedimentation

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

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

are considered to be in compliance with the standard if approved best management practices (BMPs) have been implemented.

Statistics compiled by the US Department of Agriculture, Natural Resources Conservation Service indicate a statewide decline in erosion from 1982 to 1992 (USDA, NRCS, 1992) as shown in Table 3.1.

Table 3.1 Overall Erosion Trends in North Carolina

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

The NRCS statistics also indicate a statewide reduction per acre on cropland erosion using the Universal Soil Loss Equation (Table 3.2).

Table 3.2 USLE Erosion on Cultivated Cropland in North Carolina

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

While there is an overall 10-year downtrend statewide in the erosion rate on agricultural lands, the erosion rate/acre and the 10-year trends vary by region as shown in Table 3.3. The greatest improvement in erosion control is seen in the Southern Piedmont and Sand Hills with a small uptrend in the tidewater area and a significant increase in the mountains. In the mountain region, it is noted that while the 10-yr trend is up, the five-year trend from 1987 to 1992 was down. The reasons for the dramatic changes in the mountain basin erosion rates are not fully known. One factor changes in some erosion rates assigned to soils in this region. Another may be related to the growth in the Christmas tree industry. Christmas trees plantations are considered to be agricultural lands, and many of these are located on steep hillsides.

Table 3.3 North Carolina Erosion on Major Land Resource Areas (MLRA) in Tons/acre/yr

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

Sedimentation in the Cape Fear River Basin

Sedimentation and erosion is the most widespread cause of freshwater stream impairment in the Cape Fear River Basin. Use support information presented in Table 4.13 of Chapter 4 indicates that over 600 miles of streams were thought to be impaired as a result of sedimentation. Sediment-related stream impairment is listed by subbasins. It should be pointed out that the most of the stream miles identified as being impaired by sediment are based on the best professional judgment of field personnel from various nonpoint source agencies that were presented at a series of nonpoint source workshops held in the mid to late 1980s. Accordingly, the figures presented here are, for the most part, at least eight years old and predate many advancements made in sediment control in several programs. The NRCS data indicate statewide improvements in overall erosion rates and in cropland erosion rates over the ten-year period from 1982 to 1992. Sections 5.3.1, 5.3.3 and 5.3.6 describe sediment control programs for agriculture, construction and forestry in which significant improvements have been made or mandated since 1989. Section 6.6 of Chapter 6 discusses strategies for improving sediment control.

3.2.5 Fecal Coliform Bacteria

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

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

Fecal Coliform Bacteria in the Cape Fear River Basin

According to Table 4.13 in Chapter 4, there are 26 miles of streams in subbasin 02 considered to be use-impaired due to elevated levels of fecal coliform bacteria at ambient monitoring stations. This impairment was determined based on stations where the geometric mean for all samples (minimum 10 samples) exceeded 200 MPN. In addition, there are approximately 4,800 acres of shellfish (SA) waters in the coastal portion of the basin that are closed to harvesting because of unacceptably high levels of fecal coliform bacteria (Table 4.14 of Chapter 4). Management strategies for addressing fecal coliform bacteria are presented in Section 6.9 of Chapter 6.

3.2.6 Color

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

and because a discharger may have high color values but no visual impact instream due to dilution or the particular color of the effluent. While no waters in the basin have been identified as use-impaired due to color, color has been identified as a concern in several streams in subbasins 01, 02, 08 10 and 22. Section 6.8 in Chapter 6 discusses ongoing efforts to study color and to develop a realistic approach to addressing this problem.

3.3 POINT SOURCES OF POLLUTION

3.3.1 Defining *Point* Sources

Point sources refers to discharges that enter surface waters through a pipe, ditch or other well-defined points of discharge. The term most commonly refers to discharges associated with wastewater treatment plant facilities. These include *municipal* (city and county) and *industrial* wastewater treatment plants as well as small *domestic* discharging treatment systems that may serve schools, commercial offices, residential subdivisions and individual homes. In addition, discharges from *stormwater systems* at industrial sites are now considered point source discharges and are being regulated under new urban stormwater runoff regulations being required by the U.S. Environmental Protection Agency (EPA). The urban stormwater runoff program is discussed in more detail in Chapter 5 and Section 6.8 in Chapter 6. The primary water quality pollutants associated with point source pollution are oxygen-demanding wastes, nutrients, color and toxic substances including chlorine, ammonia and metals. In the Cape Fear River Basin, there are an estimated 181 miles of freshwater streams impaired due to point sources.

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

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

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

3.3.2 Point Source Discharges in the Cape Fear River

In the Cape Fear River Basin, there are 641 permitted NPDES dischargers. Table 3.1 summarizes the number of dischargers and their total permitted and actual 1993 flows for each subbasin and by broad categories of dischargers including majors, minors, domestic, municipal, industrial (process and nonprocess) and stormwater. A distribution map of the discharge facilities is shown in Figures 3.4a, b and c (upper, middle and lower basin).

Of the total 641 dischargers, 54 are major facilities, 228 are domestic, 58 are municipalities and 212 are industries. The total permitted flow for all facilities is 397 million gallons per day (MGD) with the actual measured flows being 524 MGD. The reason that the average actual flow is higher than the permitted flow is because some industrial discharges, such as those for cooling water, stormwater or nonprocess wastewater, do not have a total flow limit specified in their permit although they monitor and report total flow anyway. Meaningful comparisons between permitted and actual flows can be seen in the municipal and domestic wastewater categories where the actual flows are 60% and 47% of their respective permitted flows.

Table 3.5 lists municipal wastewater treatment facilities that accept discharges from industries that must be pretreat their wastes prior to discharging them to the municipal facility. These industries are referred to as significant industrial users or SIUs. The state's pretreatment program is described briefly in Section 5.2.6 in Chapter 5.

3.4 NONPOINT SOURCES OF POLLUTION

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

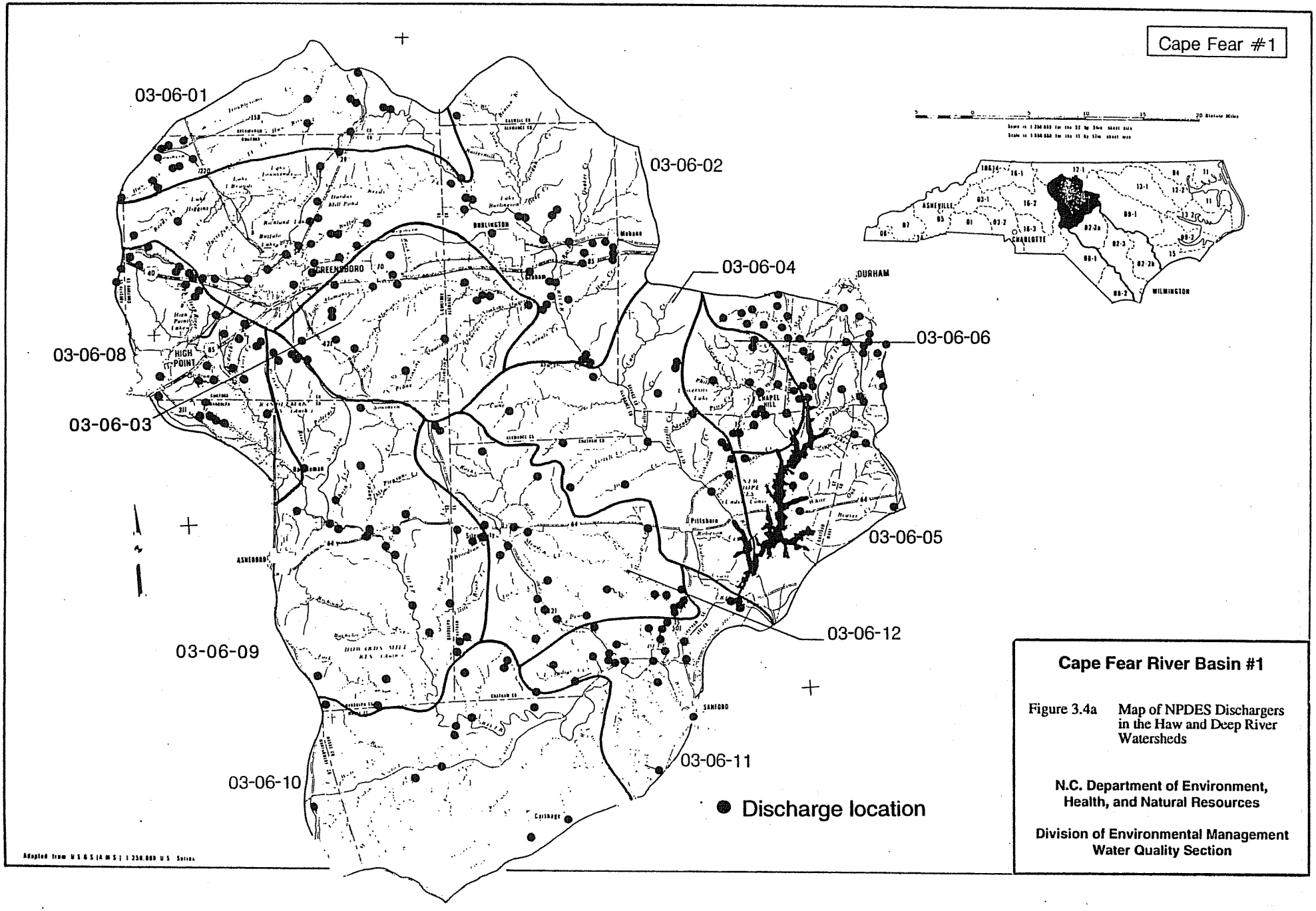
Sediment and nutrients are major pollution-causing substances associated with nonpoint source pollution. Others include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or removed from the atmosphere and carried into surface waters. Unlike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

3.4.1 Agriculture

There are a number of activities associated with agriculture that may impact water quality if not done properly. Land clearing and plowing render soils susceptible to erosion which in turn can cause stream sedimentation. Contour plowing, no-till conservation tillage, terracing and grassed waterways are several common methods used by most farmers to minimize soil loss. Maintaining a vegetated buffer between fields and streams is another excellent means of minimizing soil loss to streams although this practice is not always utilized because it may necessitate taking some land out of production. While sedimentation is the most widespread cause of stream impairment resulting from agricultural activities, it should be noted that statewide agricultural soil loss rates had dropped from 1982 to 1992 based on statistics compiled by the USDA Natural Resources Conservation Service (Section 3.2.4).

Table 3.4 Summary of NPDES Discharger Data in the Cape Fear River Basin by Category and Subbasin (6/1/93 to 6/1/94)

	SUBBASINS																							
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Total Facilities	21	105	23	23	36	19	38	52	36	13	21	22	15	16	23	8	89	13	10	2	4	26	19	7	641
Facs. w/o Stmwtr & Gen Perm.	14	39	11	9	7	8	19	27	19	5	7	4	6	11	6	6	67	3	7	2	3	13	6	6	305
Total Permitted Flow (MGD)	7.76	69.46	0.15	0.84	26.68	23.24	13.22	16.23	8.49	1.76	6.02	4.02	9.03	2.72	37.91	8.21	141.96	0.10	4.33	0.62	1.40	9.85	2.45	0.12	396.57
# of Facilities Reporting	12	34	11	9	6	6	18	25	16	5	7	4	6	9	6	6	52	2	7	2	2	11	6	3	265
Total Avg. Flow (MGD)	3.14	50.88	0.41	0.45	13.28	10.53	282.27	17.56	6.21	0.84	3.91	1.92	5.11	6.39	22.00	18.65	68.42	0.02	3.03	0.58	1.24	5.18	1.32	0.33	523.67
Major Dischargers	2	8	0	0	2	1	5	1	2	1	1	1	3	2	4	3	12	0	1	0	2	2	1	0	54
Total Permitted Flow (MGD)	7.59	67.30	0.00	0.00	26.00	8.00	11.59	16.00	7.75	1.00	5.00	4.00	6.70	1.50	37.89	7.50	36.63	0.00	3.00	0.00	1.40	5.97	1.07	0.00	255.88
# of Facilities Reporting	2	8	0	0	2	1	5	1	2	1	1	1	3	2	4	3	11	0	1	0	2	2	1	0	53
Total Avg. Flow (MGD)	2.96	48.66	0.00	0.00	12.43	6.87	281.17	11.47	5.75	0.57	3.22	1.92	4.79	6.21	21.41	17.87	63.77	0.00	2.10	0.00	1.24	2.70	0.67	0.00	495.79
Minor Dischargers	12	31	11	7	5	7	11	26	16	4	6	3	3	9	2	3	55	3	6	2	1	11	5	6	245
Total Permitted Flow (MGD)	0.17	2.16	0.15	0.84	0.68	15.24	1.63	0.23	0.75	0.76	1.02	0.02	2.33	1.22	0.03	0.71	5.33	0.10	1.33	0.62	0.00	3.88	1.38	0.12	40.69
# of Facilities Reporting	10	26	11	9	4	5	13	24	14	4	6	3	3	7	2	3	41	2	6	2	0	9	5	3	212
Total Avg. Flow (MGD)	0.18	2.22	0.41	0.45	0.85	3.65	1.10	6.09	0.46	0.27	0.69	0.01	0.32	0.18	0.59	0.78	4.65	0.02	0.93	0.53	0.00	2.48	0.65	0.33	27.83
100% Domestic Wastewater	12	31	14	20	27	13	10	14	23	5	11	16	1	6	1	1	17	1	1	1	0	0	3	0	228
Total Permitted Flow (MGD)	0.17	0.62	0.15	0.06	0.68	0.13	0.12	0.23	0.20	0.01	0.01	0.02	0.33	1.13	0.03	0.01	1.82	0.05	0.01	0.02	0.00	0.00	0.23	0.02	6.04
# of Facilities Reporting	9	18	10	5	3	2	5	11	8	2	2	3	1	5	1	1	16	1	1	1	0	0	3	0	108
Total Avg. Flow (MGD)	0.05	0.22	0.09	0.04	0.19	0.07	0.02	0.14	0.07	0.01	0.00	0.01	0.21	0.18	0.00	0.00	0.39	0.01	0.00	0.06	0.00	0.00	0.08	0.00	1.84
Municipal Facilities	1	6	0	2	2	2	4	2	3	3	1	1	2	2	3	1	9	0	6	1	1	4	1	1	58
Total Permitted Flow (MGD)	7.50	66.00	0.00	0.78	26.00	8.00	2.20	16.00	8.23	1.75	5.00	4.00	4.20	1.56	37.00	0.70	28.09	0.00	4.33	0.60	1.00	1.88	0.50	0.10	225.40
# of Facilities Reporting	1	6	0	2	2	1	4	1	3	3	1	1	2	2	3	1	6	0	6	1	1	4	1	1	53
Total Avg. Flow (MGD)	2.88	47.59	0.00	0.35	12.43	6.87	1.41	11.47	5.96	0.83	3.22	1.92	1.48	0.83	20.92	0.52	13.85	0.00	3.03	0.51	0.84	1.02	0.27	0.08	138.29
Major Process Industrial	2	2	0	0	0	0	4	0	0	0	0	0	1	1	1	3	8	0	0	0	1	2	1	0	26
Total Permitted Flow (MGD)	0.09	1.30	0.00	0.00	0.00	0.00	10.39	0.00	0.00	0.00	0.00	0.00	2.50	0.00	0.89	7.50	110.78	0.00	0.00	0.00	0.40	5.97	1.07	0.00	140.88
# of Facilities Reporting	1	2	0	0	0	0	4	0	0	0	0	0	1	1	1	3	8	0	0	0	1	2	1	0	25
Total Avg. Flow (MGD)	0.08	1.08	0.00	0.00	0.00	0.00	280.34	0.00	0.00	0.00	0.00	0.00	1.67	5.39	0.49	17.87	50.28	0.00	0.00	0.00	0.40	2.70	0.67	0.00	360.96
Minor Process Industrial	0	8	1	0	0	2	4	14	2	1	3	0	2	0	0	2	17	2	0	0	0	3	2	1	64
Total Permitted Flow (MGD)	0.00	0.04	0.00	0.00	0.00	0.11	0.51	0.00	0.07	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.91	0.05	0.00	0.00	0.00	2.00	0.65	0.00	5.35
# of Facilities Reporting	0	5	0	0	0	2	4	12	4	0	2	0	0	0	0	1	14	1	0	0	0	4	1	1	51
Total Avg. Flow (MGD)	0.00	1.66	0.00	0.00	0.00	0.07	0.46	5.48	0.11	0.00	0.49	0.00	0.00	0.00	0.00	0.25	0.72	0.01	0.00	0.00	0.00	1.46	0.30	0.25	11.25
Nonprocess Industrial	1	21	2	2	2	1	5	4	3	2	3	3	4	5	6	0	27	3	1	0	1	13	8	5	122
Total Permitted Flow (MGD)	0.00	1.50	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.01	0.00	2.00	0.02	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.90
# of Facilities Reporting	1	3		2	1	1	1	1	1	0	2	0	2	1	1	0	8	0	0	0	0	1	0	1	27
Total Avg. Flow (MGD)	0.13	0.34	0.32	0.06	0.66	3.51	0.04	0.47	0.07	0.00	0.19	0.00	0.11	0.01	0.58	0.00	2.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.22
Stormwater Facilities	5	37	6	1	5	1	11	18	5	2	3	2	5	2	12	1	11	7	2	0	1	4	4	0	145
Total Avg. Flow (MGD)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

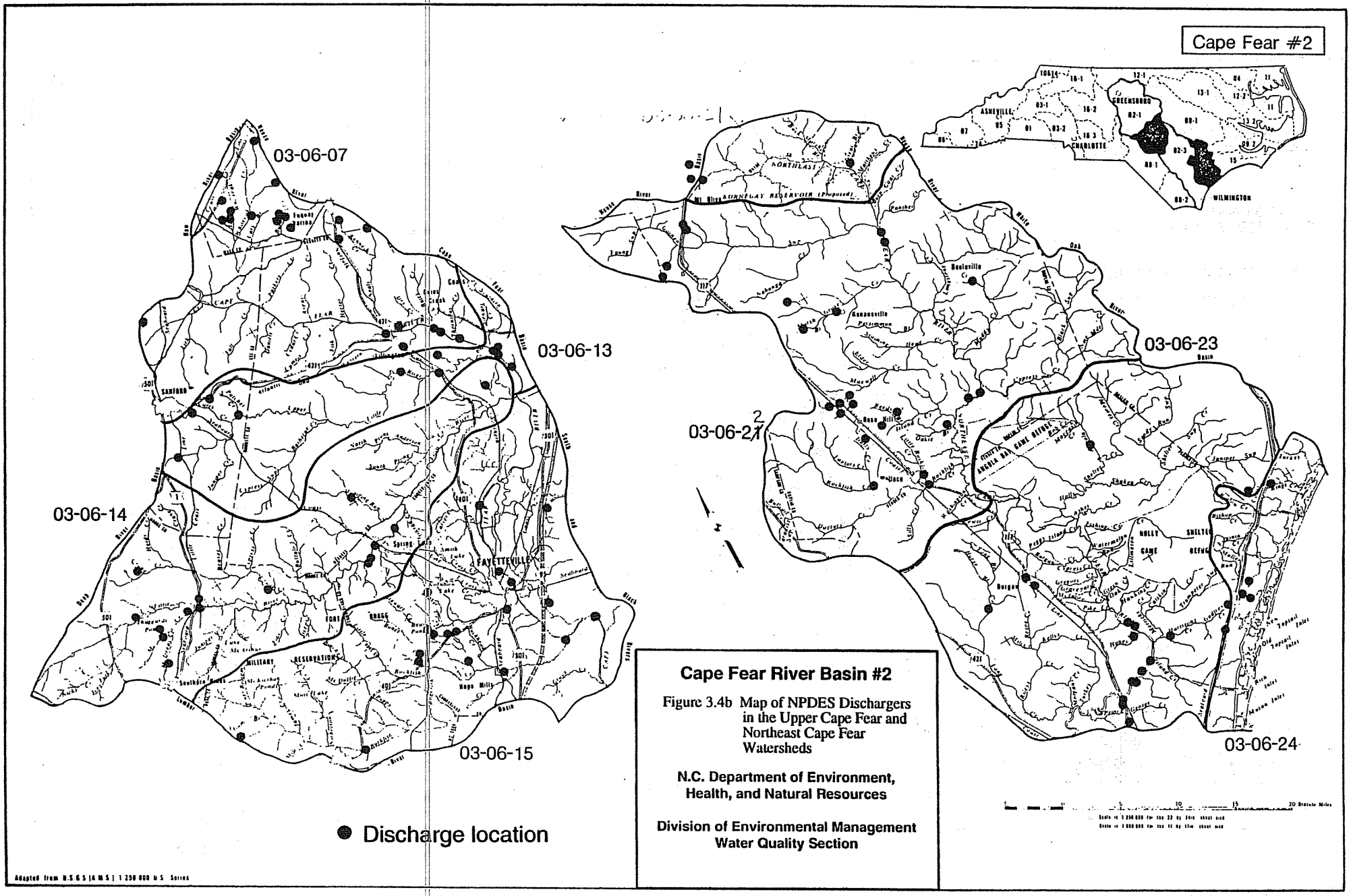


Cape Fear River Basin #1

Figure 3.4a Map of NPDES Dischargers in the Haw and Deep River Watersheds

N.C. Department of Environment, Health, and Natural Resources

Division of Environmental Management Water Quality Section

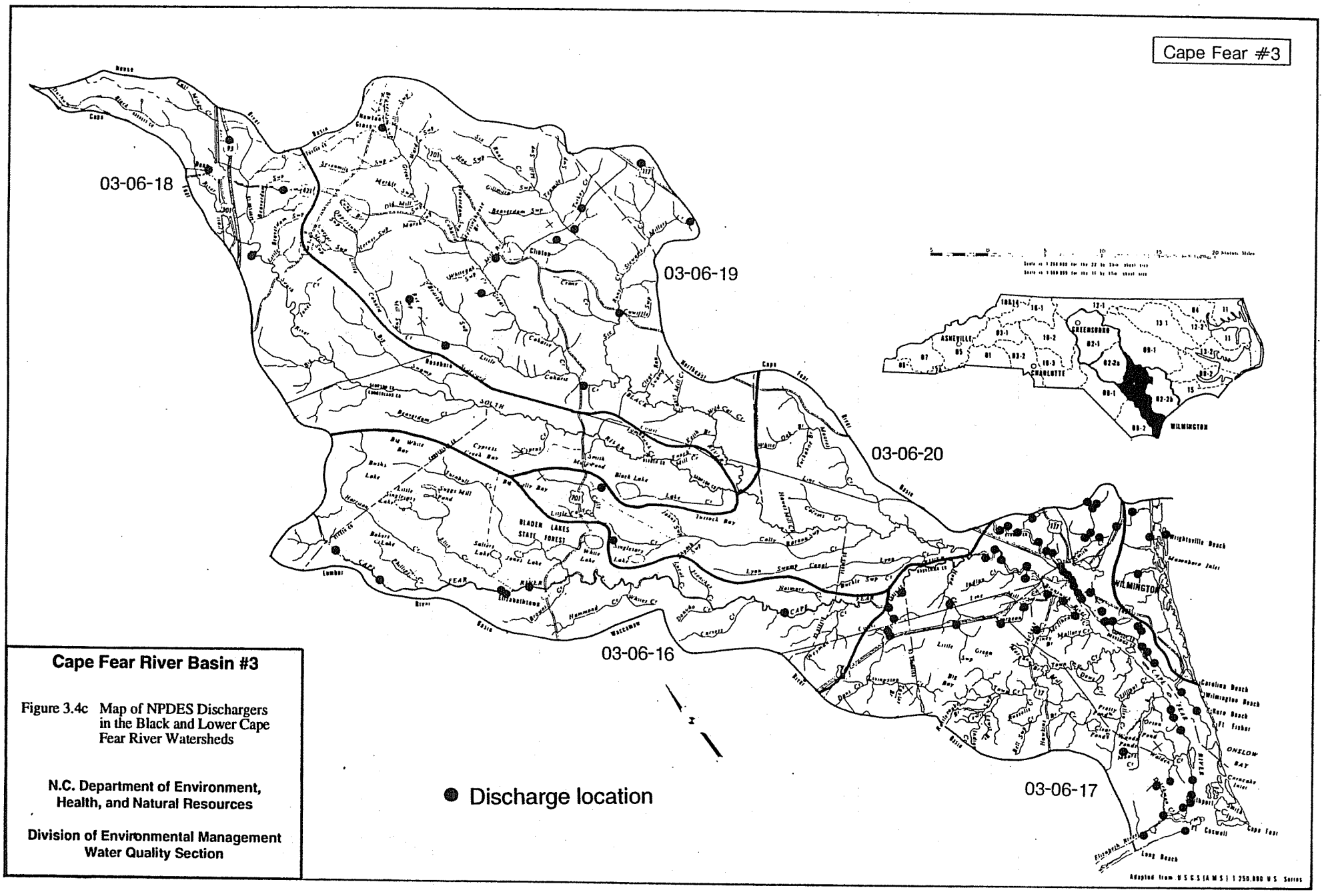


Cape Fear River Basin #2

Figure 3.4b Map of NPDES Dischargers in the Upper Cape Fear and Northeast Cape Fear Watersheds

N.C. Department of Environment, Health, and Natural Resources

Division of Environmental Management Water Quality Section



Cape Fear River Basin #3

Figure 3.4c Map of NPDES Dischargers in the Black and Lower Cape Fear River Watersheds

N.C. Department of Environment, Health, and Natural Resources

Division of Environmental Management Water Quality Section

Table 3.5 NPDES Facilities in the Cape Fear River Basin with Pretreatment Programs

Subbasin	Facility Name	NPDES or ND #	WWTP SIUs	Region
01	Reidsville	NC0024881	10	Winston-Salem
02	Graham	NC0021211	9	Winston-Salem
	Burlington-S	NC0023876	19	Winston-Salem
	Burlington-E	NC0023868	13	Winston-Salem
	Greensboro-N. Buffalo	NC0024325	11	Winston-Salem
	Greensboro-T.Z. Osborne	NC0047384	21	Winston-Salem
	Mebane	NC0021474	10	Winston-Salem
05	Durham-Farrington	NC0047597	6	Raleigh
	Durham County-RTP	NC0026051	23	Raleigh
06	OWASA	NC0025241	0	Raleigh
07	Fuquay-Varina	NC0028118	2	Raleigh
	High Point-W	NC0024228	7	Winston-Salem
	Lillington	NC0021636	1	Fayetteville
	Thomasville	NC0024112	12	Winston-Salem
08	Randleman	NC0025445	5	Winston-Salem
	High Point-Eastside	NC0024210	26	Winston-Salem
09	Ramseur	NC0026565	1	Winston-Salem
	Asheboro	NC0026123	13	Winston-Salem
10	Star	NC0058548	4	Fayetteville
	Robbins	NC0062855	3	Fayetteville
	Candor	ND9900633	1	Fayetteville
11	Sanford	NC0024147	13	Raleigh
12	Siler City	NC0026441	5	Raleigh
15	Fayetteville-Rockfish Cr	NC0050105	6	Fayetteville
	Fayetteville-Cross Creek	NC0023957	13	Fayetteville
16	Elizabethtown	NC0026671	1	Fayetteville
17	Wilmington-Northside	NC0023965	5	Wilmington
19	Clinton	NC0020117	7	Fayetteville
23	Burgaw	NC0021113	1	Wilmington

NPDES or ND# = Facility's discharge permit no.
POTW = Publicly Owned Treatment Work
SIU = Significant Industrial User

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

Animal wastes are of particular interest in the Cape Fear River Basin because of the high swine and poultry populations (See Table 2.6 and Figures 2.6 and 2.7 in Chapter 2). 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 overapplication of wastes to fields, from leaking lagoons and from unpermitted flows of lagoon liquids to surface waters from improper waste lagoon management. At the present time, widespread water quality impacts from animal operations have not been documented, but localized impacts have been found. Also there are potential concerns associated with nitrate-nitrogen movement through the soil from poorly constructed lagoons and from wastes overapplied to the soil surface (i.e., in excess of agronomic rates).

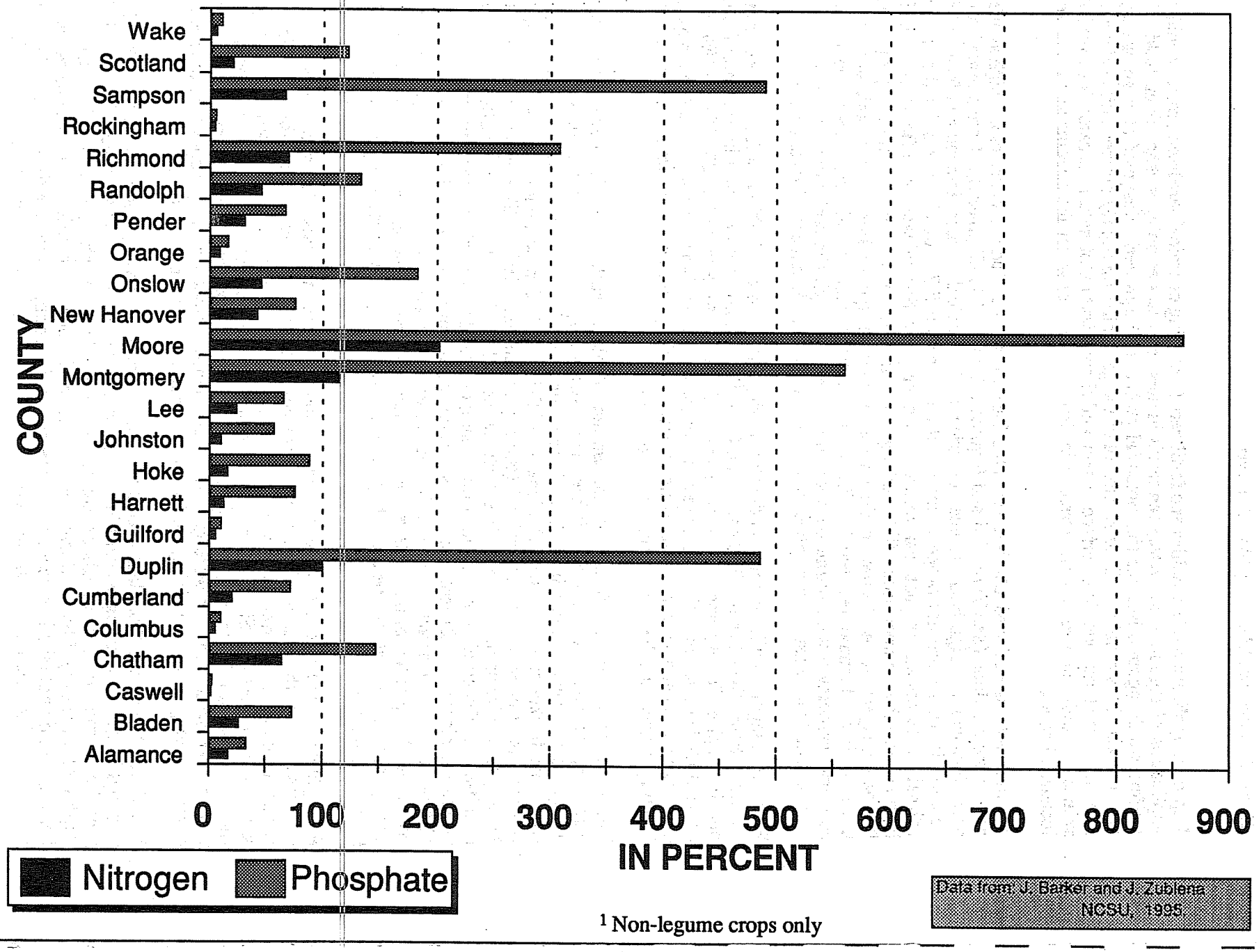
Five major lagoon spills occurred in the state during the summer of 1995 and four of these were in the Cape Fear River basin. Of those in the Cape Fear Basin, two occurred in Sampson County, one in Duplin County and one in Brunswick County. As September 25, 1995, 60% of the concentrated animal operations in those counties located in the Cape Fear basin had been inspected. Of this total, seven operations were found to have a discharge into state waters by man-made ditch, flushing system, or other similar man-made devices.

The bar chart in Figure 3.5 presents the amount of plant available nutrients from manure as a percentage of plant nutrient needs (defined as non-legume agronomic crop and forage nitrogen and phosphorus) for each county in the Cape Fear River basin. These nutrient data were calculated by Dr. James Barker and Dr. Joseph Zublena of NCSU for a draft report entitled "Livestock Manure Nutrient Assessment in North Carolina" (Barker and Zublena, 1995). The report was initiated to: 1) geographically depict where the livestock are located and identify "clustering effects", i.e., high densities of livestock production around support facilities such as feed mills, hatcheries, processing plants, etc.; 2) assess current generation of manure by county; 3) determine the amount of nutrients from manure which can be recovered and made available to agronomic crops; 4) determine the quantity of nutrients required for non-legume agronomic crops and forages in each county; and 5) calculate the percent of agronomic crop and forage nutrients which can be supplied by animal manure.

As explained in the report, plant recoverable manure nutrients are those that remain from the time the animal voids the manure till the time it is transported to the field for spreading. During this period, much of the nutrients can be lost through drying or dilution, surface runoff, volatilization or microbial digestion. Since different manure management systems either conserve or sacrifice varying amounts of nutrients, an estimate was made of the percentage of farms using specific systems. These percentages were applied to the manure characteristics appropriate to the specific method which gave the remaining nutrients after storage and treatment losses.

As indicated in Figure 3.5, plant available nitrogen from manure equals or exceeds 100% of the crop and forage plant nitrogen needs in Duplin, Montgomery and Moore Counties. Plant available phosphorus from manure equals or exceeds 100% of the plant phosphorus needs in Chatham, Duplin, Montgomery, Moore, Onslow, Randolph and Sampson Counties. It should be noted that these figures do not take into account commercial fertilizer applications in the counties. It is clear based on this information, that animal waste management in a number of counties in the basin is

Figure 3.5 Percent of Agronomic Crop and Forage [1]Nitrogen and Phosphorus Needs Supplied by Recoverable Plant Available Manure Nutrients (NCSU 1995)



[1] Non-legume crops only

becoming a critical issue, and that the animal carrying capacity of these lands (from a waste disposal standpoint) needs to be closely examined. Alternatives to cropland application need to be considered in these counties such as application on forest land or transportation/distribution of the collectable manure to counties that have capacity and could use this nutrient source in lieu of commercial fertilizers.

In the Cape Fear River Basin, it is estimated that 462 (or 40%) of the miles of freshwater streams estimated to be impaired from nonpoint sources of pollution are thought to be attributed to agriculture. The highest number of impaired stream miles in any subbasin attributed to agriculture is 73 miles in subbasin 22 (Duplin County portion of the Northeast Cape Fear watershed). Other subbasins with 20 or more stream miles thought to be impaired by agriculture include 31 miles in subbasin 01 (upper Haw River), 44 miles in subbasin 03 (Alamance Creek watershed), 47 miles in subbasin 11 (Deep River watershed in Chatham and Lee Counties), 32 miles in subbasin 16 (Cape Fear river drainage in Bladen County) and 44 miles in subbasin 18 (upper South River watershed). This information is derived from the table in Section 4.5 of Chapter 4 entitled Probable Sources of Use Support Impairment.

While, as noted above, the most widespread cause of freshwater stream impairment associated with agriculture is sedimentation, other potential concerns include nutrients, fecal coliform bacteria and biochemical oxygen demand. Nutrient-related problems, primarily seen as excessive algal or aquatic weed growth, are not always evident in the receiving stream adjoining a farm. Rather, they may be seen in a downstream impoundment, sluggish creek or estuary many miles away. Jordan Reservoir watershed, for example, is classified as nutrient sensitive waters. And there are a number of lakes in the basin that are threatened by nutrient overenrichment. In regard to pesticides, a number of fish tissue samples taken from the basin have shown concentrations of organic chemicals such as chlordane, DDT and dieldrin (Table 4.2 in Chapter 4). Chapter 5 discusses programs aimed at minimizing agricultural nonpoint source pollution. Recommended management strategies for reducing nutrients and sediment runoff are found in Sections 6.4 and 6.6 respectively, in Chapter 6. A list of agricultural BMPs is included in Appendix V.

3.4.2 Urban

Runoff from urbanized areas, as a rule, is more localized but generally more severe than agricultural runoff. The rate and volume of runoff in urban areas is much greater due both to the high concentration of impervious surface areas and to storm drainage systems that rapidly transport stormwater to nearby surface waters. These drainage systems, including curb and guttered roadways, allow urban pollutants to reach surface waters quickly and with little or no filtering by vegetated areas. These affects are further exacerbated by replacement of small streams and riparian vegetation with pipes. Urban pollutants include lawn care products such as pesticides and fertilizers; automobile-related pollutants such as fuel, lubricants, abraded tire and brake linings; lawn and household wastes (often dumped in storm sewers); and fecal coliform bacteria (from animals and failing septic systems). Many urban streams are rated as biologically poor. The population density map in Chapter 2 is a good indicator of where urban development and potential urban stream impacts are likely to occur. As summarized in Table 4.12 in Chapter 4, it is estimated that there are approximately 200 miles of streams in the Cape Fear Basin that are thought to be impaired due to urban runoff. Those subbasins with the greatest number of impaired miles associated with urban runoff include 44 miles in subbasin 02 (Greensboro/Burlington area), 30 miles in subbasin 05 (Durham/Chapel area), 41 miles in subbasin 15 (Fayetteville area) and 19 miles in subbasin 23 (Pender and Onslow county area).

3.4.3 Construction

Construction activities that entail excavation, grading or filling, such as road construction or land clearing for development, can produce large amounts of sediment if not properly controlled. As a

pollution source, construction-related activities are temporary in nature; however, as discussed under the section on sediment, above, the results can be severe and long-lasting.

Those areas where construction-related impacts are most obvious tend to be concentrated in the more rapidly developing areas of the basin. For example, subbasin 17, which includes much of the Brunswick and New Hanover County portion of the basin was estimated to have nearly 50 miles of streams impaired due to construction activities; and subbasin 05, which includes portions of Durham, Orange, Wake and Chatham Counties around Jordan Lake was estimated to have 36 miles impaired by construction. However, localized, but significant impacts are possible in every subbasin if adequate best management practices are not applied. As summarized in Table 4.12 in Chapter 4, it is estimated there are 150 miles of streams impaired due to construction activity in the basin. A list of BMPs to address construction-related water quality impacts is presented in Appendix V.

3.4.4 Forestry

Forestry, a major industry in North Carolina, can impact water quality in a number of ways. Ditching and draining of naturally forested low-lying lands in order to create pine or hardwood plantations can change the hydrology of an area and significantly increase the rate and flow of stormwater runoff. Clearing of trees through timber harvesting and construction of logging roads can produce sedimentation. Removing riparian vegetation along stream banks can cause water temperature to rise substantially, and improperly applied pesticides can result in toxicity problems. Timber harvesting occurs throughout much of the upper basin and is often done at the onset of clearing for site development. As summarized in Table 4.12 in Chapter 4, there were an estimated 23 miles of streams impaired due to forestry activities in subbasins 08, 09 and 17 based on public nonpoint source workshops in the late 1980s. A list of forestry BMPs is presented in Appendix V.

3.4.5 Mining

Mining is a common activity in the Piedmont and Coastal Plain regions and can produce high localized levels of stream sedimentation. Sediment may be washed from mining sites or it may enter streams from the wash water used to rinse some mined products. In addition, abandoned gold mined lands are suspected of being the sources of mercury in stream waters because of its historic use for the amalgamation of gold. The most prevalent type of mining activity in the Cape Fear River basin is for sand and gravel. It is estimated that 34 miles of streams have been impaired by mining activities in subbasins 02, 07, 08 and 11 according to Table 4.12 in Chapter 4. A list of BMPs to address mining is presented in Appendix V.

3.4.6 Onsite Wastewater Disposal

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

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

3.4.7 Solid Waste Disposal

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

3.4.8 Atmospheric Deposition

Recent studies in Europe (Buijisman et al. 987; Loye-Pilot et al. 1990; Fischer and Oppenheimer. 1991) and North American (NAPAP 1990; Paerl 1993; 1995) indicate that the atmosphere serves a quantitatively-important, and rapidly-growing, role in the emission and transport of anthropogenically-generated nitrogen (N) compounds. Sources include agricultural emissions of ammonia/ammonium (NH_3/ NH_4) and organic N from animal wastes and fertilizer applications, and oxides of N (NOx) emitted from fossil fuel combustion. Atmospheric deposition of N is of considerable concern from watershed and larger regional perspectives, because nitrogen is often the nutrient controlling (or limiting) plant primary production (algae and higher plants) in downwind estuarine and coastal waters (Ryther and Dunstan 1971; Nixon 1986). Excessive N loading has been implicated as a chief cause of coastal eutrophication and associated toxic algal blooms, which have increased at an alarming rate in NC waters (Paerl 1993). There is evidence that atmospherically-derived N, either as direst deposition or surface water runoff, represents a significant fraction (25->50%) of anthropogenically-derived "new" N being loaded into these waters (Duce et al. 1991; Fischer and Oppenheimer 1991). Overall, it is the second largest source (behind surface nonpoint N loading) of N impacting estuaries and coastal waters.

Coastal waters in which N is a concern include the Neuse, Tar-Pamlico, White Oak and New Rivers. The Cape Fear River estuary, unlike those of the other river systems, is open to the ocean, has much better tidal exchange and is much less conducive to algal growth than the other systems.

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CHAPTER 4

WATER QUALITY AND USE SUPPORT RATINGS IN THE CAPE FEAR RIVER BASIN

4.1 INTRODUCTION

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

Water Quality Monitoring and Assessment

- **Section 4.2** presents a summary of water quality monitoring programs conducted by the Environmental Sciences Branch of the Division of Water Quality's (DWQ's) Water Quality Section including consideration of information reported by researchers and other agencies within the Cape Fear River Basin. Seven monitoring programs are described. Basinwide data summaries are presented for several of the programs.
- **Section 4.3** presents a narrative summary of water quality findings for each of the six major watershed areas (and 24 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, and tables summarizing benthic macroinvertebrate sampling efforts.

Use-Support Ratings

- **Section 4.4** 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 4.5** presents the use support ratings for many streams and lakes in the Cape Fear basin through a series of tables and figures. Included is a color-coded 3-page use support map of the basin (Figure 4.19).

4.2 WATER QUALITY MONITORING PROGRAMS

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

- Benthic macroinvertebrate monitoring (Section 4.2.1 and Appendix II),
- Fish population and tissue monitoring(Section 4.2.2 and Appendix II),
- Lakes assessment (including phytoplankton monitoring) (Section 4.2.3 and Appendix II),
- Aquatic toxicity monitoring (Section 4.2.4),
- Special chemical/physical water quality investigations (Section 4.2.5),
- Sediment oxygen demand monitoring (Section 4.2.6), and
- Ambient water quality monitoring (covering the period 1988-1992) (Section 4.2.7).

4.2.1 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data has proven to be a reliable water quality indicator, as these organisms are relatively immobile and sensitive to subtle changes in water quality. Since many organisms in a community have life cycles of six months to one year, the effects of short term pollution (such as an oil or chemical spill) will generally not be overcome until the following generation appears. The benthic community also responds to and shows the effects of a wide array of potential pollutant mixtures.

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

In the Cape Fear River Basin, A total of 517 benthic macroinvertebrate samples have been collected from 295 monitoring locations from 1983 through 1993. The majority of these samples exhibited either Good/Fair (24%) or Fair (27%) bioclassifications, while only 8% of these samples noted Excellent bioclassifications. Bioclassifications were not given for 46 benthic macroinvertebrate samples collected from swamp-stream or euryhaline ecosystems within the Cape Fear River basin (this number also includes 4 very small streams). This is because bioclassification criteria have not been established for swamp-stream and euryhaline (brackish) ecosystems.

Ninety-four of the total monitoring locations have had data collected on two or more occasions, allowing for long-term data comparisons. Of these 94 monitoring locations, 58 (62%) had no long-term changes in bioclassification, 26 (28%) showed some improvement, and 10 (10%) noted a decline in bioclassification. Many of the improvements noted in bioclassifications were from monitoring sites in the Deep River watershed.

Locations of and summary information for all the benthic macroinvertebrate collections in the Cape Fear River basin are presented in maps and tables in sections 4.3.1 through 4.3.6. Summary information includes the site location, DWQ classification schedule Index Number, collection date, taxa richness and biotic index values and bioclassifications.

4.2.2 Fisheries Monitoring

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

Fish Community Structure

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

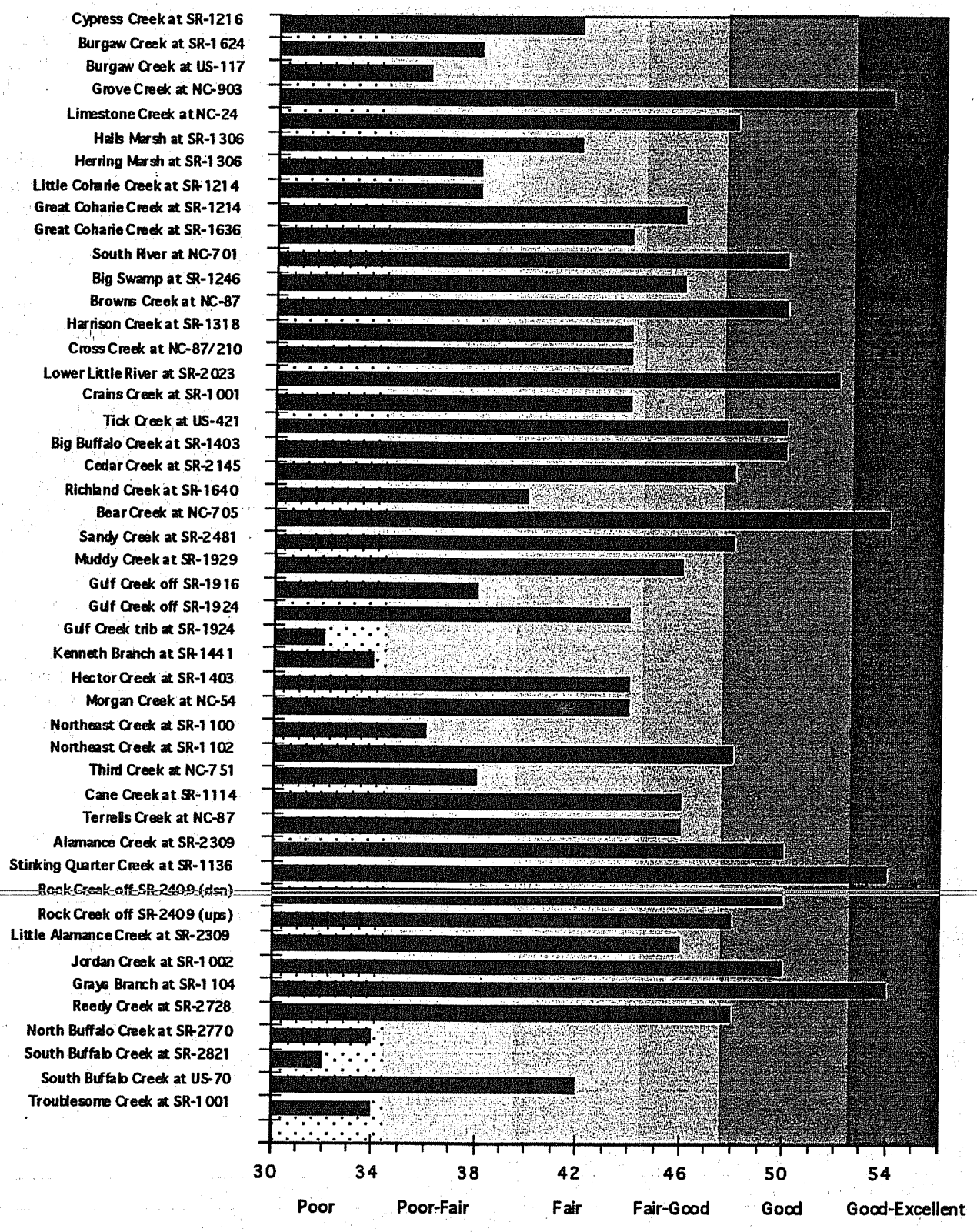
The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more 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 analyses were performed at forty-seven sites in the Cape Fear River Basin. These individual site assessments should not be interpreted as representative samplings of either the entire basin or an entire subbasin. Many of the stations sampled were in areas of known impact. Constraints in both sampling methodology and resources prevent the monitoring of a sufficient number of fish community structure locations to clearly evaluate the ecological health of the entire basin. Therefore evaluations of the fish community structure analysis should be limited to a site specific interpretation. A summary graph of the individual station location results is presented in Figure 4.1. Of the fourty-seven sites sampled, 12 were rated as Poor or Poor-Fair, 17 rated as Fair or Fair-Good, and 18 rated as Good or Good-Excellent. Those sites which were rated as Poor or Poor-Fair and reasons for these ratings are presented in Table 4.1. Grays Branch, Stinking Quarter Creek, Bear Creek, and Grove Creek each received rating in the Good-Excellent category. Some of the sites which were rated Poor or Poor-Fair have already had remedial action taken or planned. The Cherokee Brick Quarry which drains into a tributary of Gulf Creek is currently applying for a stormwater permit, BMP's are being initiated in the Herring Marsh drainage, and the Burgaw WWTP has been upgraded since our sampling date in 1985.

Table 4.1 Cape Fear Basin Fish Community Structure Sites which rated Poor or Poor-Fair

SITE	SUBBASIN	REASONS FOR RATINGS
Troublesome Cr at SR-1001	03-06-01	nutrient enrichment
South Buffalo Cr at SR-2821	03-06-02	below WWTP and urban runoff
North Buffalo Cr at SR-2770	03-06-02	below two WWTP's, urban runoff, and poor habitat
Third Cr at NC-751	03-06-05	urban runoff and low flows
Northeast Cr at SR-1100	03-06-05	below WWTP and urban runoff
Kenneth Branch at SR-1441	03-06-07	nutrient enrichment and sedimentation
Gulf Cr trib at SR-1924	03-06-07	sedimentation, nutrient enrichment and low flow
Gulf Cr off SR-1916	03-06-07	sedimentation
Little Coharie Cr at SR-1214	03-06-19	unclear
Herring Marsh at SR-1306	03-06-22	unclear
Burgaw Cr at US-117	03-06-23	below WWTP and sedimentation
Burgaw Cr at SR-1216	03-06-23	below WWTP and sedimentation

Figure 4.1 Site Specific Summary of Fish Community Structure Evaluations



* Scale ranges from 0-60 (no values were found in the very poor or excellent range).

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. Thus results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water. Fish tissue analysis results are also used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

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

The FDA levels were developed to protect humans from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish tissue consumption. A list of fish tissue parameters accompanied by their FDA criteria are presented in Appendix II. At present, the FDA has only developed metals criteria for mercury (1.0 ppm). Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of the Water Quality Section.

In the Cape Fear Basin, 618 fish tissue samples from 51 locations have been analyzed from 1980 through 1994. EPA screening criteria for organics and metals (mercury) were equalled or exceeded in 52 samples at 16 sites. The FDA limit of 1.0 ppm for mercury was exceeded in ten samples at seven sites. Sampling locations are presented in Table 4.2. The term organics in the table includes the following substances: Dieldrin, DDT, Chlordane, Heptachlor epoxide, Heptachlor, Endrin and Lindane. None of these organic substances was found to exceed its FDA limit.

4.2.3 Lakes Assessment Program (including Phytoplankton)

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

Phytoplankton are microscopic algae found in the water column of lakes, rivers, streams, and estuaries. Phytoplankton populations respond to nutrient availability and other environmental factors such as light, temperature, pH, salinity, water velocity, and grazing by organisms in higher trophic levels. Phytoplankton may be useful as indicators of eutrophication and are often collected with ambient water quality samples from lakes. Prolific growths of phytoplankton, often due to high concentrations of nutrients, sometimes result in "blooms" in which one or more species of algae may discolor the water or form visible mats on top of the water. Blooms may be unsightly and deleterious to water quality, causing fish kills, anoxia, or taste and odor problems. The Algal Bloom Program was initiated in 1984 to document suspected algal blooms with species identification, quantitative biovolume, and density estimates. Usually, an algal sample with a

Table 4.2 Fish Tissue Sampling Sites and Partial Data Summary in the Cape Fear River Basin

LOCATION	SUB-BASIN	YEAR	TOTAL SAMPLES	> EPA SCREENING CRITERIA (*Organics or Metals)	> FDA LIMIT
Reedy Fork at NC-87 at Ossipee	02	85	15		
Lake Burlington	"	82	7		
Haw River at US 70, Haw River	"	85	8		
Haw River at Saxapahaw	"	80-89	47	5 organics, 2 mercury	
Alamance Creek at SR2116	"	85	4		
Cane Creek at SR 1100	04	84	9		
Haw River at Bynum	"	85-86	17	1 organics, 1 mercury	1 mercury
Jordan Reservoir above Stinking Creek	"	82-90	35		
Third Fork Creek Near Blands	05	85	8		
Northeast Creek at SR 1100	"	85	11		
Jordan Reservoir at mouth of New Hope Cr	"	82-83	20	1 - mercury	1 mercury
Jordan Reservoir at Farrington Point	"	82 & 90	16	1 - mercury	1 mercury
New Hope River Tributary at SR 1716	"	86	4		
Jordan Reservoir near mouth of Beaver Cr	"	82-83	21		
Jordan Reservoir at Folkner Creek	"	83	12	1 - mercury	1 mercury
Morgan Creek at SR 1726	06	85	12		
Jordan Reservoir at mouth of Morgan Cr	"	82-83	24		
Cape Fear River at Moncure	07	87	5	1 = mercury screeing level	
Cape Fear River at Lillington	"	80,87,90	9	2 organics	
Deep River at US 85	08	89	4		
Copper Branch	"	89	2		
Reddicks Creek at SR 1113	"	89	5		
Deep River at SR 1113	"	89	2		
Muddy Creek near Glenola	"	94	4		
Deep River at Randleman	"	85	10		
Deep River at Worthville	09	83-84	25		
Deep River at Main St in Ramseur	"	87	4		
Cabin Creek at SR 1275	10	88	10		
Bear Creek at NC 705	"	88	10		
Suck Creek Trib near Zion Grove	"	87	2		
Flat Creek near Iverness	14	84	3		
Reese Creek at SR 1728	15	88	2	1 organics	
Cape Fear River at Fayetteville	"	87	5		
Upchurch Pond	"	93	17	2 mercury	
Cape Fear River Near Tar Heel	16	92	4		
Cape Fear River at Elizabethtown	"	84-94	51	2 organics, 7 mercury (PCB > EPA limit)	2 mercury
Cape Fear River at Elwells Ferry	"	90-91	10		
~~Cape Fear River at Lock & Dam #1~~	"	~~80-92~~	~~7~~	~~1 organics (PCB)~~	
Northeast Cape Fear nr Castle Hayne	17	80-81	5		
Sutton Lake	"	88	15		
Sturgeon Creek at SR 1427	"	86	6		
Cape Fear River at Wilmington	"	85-90	13		
Boilings Springs Lake	"	93	11	5 mercury	2 mercury
Snows Cut near Wilmington	"	84	7		
South R nr SR 1503 nr Parkersburg	18	84-87	22	2 mercury	
Black River off SR 1133	20	86	5	2 mercury	2 mercury
Limestone Creek at NC 24	22	87	2		
Northeast Cape Fear River at NC 24	"	87-94	35		
Northeast Cape Fear River at US 117	23	92	25	10 mercury	
ICW at Spicers Bay nr Stump Sound	24	84	11		

* Organics include Dieldrin, Chlordane, Endrin, Lindane, DDT, PCB, Heptachlor and Heptachlor epoxide

biovolume larger than 5000 mm^3/m^3, density greater than 10,000 units/ml, or chlorophyll *a* concentration approaching or exceeding 40 µg/l (the North Carolina state standard) constitutes a bloom. Bloom samples may be collected as a result of complaint investigations, fish kills, or during routine monitoring if a bloom is suspected. There were thirty-six lakes in the Cape Fear River Basin sampled as part of the Lakes Assessment Program.

Each lake is individually discussed in the appropriate subbasin section with a focus on the most recent available data. Figure 4.2 shows the most recent NCTSI scores for the 36 lakes of the Cape Fear River basin. NCTSI scores are described in Appendix II. All of the lakes, with the exception of Hope Mills Lake, were sampled most recently in 1993. Thirty-four of the thirty-six lakes were fully supporting their designated uses. Sixteen of those lakes are listed as Threatened which identifies some cause for concern if precautions are not taken. One lake is designated as Not Supporting (Greenfield Lake) and one as partially supporting (Bay Tree Lake). The threatened and impaired lakes are presented Table 4.3.

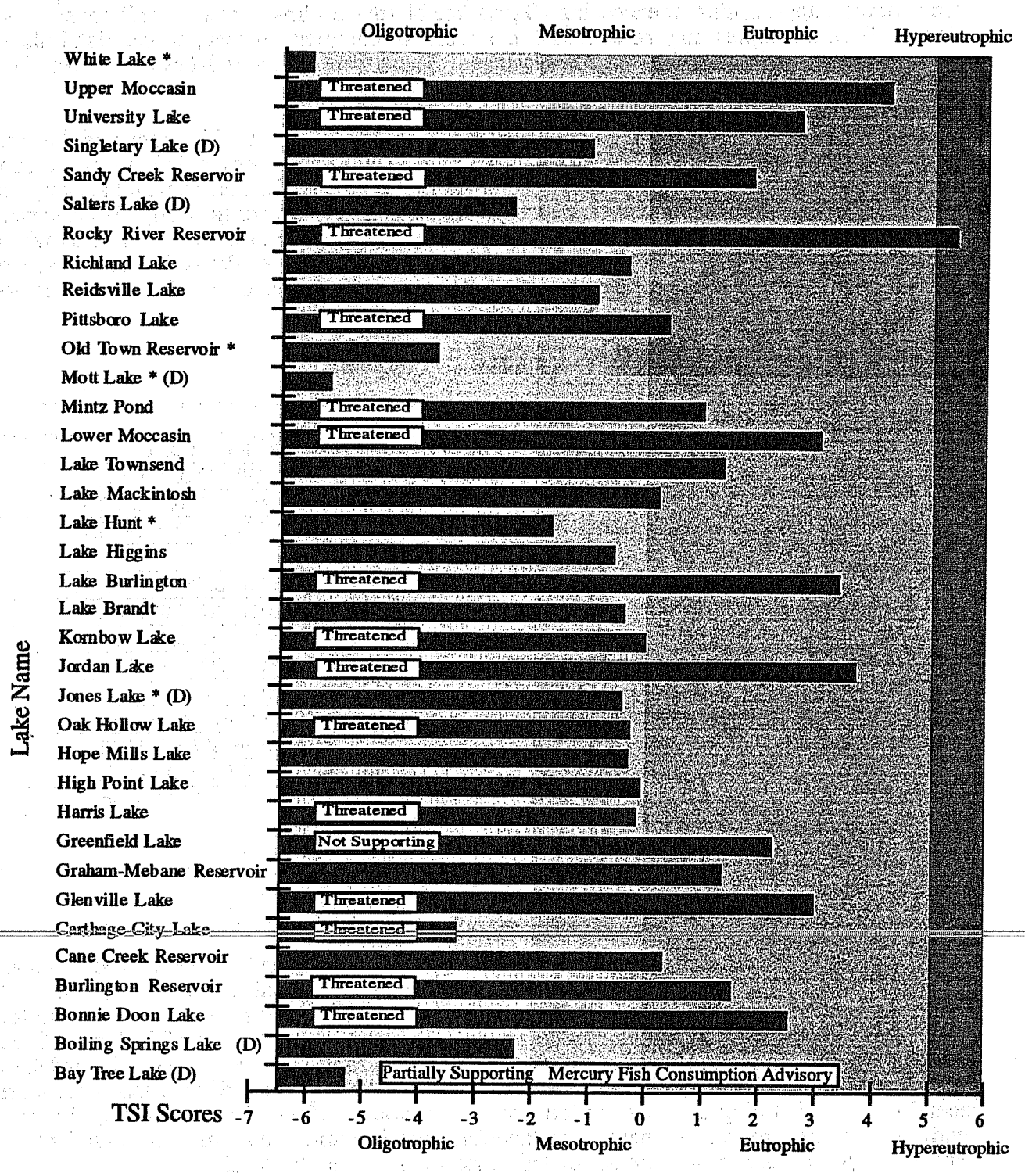
Table 4.3 Threatened and Impaired Lakes in the Cape Fear River Basin

LAKE	STATUS	CAUSES
Pittsboro Lake	Support-threatened	Algal blooms, Aquatic weeds,Elevated D.O.
Jordan Reservoir	Support-threatened	Elevated nutrients (TP 0.07MG/L,TN 0.58MG/L)
Upper Moccasin Lake	Support-threatened	Elevated nutrients (TP 0.12 MG/L,TN 0.92 MG/L)
Sandy Creek Res.	Support-threatened	Elevated nutrients (TP 0.07 MG/L,TN 0.77 MG/L)
Carthage City Lake	Support-threatened	Aquatic Weeds
Rocky River Res.	Support-threatened	Elevated nutrients (TP 0.095 MG/L,TN 1.01 MG/L)
Bonnie Doone Lake	Support-threatened	Elevated nutrients (TP 0.12 MG/L,TN 1.07 MG/L)
Mintz Pond	Support-threatened	Elevated nutrients (TP 0.08 MG/L,TN 0.58 MG/L)
Glenville Lake	Support-threatened	Elevated nutrients (TP 0.07 MG/L,TN 0.67 MG/L)
Greenfield Lake	Not Supporting	Algal blooms, Fish kills, Aquatic Weeds
University Lake	Support-threatened	Elevated nutrients (TP 0.065 MG/L,TN 0.66 MG/L)
Lower Moccasin Lake	Support-threatened	Elevated nutrients (TP 0.06 MG/L,TN 0.61 MG/L)
Lake Burlington	Support-threatened	Elevated nutrients (TP 0.065 MG/L,TN 0.56 MG/L)
Kornbow Lake	Support-threatened	Elevated nutrients (TP 0.05 MG/L,TN 0.78 MG/L)
Oak Hollow Lake	Support-threatened	Algal blooms
Harris Lake	Support-threatened	Elevated nutrients (TN 0.61 MG/L)
Burlington Lake	Support-threatened	Elevated nutrients (TN 1.51 MG/L)
Bay Tree Lake	Partially Supporting	Mercury fish consumption advisory

Precipitation during the 1993 growing season (i.e., May through September) was very low. Mean rainfall for the Cape Fear section of the state (northern piedmont, central piedmont, central coastal plain, and southern coastal plain) was 3.33 inches. This was the lowest mean rainfall amount for the time period covering the growing seasons of 1990 through 1993. Mean rainfalls for the Cape Fear River region during the growing seasons of 1990, 1991, and 1992 were 4.03, 4.65, and 4.76 inches, respectively (NOAA, 1993). Many of the lakes in the Cape Fear River Basin were most recently sampled during the low rainfall growing period of 1993. Improving trophic state conditions observed in some of these lakes, therefore, may be indicative of this low rainfall which reduced nonpoint source runoff and associated nutrient loading into the lakes.

Seven lakes have been sampled for the potential of supporting algal growth with the Algal Growth Potential Test (AGPT) in the Cape Fear River Basin. These are Jordan Reservoir, Harris Lake, White Lake, Lake Hunt, Mott Lake, Old Town Reservoir and Jones Lake. The results of the Algal Growth Potential Test are mentioned in each of the appropriate subbasin discussions. The

Figure 4.2 Lake Assessment Data for Cape Fear Basin: Trophic Status Index (TSI) Scores



Notes: All lakes sampled in 1993. Exception: Hope Mills Lake (1988). See Appendix II for explanationof trophic status and TSI calculations.

* Reference Lake

(D) Dystrophic Lake

objective of the Algal Growth Potential Test is to assess a waterbody's potential for supporting algal biomass and to determine whether algal growth is limited by nitrogen, by phosphorus, or co-limited by both nutrients. When a waterbody supports algal growth at bloom levels without additional increases in nitrogen and/or phosphorus, the system may be subject to frequent nuisance algal blooms. The test exposes a standard alga, Selenastrum capricornutum, to the test water (this constitutes the control). Additional test samples are enriched with nitrogen or phosphorus. When one of these nutrients is added to a water sample which is growth limiting to that nutrient, the resulting mean standing crop (MSC) will generally reflect the level of added nutrient. In some cases, the bioavailable nitrogen and phosphorus in a sample may approach their optimum ratio for growth of the test alga and the addition of nutrients may not clearly identify the limiting nutrient. A waterbody may be protected from nuisance algal blooms if an AGPT value is consistently less than or equal to 5 mg/l.

4.2.4 Aquatic Toxicity Monitoring

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Results of these tests have been shown by several researchers to be predictive of discharge effects on receiving stream populations. In the Cape Fear River basin their are 119 facilities that are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Other facilities may be tested by DWQ's Aquatic Toxicology Laboratory. 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.

4.2.5 Chemical/Physical Characterizations

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

4.2.6 Sediment Oxygen Demand

If oxygen depletion is suspected due to the characteristics of benthic sediments then sediment oxygen demand (SOD) studies may be performed. Each stream reach is divided into a series of model segments. The number of stream segments that must be evaluated with an intensive survey depends on the individual study and the spatial resolution desired. Intensive surveys and SOD evaluations are reported as a series of field data tables and summaries of laboratory analysis reports. For the purposes of this report, intensive surveys and SOD studies that have been performed within each subbasin will be listed in table format accompanied by a brief summary of surveys that have been performed within the last five years. Raw data from these studies are available on request.

There have been thirty-five Sediment Oxygen Demand (SOD) studies conducted in the Cape Fear River Basin between August 1988 and June 1994. Twelve of those studies were conducted at a

control site in the headwaters of Jordan Reservoir in Chatham County and were designed to confirm reproducibility of SOD test data and the ability to correct SOD rates for a range of ambient temperatures. Average SOD rates for the first 8 SOD tests (September 1989 to June 1991) were relatively consistent over a range of ambient temperatures. Morgan Creek SOD tests conducted after March 1992, however, resulted in a noticeably higher trend in SOD rates indicating physical changes occurring at the site and probable water quality changes occurring in the upstream drainage area. (See: Morgan Creek/Chatham County 03-06-06)

A general observation in average SOD rates for the Cape Fear Basin is an apparent trend of higher values measured in the upper to mid reaches of the basin and progressively decreasing rates at stations downstream in the basin. This may be due to the concentration of inputs from urbanized areas in the upper reaches and changes in hydrology and increased dilution in the lower reaches of the Cape Fear system. An exception to this observation is the SOD test conducted in the Tangle Oaks marina which resulted in a very high average rate. The marina site, although located in the Cape Fear Basin, may reflect rates resulting from a isolated concentration of organic inputs associated with activities occurring in and around the marina site.

4.2.7 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine (saltwater) water quality monitoring stations (about 380 statewide) strategically located for the collection of physical and chemical water quality data. The type of water quality data, or parameters, that are collected is determined by the waterbody's freshwater or saltwater classification and corresponding water quality standards. Table 4.4 summarizes the types of water quality data collection conducted at ambient stations. AMS data for the Cape Fear Basin are summarized Section 4.3.

Table 4.4 Ambient Monitoring System Parameters

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

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

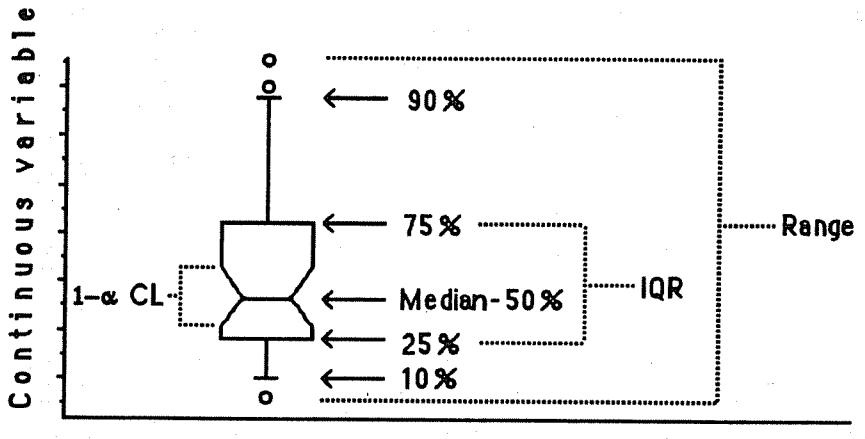
WATER SUPPLY
- chlorides,
- total coliforms,
- manganese,
- total dissolved solids

SA WATERS: Fecal coliforms (tube method where appropriate)

Ambient water quality data are often summarized using box and whisker plots (for examples see Figures 4.17 and 4.18). Figure 4.3 provides an explanation of how to interpret the plots.

Figure 4.3 Box and Whisker Plots

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



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

AMS stations for the basin are listed in Table 4.5 below. North Carolina has 69 stations within the Cape Fear River Basin. For the purpose of this summary, the basin has been divided into six major watershed areas (Haw River, Deep River, Upper Cape Fear, Black River, Northeast Cape Fear and lower Cape Fear and coastal areas. All ambient monitoring sites are shown in the figures accompanying the water quality summaries in Section 4.3.1 through 4.3.6 for each of the major watershed areas. A schematic map of the basin showing ambient monitoring stations on the mainstems of the Haw, Deep, Cape Fear and Northeast Cape Fear Rivers is presented in Figure 4.4.

Table 4.5 Ambient Monitoring System Stations Within the Cape Fear Basin.

	STORET No	Primary No	Station Name	County	Subbasin
Haw River Mainstem					
	B0040000	02093250	Haw River At SR 2109 Near Oak Ridge, NC	Guilford	030601
	B0050000	0209331280	Haw River At US 29a Near Benaja, NC	Rockingham	030601
	B0210000	02093599	Haw River At SR 1561 Near Altamahaw, NC	Alamance	030601
	B1140000	02096500	Haw River At Haw River, NC	Alamance	030602
	B2000000	02096879	Haw River At SR 1005 Near Saxapahaw, NC	Alamance	030602
	B2100000	02096960	Haw River At US Hwy 15-501 Near Bynum, NC	Chatham	030604
	B4050000	02098198	Haw River Below B. Everette Jordan Dam Nr Moncure, NC	Chatham	030604
Haw River Tributaries					
	B0160000	02093423	Little Troublesome Creek At SR 2600 Near Reidsville, NC	Rockingham	030601
	B0540000	02095500	North Buffalo Creek At SR 2832 Near Greensboro, NC	Guilford	030602
	B0750000	02095091	South Buffalo Creek At SR 2821 At Mcleansville, NC	Guilford	030602
	B0840000	02095681	Reedy Fork At NC Hwy 87 At Ossipee, NC	Alamance	030602
	B1090000	0209622751	Jordan Creek At SR 1002 Near Union Ridge, NC	Alamance	030602
	B1260000	0209651840	Town Branch At SR 2109 Near Graham, NC	Alamance	030602
	B1960000	02096813	Alamance Creek At SR 2116 At Swepsonville, NC	Alamance	030602
	B1670000	0209666850	Little Alamance Creek At NC Hwy 61 Near Whitsett, NC	Guilford	030603
	B2450000	02097189	Robeson Creek At SR 1939 Near Seaforth, NC	Chatham	030604
	B3040000	02097314	New Hope Creek At SR 1107 Near Blands, NC	Durham	030605
	B3660000	0209741955	Northeast Creek At SR 1100 Near Nelson, NC	Durham	030605
	B3900000	02097521	Morgan Creek At SR 1726 Near Farrington, NC	Chatham	030606
Deep River Mainstem					
	B4240000	02099000	East Fork Deep River At SR 1541 Near High Point NC	Guilford	030608
	B4615000	02099500	Deep River At SR 1921 Near Randleman, NC	Randolph	030608
	B4800000	02100219	Deep River At SR 2128 At Worthville, NC	Randolph	030609
	B5070000	02100500	Deep River At Main St At Ramseur, NC	Randolph	030609
	B5190000	02100747	Deep River At SR 1456 Near High Falls, NC	Moore	030609
	B5520000	0210102530	Deep River At NC Hwy 22 At High Falls, NC	Moore	030610
	B5575000	02101402	Deep River At NC Hwy 42 At Carbonton, NC	Chatham	030611
	B5820000	02101577	Deep River At US Hwys 15-501 Near Sanford, NC	Lee	030611
	B6050000	02102049	Deep River At CSX Railroad Bridge At Moncure, NC	Chatham	030611
Deep River Tributaries					
	B4410000	02099484	Richland Creek @ SR 1145 Nr High Point, NC	Guilford	030608
	B4890000	0210029550	Hasketts Creek At SR 2128 Near Central Falls, NC	Randolph	030609
	B5480000	02101001	Bear Creek At NC Hwy 705 At Robbins, NC	Moore	030610
	B6010000	02101946	Rocky River At US Hwys 15-501 Near Center Grove, NC	Chatham	030612
Cape Fear Mainstem					
	B6160000	02102178	Cape Fear River At NC Hwy 42 Near Corinth, NC	Chatham	030607
	B6370000	02102500	Cape Fear River At US Hwy 401 At Lillington, NC	Harnett	030607
	B6840000	02102696	Cape Fear River At NC Hwy 217 Near Erwin, NC	Harnett	030613
	B7600000	02104000	Cape Fear River At NC Hwy 24 At Fayetteville, NC	Cumberland	030615
	B8300000	02105500	Cape Fear River @ William O. Huske Lock Nr Tar Heel, NC	Bladen	030616
	B8305000	02105512	Cape Fear River At SR 1316 Near Tarheel, NC	Bladen	030616
	B8340000	02105544	Cape Fear River At Lock And Dam #2 Near Elizabethtown, NC	Bladen	030616
	B8350000	02105769	Cape Fear River At Lock #1 Near Kelly, NC	Bladen	030616
	B8360000	02105771	Cape Fear River At NC Hwy 11 Near Kelly, NC	Bladen	030616
	B8450000	02105825	Cape Fear River Above Neils Eddy Landing Near Acme, NC	Columbus	030617
	B9020000	02107570	Cape Fear River Below Hale Point Landing Nr Phoenix, NC	Brunswick	030617
	B9050000	02107576	Cape Fear River At Navassa NC	Brunswick	030617
	B9800000	02108736	Cape Fear River @ Channel Marker #55 @ Wilmington, NC	New Hanover	030617
	B9820000	02108757	Cape Fear River @ Channel Marker #50 Near Wilmington NC	New Hanover	030617
Cape Fear Tributaries					
	B6830000	02102634	Upper Little River At SR 2021 Near Erwin, NC	Harnett	030613
	B7280000	02103000	Little River[Lower] At NC Hwys 87&24 At Manchaster, NC	Cumberland	030614
	B7245000	02102897	Lower Little River At SR 2023 Near Lobelia, NC	Moore	030614
	B7700000	0210426450	Rockfish Creek At SR 1432 Near Raeford, NC	Hoke	030615
	B8220000	02104500	Rockfish Creek At US Hwy 301 Near Hope Mills, NC	Cumberland	030615
	B8445000	02105814	Livingston Creek At Mouth Near Riegelwood, NC	Columbus	030617
Black River Mainstem					
	B8750000	02106500	Black River At NC Hwy 411 Near Tomahawk, NC	Sampson	030619
	B9013000	0210756250	Black River Ds Raccoon Island Near Huggins, NC	Pender	030620
Black River Tributaries					
	B8919000	02107000	South River At SR 1503 Near Parkersburg, NC	Bladen	030618
	B8540000	02106000	Little Coharie Creek At NC Hwy 24 Near Roseboro, NC	Sampson	030619
	B8725000	0210643010	Six Runs At SR 1960 Near Taylors Bridge, NC	Sampson	030619
Northeast Cape Fear River Mainstem					
	B9080000	02107586	Northeast Cape Fear River At SR 1937 Near Mt Olive, NC	Wayne	030621
	B9290000	02108000	Northeast Cape Fear River @ NC Hwy 41 Nr Chinquapin, NC	Duplin	030622
	B9580000	02108619	Northeast Cape Fear River @ US Hwy117 @ Castle Hayne NC	New Hanover	030623
	B9740000	0210869230	Northeast Cape Fear River @ US Hwy 421 @ Wilmington, NC	New Hanover	030617
Northeast Cape Fear River Tributary					
	B9470000	02108563	Rockfish Creek At I-40 Near Wallace, NC	Duplin	030622
Coastal Area					
	B9879000	CPF213M4	Carolina Beach Harbor Near Icw & Below Snow's Cut	New Hanover	030624
	B9874000	0209321820	ICW At US Hwys 74 & 76 At Wrightsville Beach, NC	New Hanover	030624
	B9860000	0209320420	Intra-Coastal Waterway At NC Hwy 210 At Goose Bay, NC	Onslow	030624
	B9876000	0209323270	Intra-Coastal Waterway Near Everett Creek	New Hanover	030624
	B9872500	CPF213K4	Intra-Coastal Waterway Near Howe Point	New Hanover	030624
	B9872000	CPF213K	Intra-Coastal Waterway Near Long Point	Pender	030624
	B9865000	CPF213F	Intra-Coastal Waterway Near Morris Landing	Onslow	030624

Note: Locations of all of these stations are shown on the major river watershed maps in Section 4.3. Locations of stations on the mainstems of the Cape Fear, Northeast Cape Fear, Deep and Haw Rivers are shown on the schematic map in Figure 4.4

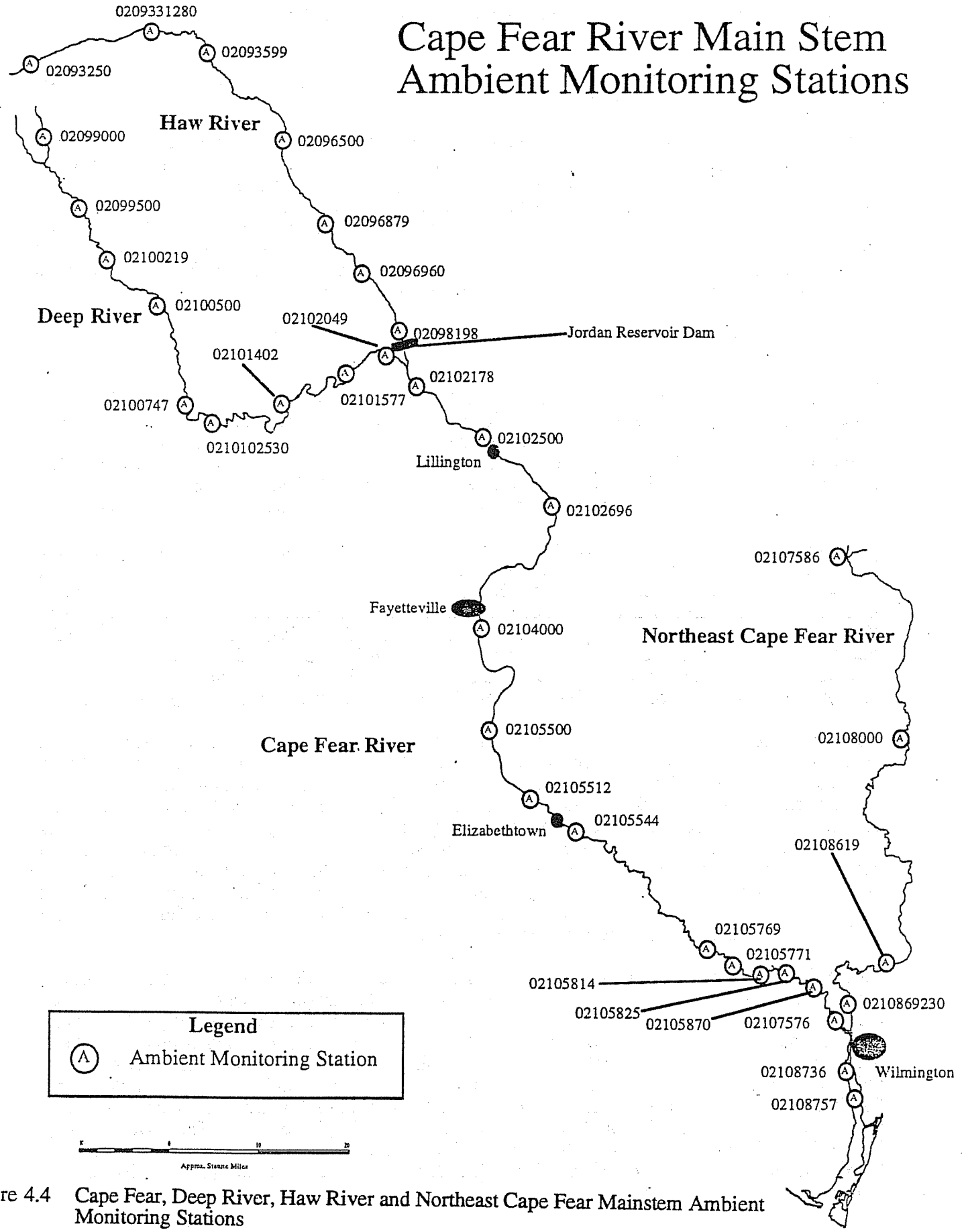


Figure 4.4 Cape Fear, Deep River, Haw River and Northeast Cape Fear Mainstem Ambient Monitoring Stations

4.3 NARRATIVE WATER QUALITY SUMMARIES BY MAJOR WATERSHED AREAS AND SUBBASINS

Water quality is summarized below for each of the six major watersheds in the Cape Fear River Basin. Each watershed is composed of 3 to 6 subbasins. The summaries are based on monitoring data collected by DWQ. Locations of the monitoring sites are presented in the accompanying watershed maps. There are 2 maps for each watershed area. The first of each set shows the benthic macroinvertebrate sites. The second shows ambient monitoring, lakes, fish community and fish tissue sampling sites. Table 1 in Appendix II contains more detailed information for all of the benthic monitoring sites in the basin. Data upon which these summaries are based are compiled in the draft basinwide assessment document for the Cape Fear River Basin (NC DEHNR, 1993).

4.3.1 Haw River/Jordan Reservoir Watershed (Subbasins 01 through 06)

Haw River Drainage

The Haw River originates in the Piedmont near Oak Ridge in Guilford County and drains 1,526 square miles. The river falls from about 1,000 feet above sea level to an elevation of 158 feet at its confluence with the Deep River. The upper two-thirds has an average fall of 6.5 feet per mile. The fall in this lower third varies considerably from 18 feet to 0.5 feet per mile. The watershed topography is generally rolling hills. The textile industry has historically been a principal industry in the area, but the industrial base has expanded, and agriculture is also important in the watershed.

The most upstream tributaries of the Haw River are Troublesome and Little Troublesome Creeks. The combination of agricultural land use and highly erodable soils produces widespread nonpoint source problems in both the upper Haw River and Troublesome Creek watersheds. Benthic macroinvertebrate surveys in 1993 produced Fair and Good-Fair bioclassifications at two upstream Haw River sites. Some recent improvement in the invertebrate bioclassification was observed for the Haw River near Altamahaw in 1993, improving from Fair or Good-Fair (1985-1990) to Good in 1993. Troublesome Creek received a Good-Fair bioclassification, although a single fish survey in Troublesome Creek produced a Poor ecological health rating (discussed in next paragraph).

Benthic macroinvertebrate surveys have assigned a Fair rating to Little Troublesome Creek just below the Reidsville WWTP discharge in 1987 and 1992, with a Poor rating further downstream in 1993. Troublesome Creek received a Poor ecological health rating based on a fish community assessment in 1993. This site had no sucker species and only limited numbers of darter, sunfish, and intolerant species thus indicating habitat degradation. Trophic composition was out of proportion with an increase in the percentage of omnivores, indicating nutrient enrichment. Urban runoff has also contributed to this problem, with a Fair rating in 1992 for Little Troublesome Creek above the discharge. Water chemistry from the ambient site on Little Troublesome Creek consistently had high copper concentrations. Lake Hunt and Reidsville Lake fully support all designated uses and usually have been evaluated as mesotrophic.

As the Haw River continues downstream, it is joined by Reedy Fork and its two major tributaries, North and South Buffalo Creeks. There are several major dischargers in the Greensboro area, but the largest of these are the Greensboro T.Z. Osborne South Buffalo Creek WWTP (20 MGD) and the Greensboro North Buffalo Creek WWTP (16 MGD). The Greensboro wastewater plants have been monitored by water chemistry samples at ambient sites, self-monitoring toxicity data, and collections of both benthic macroinvertebrates and fish. Water chemistry from both North and South Buffalo Creeks is characterized by high conductivities, high nutrient concentrations, and high total residue. Both fish and macroinvertebrate sampling have shown Poor water quality below these discharges. Upstream biological collections have also shown Poor water quality in North Buffalo Creek (urban runoff and Cone Mills discharge), but Fair water quality in South

(continued at bottom of page 4 - 19)

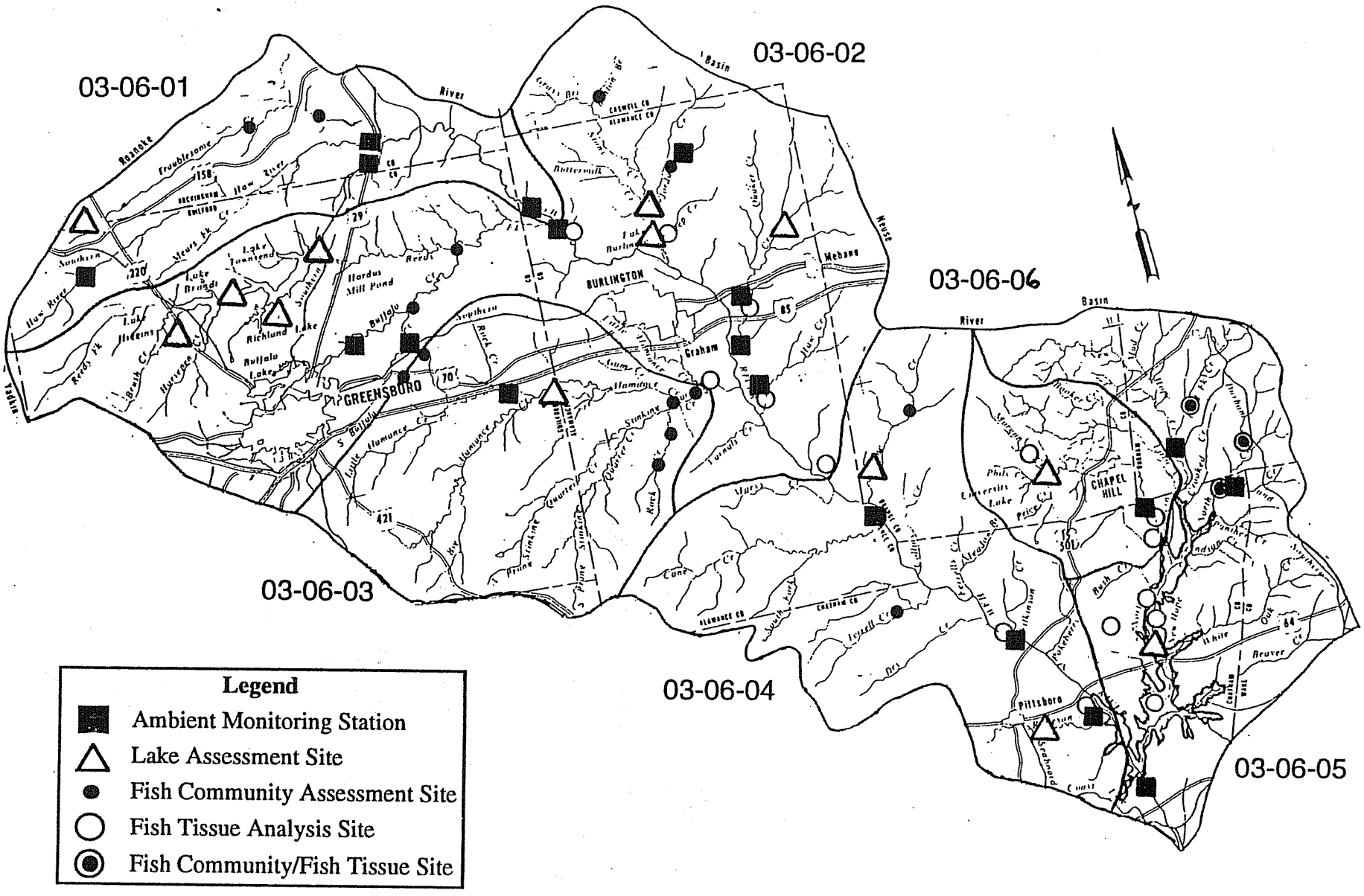


Figure 4.5 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sampling Sites in the Haw River/Jordan Lake Watershed (Subbasins 01 to 06)

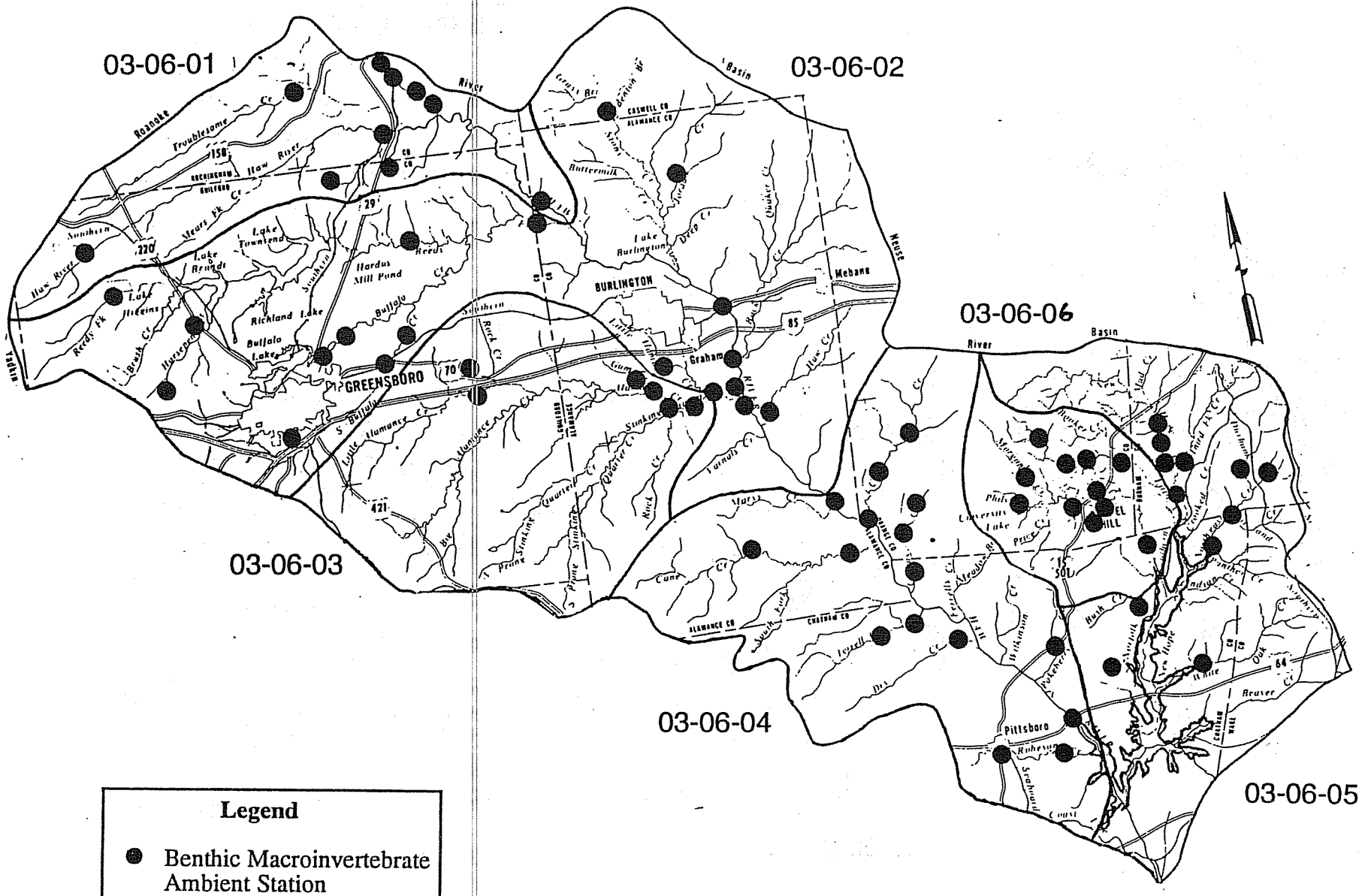


Figure 4.6 Benthic Macroinvertebrate Monitoring Stations in the Haw River/Jordan Lake Watershed (Subbasins 01 to 06)

Table 4.6 Benthic Macroinvertebrate Sampling Sites Data Summary for the Haw River/Jordan Lake Watershed (83-93)

Subbasin 01

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Haw R at Oak Ridge, SR 2109, Guilford	-/B-1	16-(1)	07/93	-/9	-/5.67	Fair
			05/85	59/11	6.50/4.73	Fair
Haw R, US 29 Bus, Rockingham	-/B-2	16-(1)	07/93	56/20	5.76/4.91	Good-Fair
Haw R nr Altamahaw, NC 87, Alamance	P/B-3	16-(1)	07/93	69/22	5.77/4.95	Good
			07/90	63/12	7.10/5.48	Fair
			07/87	65/14	6.33/5.65	Good/Fair
			05/85	65/23	6.50/4.91	Good/Fair
Brooks Lake Trib, Scout Camp, Guilford	114/B-4	16-4-1-(1)	06/90	53/15	4.21/2.44	Excellent*
			06/85	79/20	4.95/2.55	Excellent*
Candy Cr, SR 2700, Guilford	115/B-5	16-5	06/90	59/10	6.56/5.72	Fair
			06/85	69/11	6.96/6.16	Fair
Troublesome Cr, SR 2422, Rockingham	-/B-6	16-6-(0.7)	07/93	-/18	-/5.21	Good-Fair
L Troublesome Cr, ab Reidsville WWTP, Guilford	89/B-7	16-7	01/92	42/8	6.74/5.63	Fair
			12/87	68/18	6.68/5.21	Good/Fair
L Troublesome Cr, be Reidsville WWTP, Guilford	90/B-8	16-7	01/92	33/7	6.83/5.15	Fair
			12/87	37/11	7.26/4.33	Fair
L Troublesome Cr, SR 2598, Rockingham	1/B-9	16-7	05/85	36/3	7.72/7.22	Poor
L Troublesome Cr, SR 2600, Rockingham	-/B-10	16-7	07/93	42/3	7.22/7.50	Poor

Subbasin 02

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Haw R at Haw R, NC 49, Alamance	10/B-1	16-(1)	05/85	58/10	6.82/5.53	Fair
			08/84	36/12	6.53/5.58	Fair
Haw R nr Graham, NC 54, Alamance	A /B-2	16-(1)	07/93	64/19	6.04/5.20	Good-Fair
			08/89	58/14	6.03/5.29	Good/Fair
			08/87	-/13	-/5.34	Fair
			07/87	74/20	6.23/5.33	Good/Fair
			09/85	60/14	6.40/5.20	Good-Fair
			05/84	66/16	7.21/5.67	Fair
			08/83	73/15	7.00/5.26	Fair
Haw R ab Alamance Cr, Alamance	11/B-3	16-(1)	05/84	64/16	6.96/5.44	Fair
Haw R be Alamance Cr, Alamance	12/B-4	16-(1)	05/84	68/20	7.12/4.56	Fair
Reedy Fk nr Oak Ridge, SR 2128, Guilford	U,4/B-5	16-11-(1)	07/93	-/19	-/4.79	Good-Fair
			07/88	69/22	5.52/4.36	Good
			04/86	77/24	5.44/4.34	Good
Horsepen Cr, US 220, Guilford	5/B-6	16-11-5-(0.5)	07/93	-/9	-/5.93	Fair
			04/86	82/22	6.46/5.06	Good/Fair
UT Horsepen Cr, Friendly Rd, Guilford	-/B-7	16-11-5-1-(2)	09/92	43/4	7.46/6.97	Poor
Reedy Fk, SR 2728, Guilford	-/B-8	16-11-(9)	07/93	-/16	-/5.94	Good-Fair
Reedy Fk nr Ossippee, NC 87, Alamance	B/B-9	16-11-(9)	07/93	68/20	6.34/5.39	Good-Fair
			08/89	67/14	6.80/5.72	Fair
			07/86	59/10	6.67/5.79	Fair
			05/85	49/12	7.66/5.85	Fair
			08/83	52/13	7.55/6.30	Fair
N Buffalo Cr, ab WWTP, Guilford	80/B-10	16-11-14-1	11/88	37/3	7.84/7.42	Poor
N Buffalo Cr, be WWTP, SR 2832, Guilf.	81/B-11	16-11-14-1	07/93	40/4	8.09/6.49	Poor
			11/88	32/1	8.51/7.78	Poor
			05/85	28/2	8.66/6.05	Poor
S Buffalo Cr, US 70 ab WWTP, Guilford	78/B-12	16-11-14-2	07/93	59/8	7.41/6.02	Fair
			08/88	63/9	7.87/6.48	Poor
S Buffalo Cr, SR 2821 be WWTP, Guilford	7/B-13	16-11-14-2	07/93	50/2	8.35/6.22	Poor
			08/88	34/1	7.79/7.78	Poor
			05/85	36/2	8.41/6.50	Poor
Mile Run Cr, SR 1400, Guilford	8/B-14	16-11-14-2-4	04/86	25/1	8.69/6.58	Poor
Stony Cr, SR 1100, Caswell	-/B-15	16-14-(1)	07/93	-/21	-/4.67	Good
			02/93	-/27	-/4.03	Good
Jordan Cr, SR 1002, Alamance	-/B-16	16-14-6-(0.5)	02/93	-/23	-/4.78	Good-Fair
Little Alamance Cr, SR 2309, Alamance	9/B-18	16-19-11	07/85	45/8	7.30/6.52	Fair
Haw Cr, SR 2158, Alamance	-/B-19	16-20-(1)	02/93	-/19	-/4.76	Good-Fair

Subbasin 03

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
L Alamance Cr, SR 3056, Guilford	-/B-1	16-19-3-(4.5)	02/93	69/24	5.36/4.70	Good
UT Rock Cr, SR 2808, Guilford	82/B-2	16-19-8-3.5-(1)	11/88	-/20	-/4.52	Good/Fair
Big Alamance Cr, NC 49, Alamance	-/B-3	16-19-(4.5)	7/93	-/19	-/5.20	Good-Fair
			2/93	-/20	-/4.27	Good-Fair
Big Alamance Cr nr Bellemont, SR 2309, Alamance	O/B-4	16-19-(4.5)	10/89	95/31	5.79/4.93	Good
			08/89	79/22	6.02/5.25	Good/Fair
			04/89	79/26	5.70/4.53	Good/Fair
			02/89	65/22	5.70/4.53	Good/Fair
			07/86	80/22	6.00/5.00	Good/Fair
Gum Cr, SR 1148, Alamance	13/B-5	16-19-7	4/86	67/14	7.51/5.92	Fair
Stinking Quarter Cr, SR 1136, Alamance	14/B-6	16-19-8	7/93	-/16	-/5.01	Good-Fair
			2/93	-/25	-/4.01	Good-Fair
			4/86	91/30	6.00/4.95	Good

Subbasin 04

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Haw R nr Saxapahaw, SR 2158, Alamance	15/B-1	16-(1)	8/83	54/7	6.89/5.63	Fair
Haw R nr Saxapahaw, SR 1005, Alamance	C/B-2	16-(1)	7/93	60/18	5.81/5.04	Good-Fair
			7/90	71/20	6.03/4.83	Good-Fair
			8/89	60/18	6.14/5.20	Good-Fair
			7/88	74/21	6.18/4.90	Good-Fair
			7/87	71/21	5.84/4.99	Good-Fair
			7/87	-/21	-/5.04	Good
			7/86	67/19	6.10/4.89	Good-Fair
			9/85	64/23	5.54/5.03	Good
			5/85	73/24	6.24/4.84	Good-Fair
			9/84	61/13	6.44/4.90	Fair
			5/84	85/27	6.01/4.76	Good-Fair
Cane Cr, SR1114, Orange	16/B-3	16-27-(1)	7/93	-/20	-/4.05	Good-Fair
			2/93	-/28	-/3.56	Good
			4/86	110/33	5.62/4.52	Good
Cane Cr, SR 1100, Orange	-/B-4	16-27-(1)	11/84	88/27	5.90/4.88	Good-Fair
Cane Cr (West), SR 2351, Alamance	-/B-5	16-28	12/86	-/12	-/5.75	Fair
Cane Cr (West), NC 87, Alamance	-/B-6	16-28	2/93	-/20	-/4.36	Good-Fair
			12/86	-/5	-/4.85	Poor
Collins Cr, SR 1539, Chatham	-/B-7	16-30	12/86	44/4	7.02/4.12	Poor
UT Collins Cr, ab WWTP, Orange	-/B-8	16-30-(1)	8/91	52/17	5.72/4.75	Good-Fair
UT Collins Cr, be WWTP, Orange	-/B-9	16-30-(1)	8/91	63/15	5.82/5.03	Good-Fair
Terrells Cr, NC 87, Chatham	-/B-10	16-31-(2.5)	2/93	-/30	-/3.32	Good
Terrells Cr, SR 1520, Chatham	-/B-11	16-31-(2.5)	12/86	-/13	-/5.07	Fair
Dry Cr, SR 1520, Chatham	-/B-12	16-34	2/93	-/31	-/4.63	Good
			12/86	-/5	-/6.01	Poor
Haw R nr Pittsboro, US 64, Chatham	D/B-13	16-(36.7)	7/93	63/24	5.06/4.30	Good
			7/90	60/24	5.38/4.12	Good
			7/88	81/28	5.91/4.57	Good
			7/86	69/24	5.65/4.26	Good
			5/85	84/27	5.68/4.19	Good
			9/84	56/20	5.70/4.52	Good
			6/83	48/14	5.49/4.43	Good-Fair
			6/83	51/19	5.38/4.30	Good
			6/83	61/19	5.54/4.35	Good
Pokeberry Cr, SR 1711, Chatham	18/B-14	16-37	2/93	-/23	-/4.67	Good-Fair
			12/86	94/26	5.81/4.23	Good
			10/85	86/21	6.04/4.68	Good-Fair
Robeson Cr, ab Pittsboro WWTP, Chath.	116/B-15	16-38-(3)	9/90	67/7	7.61/7.00	Poor
Robeson Cr, be Pittsboro WWTP, Chath.	17/B-16	16-38-(3)	9/90	54/7	7.09/5.89	Fair
			4/86	82/11	7.25/5.89	Fair

Table 4.6 Continued

Subbasin 05

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
New Hope Cr, SR 1734, Orange	-/B-1	16-41-1-(0.5)	3/93	94/29	4.94/3.84	Good
New Hope Cr, SR 2220, Durham	66/B-2	16-41-1-(11.5)	3/87	53/14	6.70/5.71	Fair
New Hope Cr, I-40, Durham	20/B-3	16-41-1-(11.5)	10/85	49/10	7.56/6.07	Fair
New Hope Cr, SR 1107, Durham	21/B-4	16-41-1-(11.5)	10/85	32/5	7.56/6.65	Poor
UT New Hope Cr, SR 1716, Chatham	25/B-5	16-41-(3.5)	7/93	-/10	-/6.30	NR
			2/93	-/21	-/3.91	Good-Fair
			4/86	79/29	4.94/4.05	Good
Third Fork Cr, NC 751, Durham	22/B-6	16-41-1-12-(2)	2/93	39/8	7.78/6.64	Poor
			4/85	40/3	8.10.6.83	Poor
Northeast Cr, SR 1102, Durham	64/B-7	16-41-1-17-(0.7)	2/93	58/9	6.91/6.04	Fair
			3/87	29/3	7.71/6.50	Poor
Northeast Cr, SR 1100, Durham	24,65/B-8	16-41-1-17-(0.7)	2/93	35/7	6.99/5.83	Fair
			3/87	27/0	7.96/-	Poor
			12/86	-/4	-/6.39	Poor
			4/85	62/7	7.38/6.08	Fair
Northeast Cr, SR 1731, Chatham	-/B-9	16-41-1-17-(0.7)	7/93	46/8	7.10/6.30	Fair
			12/86	-/8	-/5.94	Fair
Burdens Cr, SR 1945, Durham	23/B-10	16-41-1-17-1-(0.7)	4/86	60/10	6.96/5.41	Fair
Cub Cr, SR 1008, Chatham	-/B-11	16-41-2-10-(0.5)	12/86	-/14	-/5.44	Fair
White Oak Cr, NC 751, Chatham	-/B-12	16-41-6-3.5)	2/93	-/13	-/4.82	Fair

Subbasin 06

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Little Cr, Pinehurst Dr, Orange	-/B-1	16-41-1-15-(0.5)	2/93	37/7	7.12/4.69	Fair
Bolin Cr, SR 1777, Orange	-/B-2	16-41-1-15-1-(0.5)	4/93	-/24	-/4.46	Good
Bolin Cr, Village Rd, Orange	-/B-3	16-41-1-15-1-(0.5)	4/93	-/24	-/3.89	Good
Bolin Cr, E Franklin St, Orange	27/B-4	16-41-1-15-1-(4)	2/93	32/8	6.50/5.34	Fair
			4/86	89/28	6.08/4.27	Good-Fair
Morgan Cr, NC 54, Orange	26/B-5	16-41-2-(1)	7/93	61/21	4.91/3.47	Good**
			2/93	91/36	4.44/3.23	Excell
			4/85	109/32	5.70/4.65	Good
Morgan Cr, Botanical Trail, Orange	-/B-6	16-41-2-(5.5)	4/93	-/16	-/4.94	Fair
			2/93	71/26	6.00/4.63	Good-Fair
Morgan Cr, ab OWASA, Orange	83/B-7	16-41-2-(5.5)	9/90	63/8	7.15/6.35	Fair
			7/88	82/13	6.91/6.29	Fair
Morgan Cr, be OWASA, Orange	84/B-8	16-41-2-(5.5)	2/93	42/7	7.08/4.93	Fair
			9/90	66/8	7.46/5.85	Fair
			7/88	52/4	7.80/7.11	Poor
Morgan Cr, SR 1726, Chatham	I/B-9	16-41-2-(5.5)	7/93	38/7	6.88/6.53	Fair
			7/90	54/8	7.16/6.47	Fair
			7/87	35/6	6.81/6.29	Fair
			4/85	40/4	7.71/5.67	Poor
			8/84	50/10	7.06/5.88	Fair
Pritchards Mill Cr, Damascus Rd, Orange	-/B-10	16-41-2-3-(2)	4/93	-/22	-/4.30	Good-Fair
Meeting of Waters Cr, Laurel Hill Rd, Orange	-/B-11	16-41-2-7	4/93	-/2	-/7.28	Poor

* Small Stream Criteria

** rating affected by very low flow

Buffalo Creek. Areas of higher water quality (Good macroinvertebrate bioclassification, Good or Good-Excellent fish IBI) include the headwaters of Reedy Fork and Stony Creek. Lake Higgins, Lake Brandt, Lake Townsend, and Richland Lake are in the upstream section of Reedy Fork and are evaluated as eutrophic (except Richland Lake is mesotrophic). Water chemistry shows some downstream recovery in Reedy Fork, and recent macroinvertebrate samples have shown improvement from Fair (1985-1989) to Good-Fair in 1993. These changes probably reflect improved waste treatment at the Greensboro facilities. The 1993 bioclassifications change from Good at the Haw River Altamahaw site to Good-Fair at the Haw River near Graham.

In the Burlington-Graham area, the Haw River collects the Alamance Creek watershed. All major streams (Big Alamance Creek, Little Alamance Creek and Stinking Quarter Creek) received Good-Fair or Good macroinvertebrate bioclassifications. Fish NCIBI ratings also indicated few problems in this watershed, with Good or Good-Excellent ratings at Rock Creek, Stinking Quarter Creek and Alamance Creek. Gum Creek is affected by a small discharger and urban runoff; it received a Fair macroinvertebrate bioclassification in 1986. The Burlington South WWTP (12 MGD) also may affect the Haw River below the confluence of Alamance Creek. Burlington Reservoir, Lake Burlington, Lake Macintosh and Graham-Mebane Reservoir in this area are eutrophic, though Lake Macintosh is a new reservoir and may not yet have stabilized.

The lower reach of the Haw River, above its confluence with B. Everett Jordan Reservoir, is approximately 25 river miles in length and contains many small to medium tributaries. Many of these tributary streams are located within the Carolina Slate Belt ecoregion and are prone to extreme low flow conditions during the summer.

Ambient water quality data have generally indicated good water quality in this section of river, with few violations in water quality criteria. Water quality data from the two lowermost Haw River locations indicate an improvement compared to data collected from upstream locations. The same is true for bioclassifications of the Haw River in this reach (Good and Good-Fair) when compared to upstream reaches near Burlington and Graham (Good-Fair and Fair). Apparently, the river has assimilated wastes generated by numerous point source dischargers near Burlington. Biological recovery is noted by consistent Good bioclassifications at the most downstream monitoring location near Pittsboro prior to the confluence with B. Everett Jordan Reservoir.

An ambient water quality location on Robeson Creek is located near the confluence with Haw River below the Pittsboro WWTP. A Fair bioclassification was assigned to this section of Robeson Creek during a biological investigation of the Pittsboro WWTP in 1990. However, the biological investigation noted that upstream water quality problems may have masked the effects of the Pittsboro WWTP. Trends in water quality data from the ambient location note significantly lower conductivity, total phosphorus, and ammonia-nitrogen in 1993 compared to values collected in 1988, suggesting an improvement in water quality.

Good and Good-Fair bioclassifications based on benthic macroinvertebrate samples were assigned to several tributary locations during 1993 surveys: both Cane Creeks, Terrells Creek, Dry Creek and Pokeberry Creek. Nonpoint source runoff from agricultural land or other nonpoint sources of pollution may account for the water quality deterioration and habitat loss in some tributaries. Fish community structure samples were collected from Terrells Creek and Cane Creek. These data indicated Fair-Good ecological health ratings and noted evidence of some nutrient enrichment based on the percentage of omnivore fish species present. Cane Creek Reservoir and Pittsboro Lake are currently classified as eutrophic. Cane Creek Reservoir is currently fully supporting its designated uses, whereas Pittsboro Lake is listed as threatened due to the occurrence of algal blooms and presence of nuisance aquatic weeds.

B. Everett Jordan Reservoir and Tributaries

Intensive monitoring and research of the 14,300 acre B. Everett Jordan Reservoir (Jordan Reservoir) has been performed by State and university personnel since the lake was filled in 1981 and DWQ investigations have been conducted since 1983. The lake was created for flood control, fish and wildlife habitat, recreation, and water supply. It is now used for water supply by the towns of Cary and Apex. The Haw River makes up 70-90% of the annual flow of Jordan Reservoir with an average retention time of five days. The New Hope arm of the lake has an average retention time of 418 days. Jordan Reservoir is about 5 miles in length on the Haw River arm and 17 miles long on the New Hope Creek arm.

Elevated nutrient and chlorophyll *a* levels have frequently been found in the lake along with periodic blooms of blue-green algae. Very high NCTSI values have been recorded from Jordan Reservoir making it one of the most eutrophic lakes in North Carolina. Historic monitoring data indicates that the lake has remained eutrophic since 1982, with little change in trophic index parameters. The highest algal growth and chlrophyll *a* values have been found in the shallow, upper reaches of the New Hope arm of the lake. The lake is currently considered Threatened.

Sediment oxygen demand (SOD) evaluations were conducted on Morgan Creek near the headwaters of the New Hope arm of the reservoir. A total of eleven SOD tests were conducted to evaluate testing procedures and provide quality assurance (QA) data. Results of these investigations noted negative SOD rates ranging from -1.0 gr/m^2/day to -2.3 gr/m^2/day. These results suggest that upstream sources are causing oxygen depletion of sediments within this arm of Jordan Reservoir. In addition, more negative SOD rates were noted during the most recent investigations (1992 and 1994) when compared to earlier investigations (1989 and 1990), suggesting that water quality conditions are deteriorating in the catchment.

Major tributaries to Jordan Reservoir, besides the Haw River, include Northeast, New Hope and Morgan Creeks. Both point and nonpoint sources of pollution have affected streams in this highly urbanized Chapel Hill and Durham area. Ambient water quality stations are located below Durham's two WWTPs, which discharge to Northeast Creek and New Hope Creek and have instream waste concentrations of 100% and 99.5%, respectively under 7Q10 low flow conditions. Elevated median summer concentrations of nitrate/nitrite-nitrogen and conductivity have been noted from both monitoring locations. On Morgan Creek below the OWASA/Mason Farm WWTP, A noticeable decrease in total phosphorus concentrations has been noted during the period from 1988 to 1993. This facility has an instream waste concentration of 93% under 7Q10 flow conditions. Fecal coliform excesses have consistently been found at all three of the above ambient sites.

Several benthic macroinvertebrate investigations have been conducted to determine the impacts of the Durham Triangle WWTP to Northeast Creek. These investigations have found Fair or Poor bioclassifications at both the upstream and downstream sampling locations. It appears that upstream water quality is being impacted to some degree by urban runoff and by summer low-flow conditions exacerbated by beaver dam impoundments. Good bioclassifications based on benthos data were assigned to an upstream site on New Hope Creek and one very small tributary catchment of B. Everett Jordan Reservoir (UT New Hope Creek). Fish community structure analyses have found Poor/Fair ecological health ratings at lower reaches of Third and Northeast Creeks. A Good ecological health rating was given to an upstream location on Northeast Creek.

The upstream reaches of Morgan and Bolin Creeks have Good to Excellent bioclassifications based on benthic macroinvertebrate data. Land use patterns within these headwater catchments appear to be agricultural with dairy operations and row crops. Water quality conditions degrade as streams flow through the suburban and urban sections of Chapel Hill. A benthic macroinvertebrate site on Bolin Creek at East Franklin Street declined from Good-Fair in 1986 to Fair in 1993. Nonpoint runoff from these areas may have impacted water quality conditions in these streams. A benthos site on Morgan Creek below OWASA improved from Poor in 1988 to Fair in 1990 and 1993.

A fish community structure sample was collected from Morgan Creek at NC 54. This site is used as a reference monitoring location by Triangle J Council of Governments and was assigned an Excellent bioclassification based on benthic macroinvertebrate data. However, the fish sample gave this stream reach a Fair ecological health rating and suggested the potential effects of nutrient enrichment. University Lake on Morgan Creek is eutrophic, but is currently supporting its uses.

4.3.2 Deep River Watershed (Subbasins 08 through 12)

Deep River Drainage Mainstem

The Deep River originates in eastern Forsyth County and flows about 116 miles, draining about 1,442 square miles, to its confluence with the Haw River. The fall line, separating the Piedmont from the Coastal Plain ecoregions, lies at this confluence. The Deep River flows over 16 small dams between High Point and it's confluence with the Haw River, which slow the river's velocity and limit the system's assimilative capacity. The average slope along the entire river from the High Point dam to its mouth is about 5 feet per mile. The fall is rapid down to the mouth of McLendons Creek, where it begins to flatten out. The watershed terrain changes from hilly and rolling in Randloph and Guilford Counties to flat or gently rolling in Moore and Lee Counties with some swampy areas. The river generally has high banks and few large flood plains.

Its headwaters, the East and West Forks of the Deep River, are both affected by nonpoint source runoff, small dischargers, and by low summer flows. Both streams are within largely agricultural catchments, but have urbanized segments near their headwaters. Macroinvertebrate samples during 1993 indicated Fair water quality in the East Fork, but Good-Fair water quality in the West Fork. The East Fork catchment has more development, including a large oil storage area.

Urban areas in the Deep River watershed include Kernersville, High Point, Randleman, Ramseur, Asheboro, and Sanford. Municipal wastewater treatment plants in these cities discharge either directly or indirectly to the Deep River, and their effluents may make up the majority of the flow during low flow periods. As a result, severe water quality problems have been observed throughout the upper portion of the Deep River. The river has been intensively sampled since 1983. Some improvements have been observed during this time period based on examination of benthos data, although as discussed below on pages 4-27 and 4-28, water quality in the Deep River continues to be stressed, and further improvements in quality may be limited by increasing urbanization. The observed improvements have been related to upgrades at several wastewater treatment plants. Using benthos data, an upstream site on the Deep River improved from Poor to Fair after the Jamestown WWTP ceased discharge in 1984. A site further downstream near the Guilford/Randolph County line improved from Poor in 1983 to Fair in 1984-1986. This site showed some further improvement in 1987-1990, but achieved a Good-Fair rating only in July 1988. Copper concentrations at this site are still sometimes above NC Action Levels. The Randleman WWTP is permitted to discharge 1.75 MGD directly to the Deep River. A Deep River site at Randleman improved from Poor in 1985 to Fair in 1986-1988, and to Good-Fair in 1993.

In the 25 river miles from Randleman to the Randolph/Moore County line there are three ambient locations at Worthville, Ramseur and Central Falls. Ambient water chemistry suggests a general trend of more water quality standard/action level exceedances or higher concentrations of nutrient parameters at the upstream location near Worthville and better water quality at downstream locations. This trend indicates that instream assimilative capacity of the Deep River and dilution are improving water quality at downstream reaches. Some excesses were noted for mercury at the Worthville and Central Falls locations. Benthos data from the Deep River at Ramseur have shown improvement from Fair in 1983 and 1985 to Good-Fair through 1993. The Ramseur WWTP has passed all of their recent chronic tests and are in compliance with their NPDES permit.

Benthos data from a location in Moore County have consistently indicated an Excellent bioclassification. Most of the Deep River in Moore County (from Grassy Creek to NC 42 near Carbonton) is classified as HQW. Ambient water quality samples are collected from the Deep River at High Falls and the Deep River at Carbonton. Copper and iron levels exceeded action levels for 33% and 29%, respectively, of the samples collected from the Deep River at High Falls. The excess percentages for these metals for the Deep River at Carbonton increased to 38% for copper and 56% for iron. Fecal coliform counts also exceeded state standards for 38% of the samples from the Carbonton site.

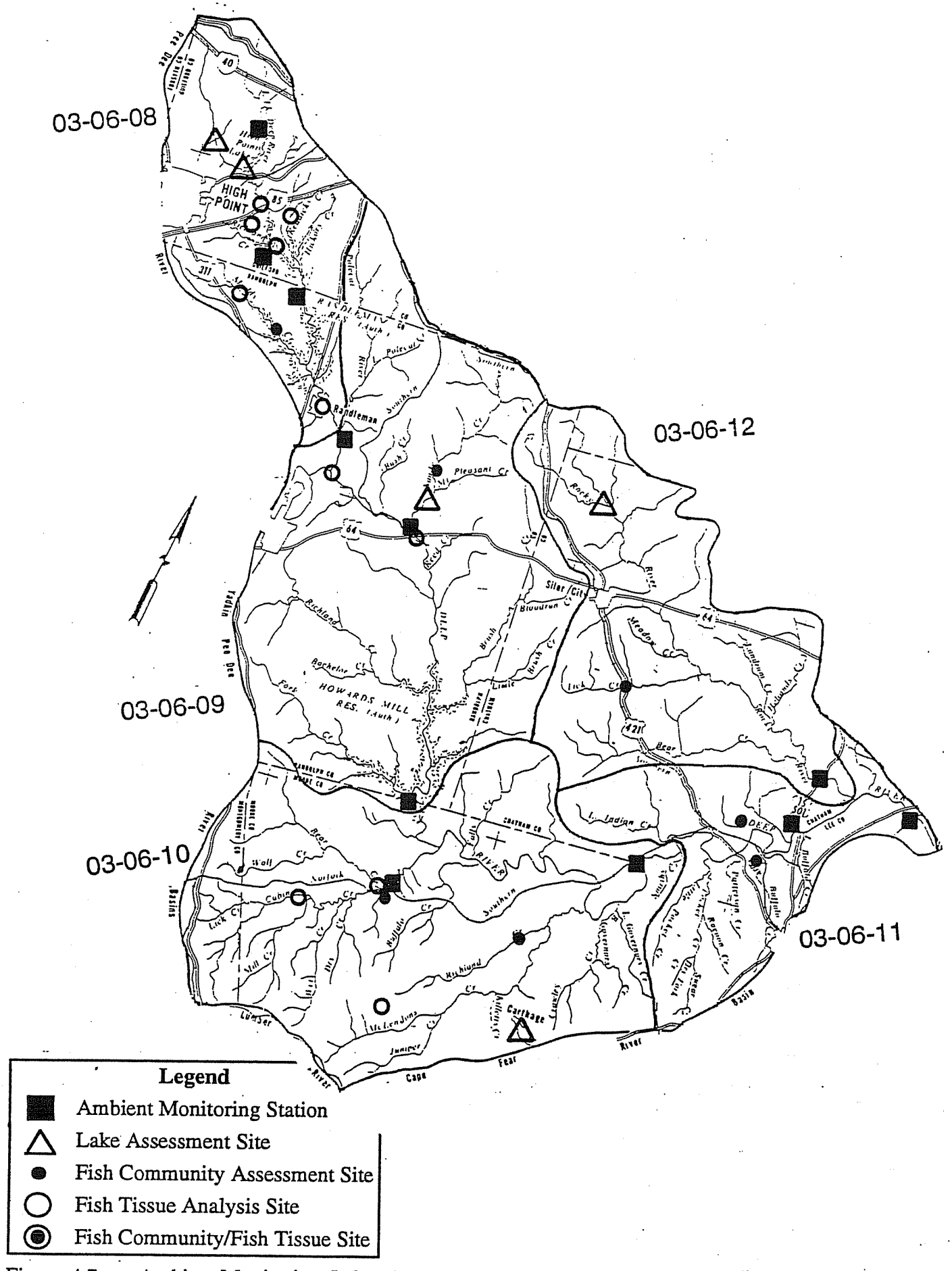


Figure 4.7 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sampling Sites in the Deep River Watershed (Subbasins 08 to 12)

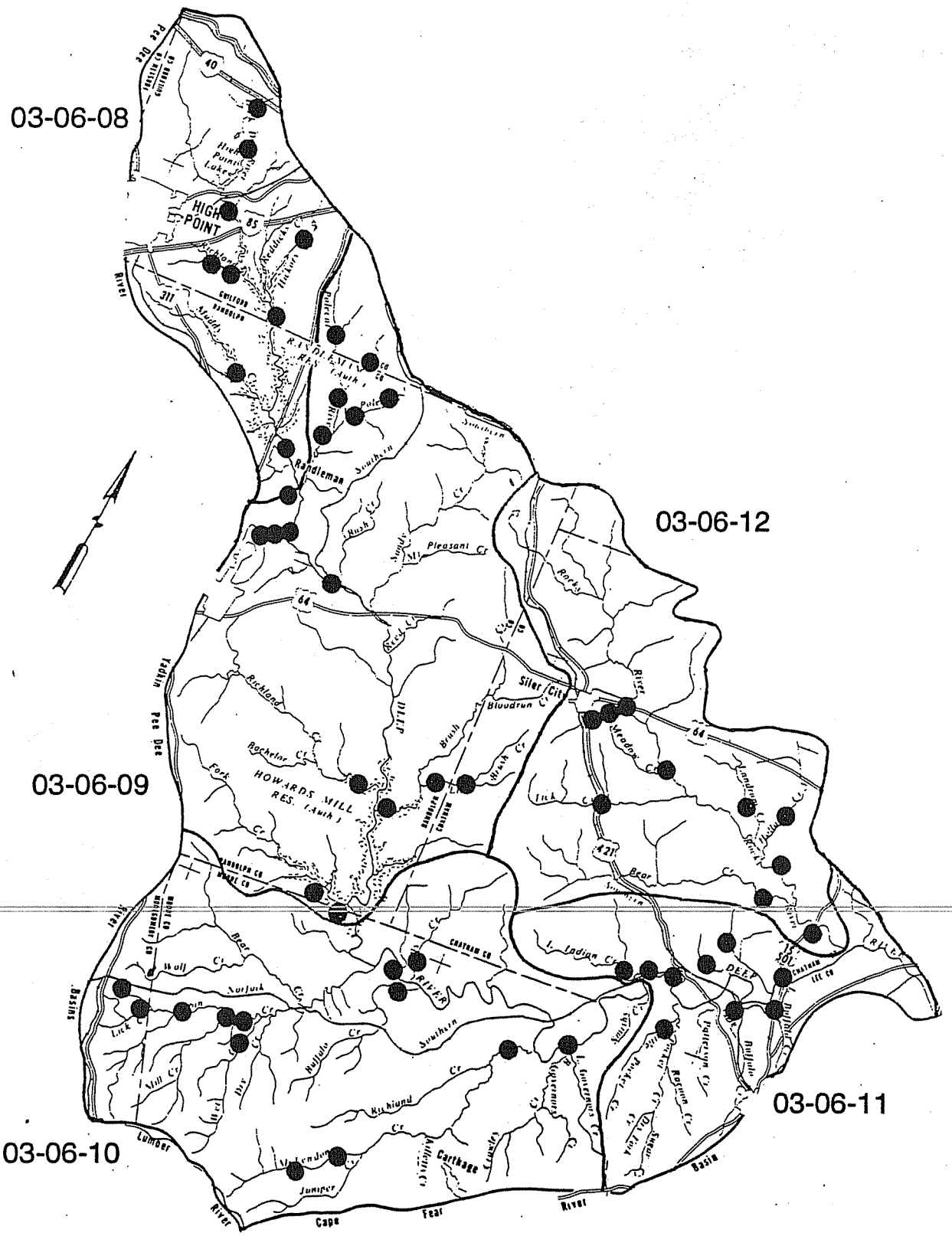


Figure 4.8 Benthic Macroinvertebrate Monitoring Stations in the Deep River Watershed (Subbasins 08 to 12)

Table 4.7 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Deep River Watershed (83-93)

Subbasin 08

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
E Fk Deep R, SR 1541, Guilford	-/B-1	17-2-(0.3)	02/93	-/12	-/5.86	Fair
UT E Fk Deep R, I-40, Guilford	-/B-2	17-2-(0.3)	09/92	38/5	6.85/5.05	Fair
W Fk Deep R, SR 1850, Guilford	-/B-3	17-3-(0.3)	07/93	-/15	-/4.66	Good-Fair
			02/93	-/27	-/4.61	Good-Fair
W Fk Deep R, SR 1818, Guilford	30/B-4	17-3-(0.7)	08/83	71/12	-/-	Fair
UT W Fk Deep R, ab LCP, Guilford	85/B-5	17-3-(0.3)	10/88	35/8	5.97/5.31	Fair
UT W Fk Deep R, be LCP, Guilford	86/B-6	17-3-(0.3)	10/88	6/0	8.41/-	Poor
Deep R, SR 1113, Guilford	31/B-7	17-(4)	08/88	81/8	7.25/6.41	Fair
			08/87	90/17	7.00/5.96	Fair
			08/86	87/13	7.07/6.26	Fair
			07/85	67/14	6.61/6.15	Fair
			08/83	11/0	8.42/-	Poor
Deep R nr Randleman, SR 1921, Guilford	G/B-8	17-(4)	07/90	73/12	7.20/6.36	Fair
			07/89	66/16	6.94/5.99	Fair
			08/88	78/11	7.29/6.17	Fair
			07/88	80/18	6.95/6.15	Good-Fair
			08/87	78/16	6.92/6.32	Fair
			07/87	-/8	-/6.57	Fair
			08/86	56/10	7.67/6.70	Fair
			08/85	64/11	7.68/6.51	Fair
			08/84	39/7	7.36/6.46	Fair
			08/83	56/9	7.86/6.39	Poor
Deep R, Randleman, US 220 Bus, Randolph	32/B-9	17-(4)	07/93	74/20	6.01/5.24	Good-Fair
			08/88	63/12	6.57/6.06	Fair
			08/87	81/17	6.60/5.91	Fair
			08/86	74/10	7.08/5.93	Fair
			08/85	56/9	7.68/6.29	Poor
			08/83	60/9	7.14/6.15	Fair
Richland Cr, ab WWTP, Guilford	-/B-10	17-7	08/88	56/10	7.30/6.41	Fair
Richland Cr, SR 1145,be WWTP, Guilford	33/B-11	17-7	07/93	53/13	7.02/6.35	Fair
			08/88	62/9	7.62/6.47	Poor
			08/87	61/9	7.70/6.49	Poor
			08/86	40/2	8.19/6.58	Poor
			07/85	30/5	8.37/6.71	Poor
			08/83	47/9	7.50/6.63	Fair
Hickory Cr, SR 1131, Guilford	-/B-12	17-8-3	02/93	-/18	-/3.30	Fair
Muddy Cr, SR 1929, Randolph	-/B-13	17-9	02/93	-/22	-/4.71	Good-Fair

CPF 09

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Deep R, SR 2122, at Worthville, Randolph	34/B-1	17-(4)	8/88	74/10	7.22/5.93	Fair
			8/87	57/9	7.14/5.82	Fair
			8/86	66/10	7.92/6.40	Fair
			7/85	47/5	8.21/6.80	Poor
			8/83	46/3	8.20/6.72	Poor
Deep R, SR 2226, at Cedar Falls, Randolph	35/B-2	17-(4)	8/88	61/16	6.25/5.10	Good-Fair
			8/87	70/17	6.82/5.69	Fair
			8/86	61/12	6.82/5.95	Fair
			7/85	65/9	7.68/6.19	Poor
			8/83	50/5	7.83/6.77	Poor
Deep R, SR 2615, at Ramseur, Randolph	H/B-3	17-(4)	7/93	67/17	6.14/5.13	Good-Fair
			7/89	73/18	5.96/5.24	Good-Fair
			8/87	78/23	6.16/4.81	Good-Fair
			8/86	75/21	6.40/5.06	Good-Fair
			7/85	74/13	6.85/5.71	Fair
			8/83	62/15	7.08/5.64	Fair
Deep R, SR 2628, at Coleridge, Randolph	36/B-4	17-(4)	8/86	89/26	6.68/5.28	Good-Fair
			8/85	104/35	5.68/4.38	Excellent
			8/83	71/19	6.87/5.60	Good-Fair

Table 4.7 Continued

Subbasin 09 (continued)

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Deep R, SR 1456, nr Jugtown, Moore	37/B-5	17-(4)	7/93	80/32	4.94/4.07	Excellent
			8/88	96/34	4.98/3.97	Excellent
			8/87	111/38	5.02/4.13	Excellent
			8/86	87/32	4.90/3.70	Excellent
			8/85	99/33	5.13/4.11	Excellent
			8/83	94/33	5.14/4.05	Excellent
Polecat Cr, NC 220 Bus, Guilford	123/B-6	17-11-(1)	7/90	78/21	5.73/5.27	Good
Polecat Cr, SR 2113, Randolph	38/B-7	17-11-(1)	2/93	-/32	-/4.31	Good
Polecat Cr, SR 2116, Randolph	38/B-8	17-11-(1)	7/93	-/9	-/4.94	NR
			8/83	77/22	6.17/5.46	Good-Fair
UT Polecat Cr, nr SR 3430, Guilford	122/B-9	17-11-2-(2)	7/90	33/1	8.91/7.41	Poor
L Polecat Cr, SR 2108, Randolph	39/B-10	17-11-3	2/93	83/32	4.56/3.43	Excellent
L Polecat Cr, SR 2113, Randolph	39/B-11	17-11-3	8/86	91/20	5.14/4.21	Good
Hasketts Cr, SR 2149, Randolph	67/B-12	17-12	2/87	56/12	7.02/5.45	Fair
Hasketts Cr, be SR 2149, Randolph	88/B-13	17-12	2/90	58/10	7.20/6.55	Fair
			8/88	66/12	7.73/6.60	Fair
Hasketts Cr, SR 2128, Randolph	68/B-14	17-12	2/90	42/9	7.48/5.47	Fair
			8/88	35/4	7.90/6.84	Poor
			8/87	33/3	7.91/5.84	Poor
			2/87	29/3	8.36/5.81	Poor
Sandy Cr, SR 2261, Randolph	91/B-15	17-16-(1)	5/89	81/19	6.45/4.38	Good-Fair
			5/88	69/15	6.10/5.24	Good-Fair
Sandy Cr, SR 2481, Randolph	92/B-16	17-16-(1)	7/93	-/22	-/4.06	Good
			2/93	-/27	-/3.28	Good
			5/89	83/25	5.32/4.39	Good
			5/88	94/32	5.36/3.98	Good
UT Sandy Cr, SR 2261, Randolph	93/B-17	17-16-(1)	5/89	80/22	5.53/4.31	Good
			5/88	76/17	6.16/4.83	Good-Fair
Mount Pleasant Cr, SR 2442, Randolph	94/B-18	17-16-3	5/89	80/22	4.91/4.03	Good
			5/88	81/27	5.28/3.90	Good
Brush Cr, SR 1102, Chatham	119/B-19	17-23	5/90	-/26	-/4.89	Good
Brush Cr, NC 22, Randolph	42/B-20	17-23	2/93	-/23	-/3.58	Good-Fair
			5/90	-/28	-/4.24	Excellent
			8/83	95/26	6.00/4.32	Good
UT Little Brush Cr, SR 1100, Chatham	118/B-21	17-23-2	5/90	-/23	-/5.01	Good
UT Little Brush Cr, SR 1005, Randolph	117/B-22	17-23-2	5/90	-/17	-/4.15	Good-Fair
Richland Cr, SR 2873, Randolph	-/B-23	17-22	7/93	-/26	-/3.88	Good
			2/93	-/23	-/3.60	Good/Fair
Flat Cr, SR 2886, Randolph	-/B-24	17-24	2/93	-/17	-/5.07	Fair
Fork Cr, SR 2873, Randolph	-/B-25	17-25	2/93	-/22	-/3.37	Good/Fair

CPF 10

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Deep R, NC 22, Moore	-/B-1	17-(25.7)	07/89	69/24	5.45/4.68	Good
Wolf Cr, SR 1403, Moore	45/B-2	17-26-4	07/88	-/17	-/5.55	Good-Fair
			02/84	91/30	5.37/3.77	Good
Cabin Cr, SR 1400, Moore	-/B-3	17-26-5-(1)	02/93	-/27	-/3.62	Good
			09/92	-/14	-/4.50	NR
Cabin Cr, private rd off SR 1002, Moore	-/B-4	17-26-5-(1)	09/92	61/11	6.37/3.72	Good-Fair
Cabin Cr, SR 1275, Moore	-/B-5	17-26-5-(1)	09/92	91/27	5.49/3.74	Good
Cotton Cr, SR 1372, Montgomery	43/B-6	17-26-5-3	09/92	35/4	6.03/4.19	Fair
			07/88	-/0	-/0	Poor
			02/84	18/2	8.79/6.53	Poor
Cotton Cr, SR 1370, Montgomery	44/B-7	17-26-5-3	09/92	42/7	6.59/5.32	Fair
			02/84	33/10	7.16/4.87	Fair
Mill Cr, nr SR 1275, Moore	-/B-8	17-26-5-4	08/93	69/22	5.19/3.68	Good
			02/93	97/39	4.10/2.90	Excellent
Wet Cr, NC 24, Moore	-/B-9	17-26-5-5	02/93	-/34	-/3.95	Good
Bear Cr, NC 705, Moore	-/B-10	17-26-(6)	08/93	73/22	6.27/4.98	Good-Fair

Table 4.7 Continued

CPF 10 (continued)

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Falls Cr, SR 1606, Moore	-/B-11	17-27	02/93	-/18	-/4.61	Fair
Buffalo Cr, NC 22, Moore	-/B-12	17-28	02/93	-/20	-/3.51	Good-Fair
McLendon Cr, SR 1210, Moore	46/B-13	17-30-(0.5)	11/84	84/28	5.33/4.27	Good
UT Suck Cr, off SR 1261, Moore	95/B-14	17-30-1-(1)	03/86	63/21	4.86/2.72	Good
			02/84	65/25	4.20/2.60	Good
McLendon Cr, SR 1628, Moore	-/B-15	17-30-(6)	08/93	61/8	6.74/5.15	Fair
			02/93	-/13	-/5.59	Fair
Big Governors Cr, SR 1625, Moore	-/B-16	17-32-(0.7)	02/93	40/10	6.13/4.48	Poor

CPF 11

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
UT Deep R, nr SR 2140, Chatham	71/B-1	17-(33.5)	09/87	64/13	6.52/5.27	Good-Fair
Indian Cr, SR 2306, Chatham	-/B-2	17-35	03/93	-/10	-/5.17	Poor
Deep R, SR 1007, Lee	69/B-3	17-(36.5)	08/93	74/25	5.69/4.84	Good
			09/87	99/32	5.67/4.23	Good
Little Pocket Cr, NC 42, Lee	-/B-4	11-37-4	02/93	-/16	-/5.04	Fair
Cedar Cr, SR 2142, Chatham	-/B-5	17-39	02/93	-/13	-/5.28	Fair
Big Buffalo Cr, SR 1403, Lee	-/B-6	17-40	08/93	-/4	-/6.19	Poor
			02/93	-/12	-/5.12	Fair
Georges Cr, SR 2142, Chatham	-/B-7	17-41	02/93	-/15	-/4.83	Fair
Deep R, US 15/501-NC 87, Lee	70/B-8	17-(41.5)	08/93	77/27	5.96/4.69	Good
			09/87	88/25	6.09/4.62	Good-Fair
Little Buffalo Cr, SR 1420, Lee	-/B-9	17-42	02/93	-/5	-/7.08	Poor

CPF 12

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Rocky R, US 64, Chatham	104/B-1	17-43-8	7/93	69/12	6.90/5.72	Fair
			8/89	57/16	6.62/5.60	Fair
Rocky R, SR 2170, Chatham	103/B-2	17-43-8	7/93	66/19	6.50/5.27	Good-Fair
			8/89	56/11	6.66/6.02	Fair
Rocky R, NC 902, Chatham	102/B-3	17-43-8	8/89	73/24	5.76/4.55	Good
Rocky R, US15/501, Chatham	124/B-4	17-43-8	7/93	85/30	5.34/4.06	Good
			7/90	98/30	5.43/4.37	Good
Loves Cr, ab WWTP nr SR 2203, Chath.	100/B-5	17-43-10	8/89	52/7	7.39/6.83	Fair
Loves Cr, be WWTP nr SR 2203, Chath.	101/B-6	17-43-10	8/89	27/2	8.32/6.61	Poor
Tick Cr, US 421, Chatham	47/B-7	17-43-13	7/93	-/5	-/6.57	NR
			8/85	80/19	6.53/5.39	Good-Fair
Landrum Cr, NC 902, Chatham	-/B-8	17-43-14	7/90	-/19	-/3.53	Good-Fair
Harlands Cr, NC 902, Chatham	-/B-9	17-43-15	7/90	-/16	-/3.78	Good-Fair
Bear Cr, SR 2333, Chatham	-/B-10	17-43-16	8/91	73/16	6.77/5.79	Fair
Bear Cr, SR 2189, Chatham	-/B-11	17-43-16	8/91	69/15	6.50/5.57	Fair
Bear Cr, SR 2155, Chatham	-/B-12	17-43-16	7/90	-/15	-/4.83	Good-Fair

Monitoring to measure improvements in water quality associated with management efforts in the Deep River has been ongoing. A review of chemical and biological information from 1983 to 1987 was included in the *Chemical and Biological Assessment of the Deep River 1983-1987 (DWQ report no. 88-01)*. Improvements in biological integrity noted at that time have remained fairly stable. Water quality of the upper Deep River area has become of particular interest to the public since local governments formed the Piedmont Triad Regional Water Authority (PTRWA) in 1986 with plans to construct Randleman Lake for a drinking water supply. Because of the intense interest in this area, two separate studies, one of the upper section of the Deep River[1], and one of the lower[2] were undertaken to measure existing water quality in the river and its tributaries.

[1]NCDEM. September, 1994. Water Quality Monitoring Data for Waters in the Upper Deep River Area:July 28, 1992-October 7, 1993.

[2]NCDEM. September, 1994. Review of Deep River/Carbonton Water Quality Investigations: 1992/1993.

As part of the study of the upper Deep River, fourteen monthly sampling events were conducted at nine different locations from July, 1992 to October, 1993. Five coliform only sampling collections were conducted at eleven locations during the month of June, 1993.

Individual fecal coliform concentrations exceeding 200/100 ml were found at all stations during this evaluation. Five sampling runs for fecal coliform were performed with in a 30 day period of time during June of 1993. The fecal coliform water quality standard of 200/100ml was violated at four of eleven locations, Muddy Creek at SR 1936 (224/100 ml), the Deep River at Highway 220 Bypass (229/100 ml), Muddy Creek at SR1922 (288/100 ml), and at Muddy Creek at SR 1941 (851/100 ml). A suspected source of these high bacteria levels was a dairy located upstream on Muddy Creek. However, additional sampling performed on Muddy Creek upstream of the dairy at SR 1922 and at SR 1941 failed to confirm it as the primary cause of the high bacteria levels.

Metals concentrations higher than action levels for copper, zinc, and iron were found in the Upper Deep River. The High Point Eastside WWTP appears to be a contributing source of copper since all samples but one with concentrations greater than 7 µg/l were found downstream of the High Point Eastside WWTP (31 observations of Copper exceeded 7µg/l) though the county landfill and Seaboard Chemical company are also in this area and drainage. Significant color concerns have been reported and observed downstream of the High Point Eastside WWTP.

Three dissolved oxygen observations less than or equal to the water quality standard of 4.0 mg/l were found in the data collected. Two of these low dissolved oxygen values were found on the Deep River above the confluence of Richland Creek at I-85 upstream from the potential influence of the High Point Eastside WWTP.

Phenols values above laboratory detection levels were found at all stations in the upper Deep River study area. Pesticides and organics were found in the data collected from the Upper Deep River study area. Violations of the water quality standard for lindane and dieldrin were found. The source of the Lindane appears to be the High Point Eastside WWTP as most of the violations were found immediately downstream. The City of High Point suspects the residential use of flea dip and shampoo containing lindane as the source of these elevated lindane levels. Numerous unidentified peaks suggested the presence of many organic chemicals. Unidentified peaks are indications of organic compounds but chemical specific confirmation and identification was not possible. During this entire study 87 samples were collected for pesticides and organics analyses. Laboratory analysis of these samples indicated as many as 1,376 unidentified peaks. Richland Creek below the High Point WWTP discharge (14 samples) had as many as 643 unidentified peaks. While Richland Creek above the Highpoint WWTP discharge (14 samples) had 41 unidentified peaks.

Elevated nutrient levels were measured throughout the study area. The lowest concentrations of nutrients were observed on Richland Creek upstream of the waste water discharge from the High Point Eastside facility. The High Point Eastside WWTP is a significant contributing source of the observed elevated nutrient levels as all nutrient parameters were generally found in higher amounts at stations downstream of the WWTP. Algal growth potential tests performed on samples collected in Muddy Creek and in the Deep River indicated that these waters have the potential for significant problems from algal response to nutrients if sufficient retention time and sunlight were available.

Studies during 1993 on the lower section of the Deep River were designed to characterize water quality in the Carbonton impoundment and to determine the relationship between the impoundment and low dissolved oxygen (D.O.) levels that have been detected downstream in the Sanford area. Low D.O. levels have been reported annually during summer months by the City of Sanford's wastewater treatment facility, located 14.7 miles downstream from the impoundment. Self-monitoring data, provided by the Sanford wastewater treatment facility, has indicated frequently occurring low D.O. values in the Deep River at their upstream monitoring station, SR 1400 near Cumnock. The reported low D.O. levels are often below the water quality standards established

for instantaneous surface readings for class "C" surface waters (< 4.0 mg/l). Water quality conditions, as indicated by low background D.O. levels in the receiving waters, makes it difficult for the Sanford facility to maintain acceptable water quality downstream from their wastewater discharge.

Results from the lower Deep River studies indicate that water quality in the study reach, including the Carbonton impoundment, is severely impacted by nutrient loading from upstream sources (EHNR, 1994a). Although non-point source input and an array of NPDES point-source dischargers contribute to nutrient loading in the Deep River, data from the 1993 sampling implicate Richland Creek, receiving waters for High Point Eastside WWTP, as a significant contributor of point-source nutrients to the Deep River . The elevated nutrient levels in the upper Deep River originate from the High Point Eastside facility and these concentrations tended to decrease moving downstream to the lower portions of the River . A small increase in nutrient levels was detected in the area between Hwy 64 (station 13) and Hwy 22 (station DR1) during the 9/93 Deep River/Carbonton sampling event, and to a lesser extent, this observation was also detected in ambient monitoring data. The nutrient concentration increase noted in this area was the subject of a special intensive monitoring effort conducted during September 1994. This additional monitoring was used to assist in determining the quantitative importance of the Highpoint WWTP discharge to the total nutrient load of the Deep River and was used in recommending the nutrient waste limits for dischargers in the upper Deep River in Chapter 6.

The water quality issues in the Deep River are further complicated by a series of dams (impoundments) which reduce velocity (time-of-travel) by pooling water upstream from each dam, especially during low-flow conditions when in-stream waste concentrations are at the highest percentage and warm temperatures contribute to biological productivity (See Figure 6.5 in Chapter 6). The increased retention time provided by these dams allow utilization of nutrients by aquatic plants (algae) resulting in excessive chlorophyll *a* and major changes in D.O. There are approximately thirteen dams in the Deep River downstream from Richland Creek, prior to the confluence with the Haw River. Time-of-travel (dye) studies conducted by DWQ in the mid 1980's indicate that during low-flow (summer) conditions, time-of-travel for the slow-moving nutrient enriched waters to move from the upper Deep River (High Point area) downstream to the Cape Fear River would be measured in months.

Water quality in the Carbonton impoundment, and possibly in other Deep River impoundments, is further compromised by stratification periodically occurring with hypoxic conditions existing in the bottom waters. Carbonton impoundment data from 1993 also suggest that during the summer, periodic flushing of hypoxic waters from the stratified impoundment occurs during occasional high flow (storm) events. When this stratification is broken, nutrient rich bottom waters are released back into the system.

In addition to the 1993 Deep River/Carbonton evaluation, ambient monitoring data (DWQ) and data from an extensive water quality study conducted on the upper Deep River (DWQ) also implicate Richland Creek and the High Point Eastside WWTP as a major source of nutrients entering the Deep River (EHNR, 1994b). Data collected during a 1992/93 upper Deep River study confirm the elevated nutrient problems detected during the Deep River/Carbonton studies.

Results from the 1992/93 Deep River/Carbonton water quality investigations clearly indicate a need for the reduction in current point source nutrient inputs, especially from the High Point Eastside wastewater treatment facility. Although water quality modeling of the Deep River is complicated due to the series of dams that influence the hydrology of the system, DWQ is recommending that appropriate nutrient limitations be placed on High Point Eastside wastewater treatment facility and other upstream dischargers as noted in Section 6.4.3 in Chapter 6.

Deep River Tributaries

Major tributary streams in the upper Deep River watershed have received either a Good-Fair rating from both macroinvertebrate and fish samples (Muddy Creek), or were rated Fair using benthos data (Richland Creek and Hickory Creek). High Point Eastside WWTP is permitted to discharge 16 MGD to Richland Creek, just above its confluence with the Deep River. The Richland Creek site improved from Poor in 1985-1988 to Fair in 1993. Further improvement will be limited by upstream problems. Chemical monitoring has shown high conductivity, high nutrients and frequent records for copper and zinc above NC Action Levels. Much of this area lies within the Carolina Slate Belt ecoregion and small tributary catchments have a tendency to go dry, or pool up, during summer low flow conditions. Polecat Creek and Little Polecat are tributaries near Randleman and the most recent benthos data has shown Good or Excellent water quality. Little Polecat Creek has been reclassified an HQW. Hasketts Creek is the next major downstream tributary. An ambient site below the Asheboro WWTP has shown very high summer median nutrient concentrations and conductivity values. Toxicity compliance records indicate that while the Asheboro facility is passing most of their chronic tests, exceptions have been noted during the first quarter of 1994.

Benthos surveys conducted in tributary catchments from Ramseur to Moore County have found Good bioclassifications at Sandy and Richland Creek, Good-Fair ratings for Brush Creek and Fork Creek and Fair water quality at Flat Creek. A fish community structure sample from Sandy Creek also gave a Good ecological health rating.

Water quality in upper Cotton Creek is impacted by the discharge from the Star WWTP (0.6 MGD). While there is still a clear impact to Cotton Creek below the Star WWTP discharge (at SR 1372), the bioclassification has improved from Poor to Fair according to the most recent macroinvertebrate data. The effects of the WWTP discharge extend the length of Cotton Creek and are evident in Cabin Creek below the Cotton Creek confluence. The bioclassification in Cabin Creek improves to Good at the Mill Creek confluence. Many of the small streams in this area have Good-Fair or better bioclassifications, including Wolf Creek, Mill Creek, Wet Creek, Bear Creek, and an unnamed tributary to Suck Creek. Big Governors Creek, Falls Creek, and portions of McLendon Creek, have Poor to Fair bioclassifications.

Fish community structure analyses have been conducted on Bear Creek, Richland Creek (the most downstream of three Richland Creeks on the Deep River), Cedar Creek and Big Buffalo Creek. Bear Creek was rated as having Good-Excellent ecological health. Cedar Creek and Big Buffalo Creek had Good ecological health ratings, while Richland Creek had a Fair ecological health rating. The Cedar Creek rating may be inflated because of the site's proximity to the Deep River. Big Buffalo and Little Buffalo Creeks receive urban runoff from the Sanford area and both were assigned Poor benthos bioclassifications. Cedar Creek, Georges Creek, Indian Creek, and Little Pocket Creek drain agricultural areas and all were assigned Fair or Poor benthos bioclassifications.

Two impoundments, High Point Lake and Oak Hollow Lake in the upper watershed, have been evaluated as eutrophic or mesotrophic. Algal blooms have been reported from both lakes, principally due to small cyanophytes. Further down, Sandy Creek Reservoir is currently considered as threatened due to elevated nutrients and elevated dissolved oxygen. Carthage City Lake is oligotrophic, but is considered as support threatened due to aquatic weed infestation.

Rocky River

The Rocky River, a major tributary of the Deep River, is approximately 35 river miles in length. It is located mainly within Chatham County. Land use within its watershed is primarily agriculture and dairy production. This watershed is also in the Carolina Slate Belt ecoregion. Such streams are more resistant to land disturbing activities because erosion from slate belt soils put less sediment into streams than other piedmont areas. Siler City is the only urban area.

Bioclassifications from monitoring locations on the mainstem of the Rocky River have indicated that upstream reaches are generally Fair (Rocky River at US 64) or Good-Fair (Rocky River at SR 2170) and that bioclassifications improve downstream. Data from the most downstream monitoring location at US 15-501, near the confluence with the Deep River, have consistently indicated Good bioclassifications. All the benthic macroinvertebrate information collected from the Rocky River has been collected during summer, low-flow conditions. The downstream improvement in bioclassification is a likely response to increased flow and habitat diversity, rather than to any improvements in water quality although the site at SR 2170 improved from a Fair rating in 1989, to Good-Fair in 1993. It is located several miles below Loves Creek and the Siler City WWTP discharge. Ambient water quality data from the Rocky River at US 15-501 indicate good water quality with very few excesses of North Carolina water quality criteria.

Several freshwater mussel species have been collected from the Rocky River, which are proposed for state protection and Threatened North Carolina protection status. In addition, the Cape Fear Shiner (Notropus mekistocholas), a federally listed endangered fish species, has been reported from several sites in the Rocky River drainage. A reach of several miles of the lower Rocky River has been designated Critical Habitat for the Cape Fear Shiner by the US Fish and Wildlife Service.

Surveys on tributaries of the Rocky River have been conducted to assess the effects of the Siler City WWTP (Loves Creek), and Hill Forest Rest Home (Bear Creek). Poor water quality was assigned to Loves Creek in 1989 below the Siler City WWTP and, in addition, the effects of the discharge were noted in the Rocky River approximately 3 miles below the confluence with Loves Creek. The wastewater treatment plant has been upgraded since that time. No effects of the Hill Forest Rest Home were noted on the benthos of Bear Creek. Several tributaries were sampled as part of an ORW investigation of the lower Rocky River (Landrum, Harlands, and Bear Creek). Data collected during this latter investigation failed to determine Excellent water quality, therefore, a reclassification was not conducted. A single fish community structure sample was collected from Tick Creek. This site was given a Good ecological health rating.

Rocky River Reservoir is currently considered as hypereutrophic and threatened due to elevated nutrients.

4.3.3 Upper Cape Fear Watershed (Subbasins 07, 13, 14 and 15)

Cape Fear River Drainage - Mainstem and Minor Tributaries

The mainstem Cape Fear River originates near the fall line and then flows 170 miles through the Coastal Plain to Wilmington, with an average fall of 0.94 feet per mile. Stream gradient is higher down to Fayetteville, where it begins to flatten out. The flat terrain of the coastal plain results in many swamp systems, but the main river is not a typical swamp stream. The drainage area of the mainstem Cape Fear River is about 6,065 square miles. At its mouth the Cape Fear empties directly into the Atlantic Ocean and much of this estuarine area has salinities high enough for the waters to be classified as shellfish waters (SA).

The Cape Fear River mainstem is a complex system which can be divided into three distinct segments: from the confluence of the Haw and Deep Rivers to Lock & Dam 3 (subbasins 07 and 15); from Lock & Dam 3 to Lock & Dam 1 (subbasin 16); and from Lock & Dam 1 to the ocean (subbasin 17). From the Deep River to Erwin, there is significant slope to the river and the dissolved oxygen standard for fresh water is met. Below Erwin, the river becomes flat and there is limited reaeration. In addition, the river receives significant point and nonpoint source loading with cumulative impacts to the river. Special studies and facility self-monitoring data have shown low DO concentrations upstream of Lock & Dam 3 with violations of the DO standard occurring under summer conditions.

Water quality and biological monitoring locations for these subbasins are shown in Figure 4.9 Benthos ratings for the Cape Fear River at Lillington have been consistently Good since 1983. Other streams in the upper Cape Fear watershed have been rated Good (UT Kenneth Creek) or Fair (Neills Creek and Kenneth Creek). Parkers Creek, Avent Creek, and Hector Creek, in the Raven Rock State Park area are currently classified as HQW. The only Poor water quality indicated by macroinvertebrates in this area was for Kenneth Creek at a location below the Fuquay-Varina WWTP (1.2 MGD) in 1990.

Fish community structure analyses have been conducted for four streams in this area: Hector Creek, Kenneth Creek, unnamed tributary to Gulf Creek, and two locations on Gulf Creek. The fish community data indicated Poor to Fair ecological health ratings for these streams. These ratings were generally lower than those suggested by the macroinvertebrate data for the same locations.

Upper Moccasin Lake, outside Sanford, has a high NCTSI score and is considered highly eutrophic and is listed as support threatened. Lower Moccasin Lake, directly below Upper Moccasin Lake, is also eutrophic but supports its designated use. Harris Lake, a 4,150 acre impoundment owned by Carolina Power and Light, has a lower NCTSI score than the other lakes and is considered mesotrophic. Harris Lake fully supports its designated uses. In addition, it contains an extremely diverse array of aquatic macrophytes, with 58 species of aquatic plants identified from it.

An Excellent bioclassification was assigned to the section of the Cape Fear River near Erwin in 1993. At the Cape Fear River at NC 24 in Fayetteville, fecal coliforms were above the state criteria 4 times from 1992-1993. Iron levels at this site were above the action level 9 of 16 times during this same time period; although, iron is frequently found in excess of action level criteria due to their association with clay soils. Benthos data from the Cape Fear River near Fayetteville have generally indicated Good water quality. Cross Creek was given a Fair bioclassification.

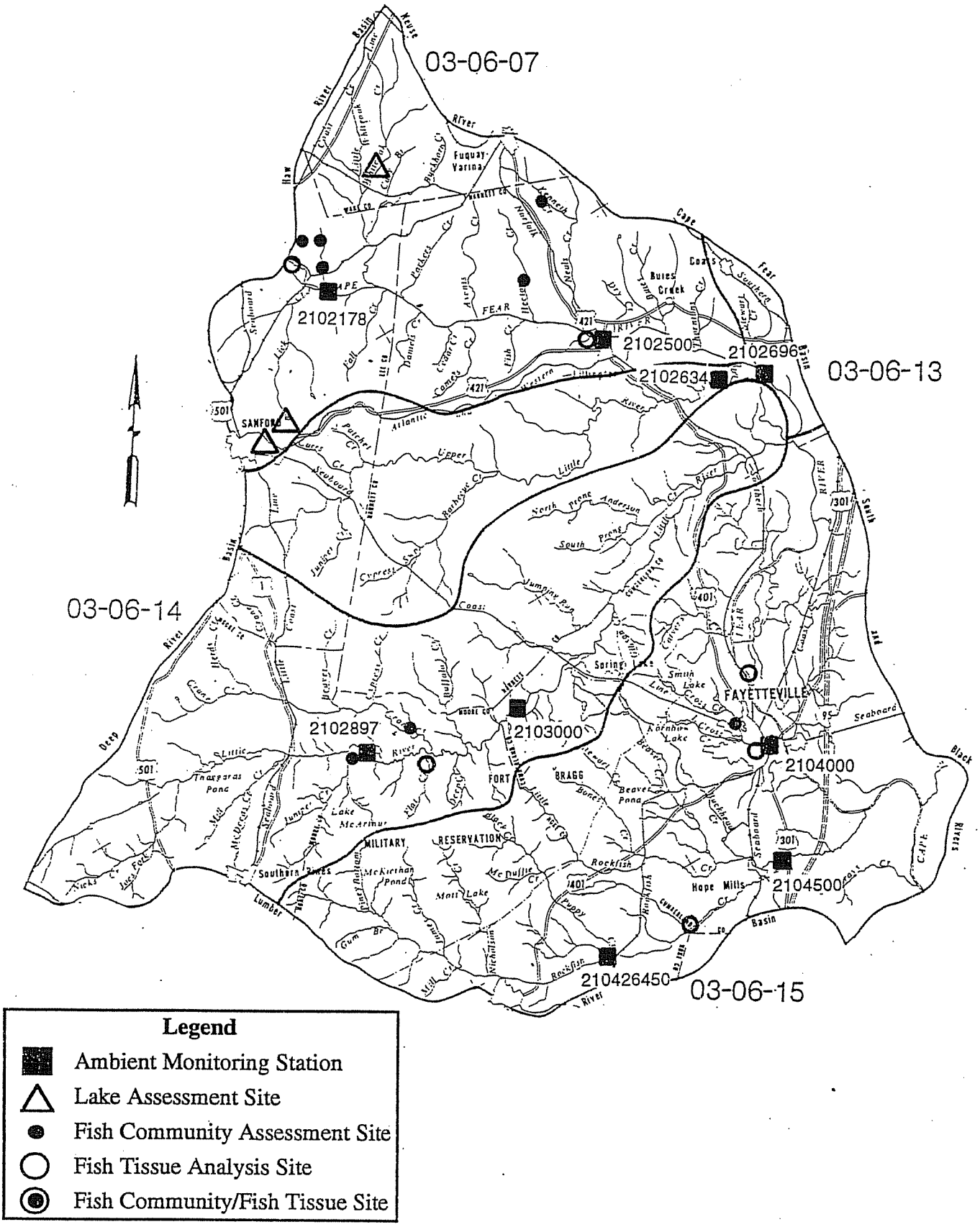


Figure 4.9 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sampling Stations in the Upper Cape Fear River Watershed Area (Subbasins 07, 13, 14 and 15)

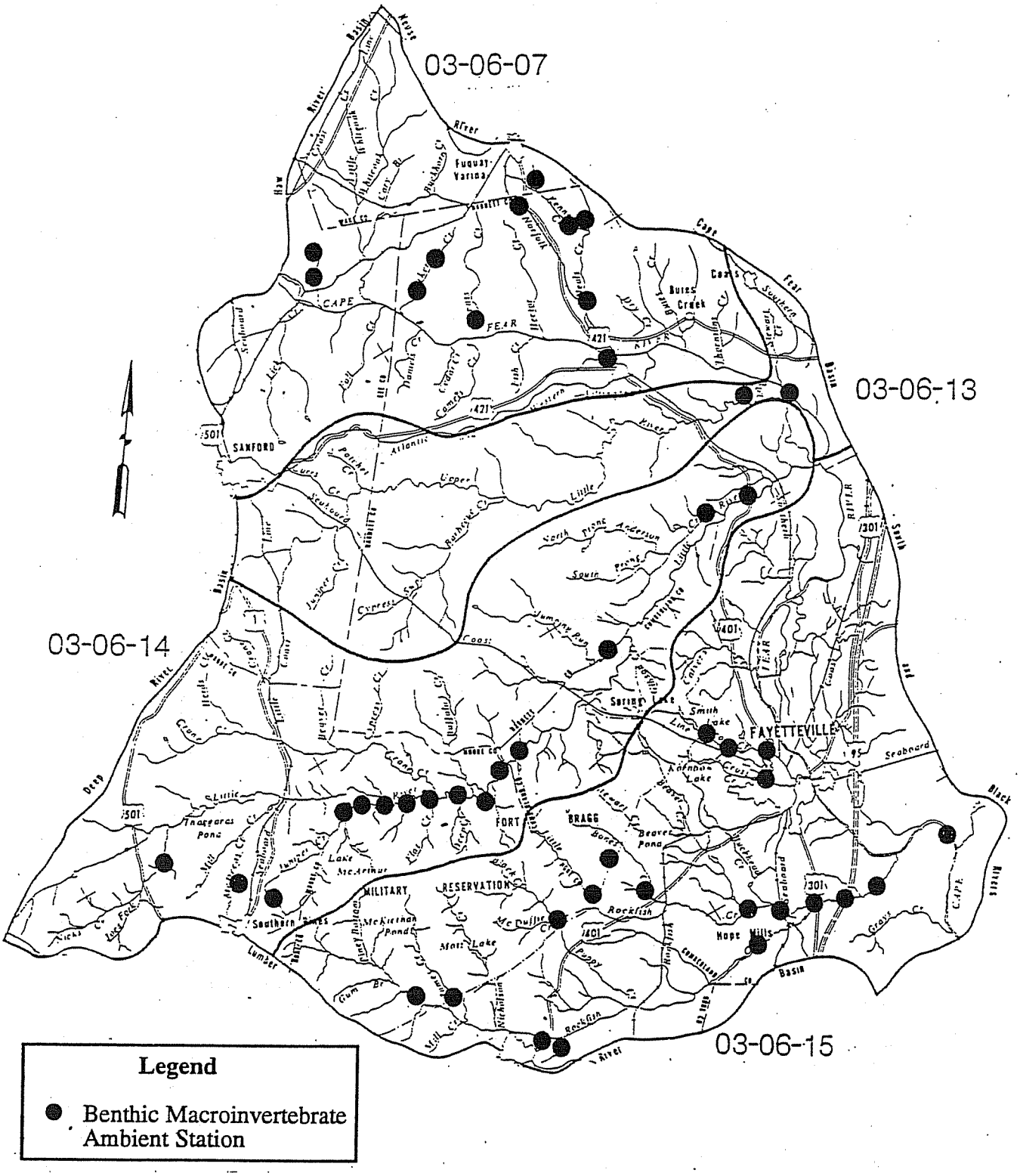


Figure 4. 10 Benthic Macroinvertebrate Monitoring Stations in the Upper Cape Fear River Watershed Area (Subbasins 07, 13, 14 and 15)

Table 4.8 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Upper Cape River Watershed (83-93)

Subbasin 07

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Gulf Cr, nr SR 1924, Chatham	-/B-1	18-5-(1)	04/93	34/6	6.64-5.38	NR
UT Gulf Cr, nr SR 1924, Chatham	-/B-2	18-5-(1)	04/93	19/4	6.62-4.49	NR
Parkers Cr, SR 1450, Harnett	-/B-3	18-9	08/93	83/25	5.35-4.30	Good
			03/93	-/27	-/4.03	Good
Parkers Cr, off SR 1418, Harnett	96/B-4	18-9	11/88	-/28	-/3.42	Excellent
Avent Cr, SR 1418, Harnett	97/B-5	18-13	11/88	-/25	-/3.92	Excellent
Hector Cr, SR 1412, Harnett	98/B-6	18-15	11/88	100/29	5.19/3.90	Excellent
Neills (Neals) Cr, SR 1441, Harnett	-/B-7	18-16-(0.7)	03/93	-/18	-/4.65	Fair
Neills (Neals) Cr, SR 1403, Harnett	99/B-8	18-16-(0.7)	11/88	-/16	-/4.25	Good-Fair
Kenneth Cr, nr SR 2772, be F-V, Wake	120/B-9	18-16-1-(2)	09/90	47/3	7.53/6.50	Poor
Kenneth Cr, SR 1441,Harnett	-/B-10	18-16-1-(2)	03/93	43/7	6.18/5.29	Fair
UT Kenneth Cr, off SR 1447, Harnett	-/B-11	18-16-1-(2)	08/81	50/15	4.10/2.69	Good
Cape Fear R, Lillington, NC 401, Harnett	F/B-12	18-(16.7)	07/93	78/30	5.76/4.72	Good
			09/90	107/36	6.05/4.65	Good
			07/88	93/30	5.88/4.63	Good
			07/86	89/29	6.07/4.78	Good
			08/85	91/29	6.14/4.88	Good
			09/84	94/25	5.95/4.81	Good-Fair
			07/83	72/30	5.18/4.37	Good

CPF 13

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Juniper Cr, SR 1144, Lee	142/B-1	18-20-6-(1)	11/88	-/9	-/4.19	Fair
Upper Little R, SR 1222, Harnett	141/B-2	18-20-(8)	08/93	56/13	6.17/4.83	Good-Fair
			12/88	77/19	6.02/4.16	Good-Fair
Upper Little R, NC 27, Harnett	-/B-3	18-20-(8)	08/93	81/26	5.51/3.95	Good
Barbeque Swp, SR 1209, Harnett	143/B-4	18-20-13	08/93	-/14	-/3.61	Good-Fair
			11/88	-/19	-/4.09	Good-Fair
Upper Little R, nr SR 2016 ab Becker, Harn.	-/B-5	18-20-(23.5)	07/91	-/23	-/3.89	Good
Upper Little R, nr SR 2016 be Becker, Harn.	-/B-6	18-20-(23.5)	07/91	-/17	-/3.00	Good-Fair
Upper Little R nr Erwin, SR 2021, Harnett	R/B-7	18-20-(23.5)	08/93	67/25	5.33/3.90	Good
			07/91	-/25	-/3.44	Good
			07/88	83/27	5.22/3.72	Good
Cape Fear R, NC 217, Harnett	-/B-8	18-(20.7)	08/93	70/31	4.97/4.27	Excellent

Subbasin 14

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Nicks Cr, NC22, Moore	144/B-1	18-23-3-(3)	8/93	-/20	-/3.22	Good-Fair
			11/88	-/22	-/2.99	Good
Lower Little R, SR 2023, Moore	133/B-2	18-23-(10.7)	8/93	70/33	4.46/3.33	Excellent
			4/90	-/35	-/3.94	Excellent
			12/88	85/35	4.60/2.63	Excellent
UT Mill Cr, nr Weymouth Springs, Moore	/B-3	18-23-11-(5)	3/86	49/11	5.31/2.99	Good
			2/84	55/16	4.66/2.67	Good
UT McDeeds Cr, bel HB/PS, Moore	B-4	18-23-11-4-1	7/93	15/0	8.46/0.00	NR
James Cr, nr SR 2023, Hoke	132/B-5	18-23-13	4/90	-/24	-/3.93	Good
James Cr, at Little River, Moore	132/B-6	18-23-13	11/88	-/22	-/2.75	Good
Horse Cr, Manchester Rd, Hoke	130/B-7	18-23-14	4/90	-/18	-/3.41	Good-Fair
Flat Cr, Manchester Rd, Hoke	48/B-8	18-23-15	4/90	-/21	-/3.52	Good
			12/84	74/24	5.18/4.05	Good
Mills Cr, Manchester Rd, Hoke	129/B-9	18-23-17-1	4/90	-/13	-/3.65	Good-Fair
UT in Sicily Drop Zone, Man. Rd, Hoke	128/B-10	18-23-17-(2)	4/90	-/2	-/2.37	Poor
Jumping Run Cr, Manchester Rd, Hoke	127/B-11	18-23-20	4/90	-/13	-/4.37	Good-Fair
McPherson Cr, Manchester Rd, Cumber.	126/B-12	18-23-23.7	4/90	-/12	-/4.70	Good-Fair

Table 4.8 Continued

CPF 14 (continued)

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Lower Little R, at Manchester, NC 87/24, Cumberland	I/B-13	18-23-(24)	8/93	64/18	5.49/4.48	Good
			7/90	73/19	6.04/4.57	Good-Fair
			7/88	50/7	7.22/5.23	Fair
			6/86	57/8	6.74/3.03	Fair
			9/84	81/25	5.34/3.73	Excellent
Lower Little R, US 401, Cumberland	-/B-14	18-23-(24)	8/93	70/26	4.93/3.58	Excellent
Jumping Run Cr, NC 210, Cumber	-/B-15	18-23-29	8/93	-/16	-/3.24	Good-Fair
Anderson Cr, SR 2031, Harnett	-/B-16	18-23-32	8/93	-/13	-/2.97	Fair

CPF 15

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Cape Fear R, ab Cross Cr, Cumberland	50/B-1	18-(26)	1/86	77/31	5.62/4.23	Good
Cape Fear R, be Cross Cr WWTP, Cumber.	51/B-2	18-(26)	1/86	84/25	6.12/3.94	Good-Fair
Cape Fear R, Person St, Cumberland	-/B-3	18-(26)	8/93	48/19	5.37/4.55	Good
Cape Fear R, be Monsanto, Cumberland	52/B-4	18-(26)	1/86	78/28	5.88/4.46	Good
Cross Cr, ab UT, Cumberland	134/B-5	18-27-(1)	4/90	-/7	-/5.04	Fair
Cross Cr, be UT, Cumberland	135/B-6	18-27-(1)	4/90	-/10	-/5.12	Fair
Cross Cr, NC 87/210, Cumberland	-/B-7	18-27-(3)	8/93	-/10	-/6.01	Fair
Little Cross Cr, ab lake, Cumberland	136/B-8	18-27-4-(1)	4/90	-/2	-/2.52	Poor
Rockfish Cr, Plank Rd, Hoke	140/B-9	18-31-(1)	4/90	-/16	-/3.78	Good-Fair
Juniper Cr, Plank Rd, Hoke	139/B-10	18-31-10	4/90	-/19	-/3.85	Good
Peddlars Br, NC 20, Hoke	148/B-11	18-31-16	2/90	36/2	8.51/-	Poor
Peddlars Br, US 401, Hoke	149/B-12	18-31-16	2/90	16/0	8.66/-	Poor
Puppy Cr, Plank Rd, Hoke	138/B-13	18-31-19	4/90	-/15	-/4.35	Good-Fair
Rockfish Cr, SR 1432, Hoke	145/B-14	18-31-(23)	8/93	61/25	4.71/3.48	Excellent
			6/90	-/16	-/4.24	Good-Fair
Rockfish Cr, SR 1115, Cumberland	146/B-15	18-31-(23)	6/90	-/17	-/4.53	Good-Fair
Rockfish Cr, US 301 Bus, Cumberland	49/B-16	18-31-(23)	7/83	60/25	5.01/4.06	Excellent
Rockfish Cr, I-95, Cumberland	S/B-17	18-31-(23)	6/90	-/24	-/4.16	Excellent
			7/88	77/31	5.17/4.13	Excellent
Rockfish Cr, NC 87, Cumberland	-/B-18	18-31-(23)	8/93	60/23	4.93/3.74	Excellent
Little Rockfish Cr, Plank Rd, Hoke	137/B-19	18-31-24-(1)	4/90	-/12	-/3.50	Good-Fair
Bones Cr Trib, nr SR 1400, Cumberland	106/B-20	18-31-24-2	1/89	44/17	6.95/5.23	Good-Fair
UT Bones Cr, be Sunset MHP, Cumberld	105/B-21	18-31-24-2	1/89	6/0	9.49/-	Poor
Little Rockfish Cr, NC 59, Cumberland	-/B-22	18-31-24-(4)	8/93	-/23	-/3.70	Good
Little Rockfish Cr, be lake, Cumberland	147/B-23	18-31-24-(7)	6/90	-/13	-/4.78	Good-Fair

Three lakes have been monitored in Bladen County: Salters Lake, Jones Lake, and White Lake. All of these are natural "Carolina Bay" lakes. Salters Lake and Jones Lake are located within state park or state forest lands and they are dystrophic systems characterized by naturally low pH (<4) and humic water. White Lake is more developed, but has been consistently classified as oligotrophic.

Both Jones Lake and White Lake have been extensively monitored as part of a study of minimally impacted lakes in North Carolina. Closer to the coast, Greenfield Lake and Boiling Springs Lake were sampled by DWQ in 1993. Greenfield Lake, near Wilmington, is classified as C SW and considered Not Supporting because of algal blooms, sedimentation and fish kills that have occurred in the lake. Boiling Springs Lake, near the Town of Boiling Springs, is classified as B SW and is considered supporting of all uses. Fish tissue samples from Boiling Springs Lake, however, detected mercury levels in bass that were close to the EPA screening limits.

Sandhills

The first major watershed in the sandhills is the Upper Little River. It has a drainage area of 220 square miles and enters the Cape Fear River below Lillington. Bioclassifications in this subbasin are generally Good-Fair or better based on macroinvertebrate data. The only exception to this

pattern is Juniper Creek, which was rated Fair. Another tributary to the Upper Little River, Barbeque Swamp, has a Good-Fair bioclassification. The bioclassification for the upper Upper Little River is Good-Fair just below the Lee/Harnett County line, but improves to Good at the NC 27 road crossing. Further downstream, the Upper Little River bioclassification recovers to Good before the stream's confluence with the Cape Fear River. There is one ambient water quality site on the Upper Little River near Erwin. Iron has been frequently measured here over the action level.

The Lower Little River watershed is much larger (500 square miles) and is largely rural, but lower reaches flow through or near Spring Lake and Fayetteville. Water quality in this watershed based on benthos data, ranges from Poor, for a small stream within the Fort Bragg Military Reservation, to Excellent in the upper portion of the Lower Little River. The Lower Little River from the headwaters to Crane Creek has been designated as High Quality Waters. The Lower Little River in this section received an Excellent benthos rating and a Good NCIBI (fish) rating. The remaining watershed has mostly Good-Fair or Good bioclassifications (Nicks Creek, James Creek, Horse Creek, Flat Creek, Mills Creek and Jumping Run Creek). The Lower Little River at Manchester has shown improvement from Fair in 1986 and 1988 to Good in 1993, though it was Excellent in 1984. The Fort Bragg WWTP, the largest discharger in this watershed (8MGD), completed a major upgrade in 1991, and discharges to the river above the Manchester site.

Ambient monitoring system data from two locations on the Lower Little River indicate generally high nutrient values and fecal coliform counts. Fecal coliform bacteria exceeded the NC criterion seven times (44%) at the Lower Little River at Manchester site. Additional study will be needed to identify the sources.

Old Town Reservoir was classified as an oligotrophic lake, all uses are being supported, and no violations of water quality were found. The lake currently has a surface water classification of WS-II NSW and is one of sixteen lakes, statewide, selected as representative of a minimally impacted lake by which other lakes in the same region can be compared.

Most benthos samples in the Rockfish Creek (confluence with the Cape Fear is below Fayetteville) and Little Rockfish Creek watersheds were assigned a bioclassification of Good or Good-Fair. Rockfish Creek below the Raeford WWTP improved from Good-Fair in 1990 to Excellent in 1993 after upgrades were made at the plant. Further downstream near Hope Mills, Rockfish Creek has been rated Excellent. (However, a 1994 special study that was conducted to assess Rockfish Creek for a potential reclassification to High Quality Waters did not find consistent Excellent ratings. Based on this work, the stream was not recommended for HQW reclassification.) Nonpoint problems are considered to be larger problems in this watershed than point sources. Causes of nonpoint pollution include urban runoff (Cross Creek) and sediment from Fort Bragg (Gum Branch, Puppy Creek). Point source discharges are mostly located in or near the Cape Fear River. Ambient water quality samples analyzed from Rockfish Creek indicate low pH distributions, high nutrient values and high coliform counts.

Bonnie Doone, Kornbow, Mintz Pond, and Glenville Lake are a series of impoundments of Little Cross Creek and serve as backup water supply sources for the City of Fayetteville. All are restricted to the public. Mott Lake and Hope Mills lake have also been monitored. Activities at Fort Bragg and the general soil type of the area have contributed to extreme sedimentation problems at Bonnie Doone Lake. Trophic states of these six lakes range from eutrophic (Bonnie Doone, Mintz Pond, Glenville Lake and Hope Mills Lake) to mesotrophic (Kornbow Lake) to dystrophic (Mott Lake). Glenville Lake and Hope Mills Lake are designated as Threatened due to the elevated nutrients found. Mintz Pond was designated Threatened due to the elevated nutrient and turbidity levels and low dissolved oxygen levels.

4.3.4 Black River Watershed (Subbasins 18, 19 and 20)

South and Black Rivers

Naming of the Black and South Rivers can cause confusion when discussing sampling sites and water quality information. The South River actually is called the Black River in its headwaters near Dunn, then becomes the South River until its confluence with the Black River, where the combined flow is named the Black River to its confluence with the Cape Fear River. These rivers have been described as among the most beautiful and least disturbed of North Carolina's coastal plain rivers. Both are slow moving, meandering, sandy bottomed, blackwater rivers, with extensive swampy floodplains dominated by bald cypress and gum trees. The South River has a drainage area of about 500 square miles, while the Black River drainage is much larger (1,560 square miles). The South River from Bladen County SR 1503 (approximately 2 miles downstream of the ambient location) to the Black River was designated High Quality Waters in 1990. The South River below Big Swamp was designated ORW in 1994.

Nonpoint runoff and/or channelization contribute to the Fair bioclassifications for the upper portions of the South (Black) River near Dunn. Much further downstream, an ambient site on the South River near Parkersburg has consistently been assigned an Excellent bioclassification since 1985, reflecting the sparsely settled catchment with very few point source dischargers. The median value for pH at this site from 1988 to 1993 was below the state standard of 6, a reflection of humic acid input from swamps. Fish tissue samples from two largemouth bass, collected in 1984 and 1987 from the ambient station, contained mercury levels slightly exceeding the EPA recommended screening value of 0.6 ppm. Tributary streams are often swampy and difficult to sample and evaluate. However, the fish community was sampled at Big Swamp and given a Good-Fair rating, which is typical for swamp systems with no flow during periods of the year. A South River fish community sample had excellent species diversity and received a rating of Good.

Bay Tree Lake, a Carolina Bay, is owned by the State of North Carolina. The lake is classified C-SW, is dystrophic, and fully supported all of its designated uses in 1993. In 1994, a fish consumption advisory was issued indicating that largemouth bass and bowfin taken from this lake should not be eaten. The advisory was issued after finding high mercury levels in fish tissue for those two fish species.

Great Coharie Creek and Six Runs Creek merge to form the Black River. Land adjacent to the Black River is primarily undisturbed forest and swamp and Clinton is the largest town in the watershed. The Black River from its source to the Cape Fear River, and Six Runs Creek below Cuwhiffle Swamp, were reclassified as ORW in 1994. The Black River from NC 411 to the South River had previously been designated HQW. These reclassifications were based on Excellent biological and physical/chemical data, as well as the river's recreational and ecological significance. An ambient site on the Black River (near Tomahawk) has consistently received an Excellent bioclassification, though high nutrient values have been found. Some small streams in this area have been affected by WWTPs, including Stewart's Creek below the Warsaw WWTP (Good-Fair). Most of the streams sampled in the watershed (Black River, Six Runs Creek, Great Coharie Creek and upstream sections of Little Coharie Creek) have received ratings of Excellent or Good. A downstream site on Little Coharie Creek declined from Good in 1989 to Good-Fair in 1993, based on benthos data. The fish communities sampled ranged from Poor-Fair ecological health ratings at the downstream Little Coharie site to Fair and Fair-Good on Great Coharie Creek. Other tributaries to the Black River have not been sampled because of their still, swamp-like nature. Singletary Lake, classified as B-SW, is used for swimming, boating, and fishing, and fully supports its designated uses.

Low dissolved oxygen levels during summer months are the only consistent water quality violation detected at another ambient monitoring station on the Black River near Huggins. Low dissolved

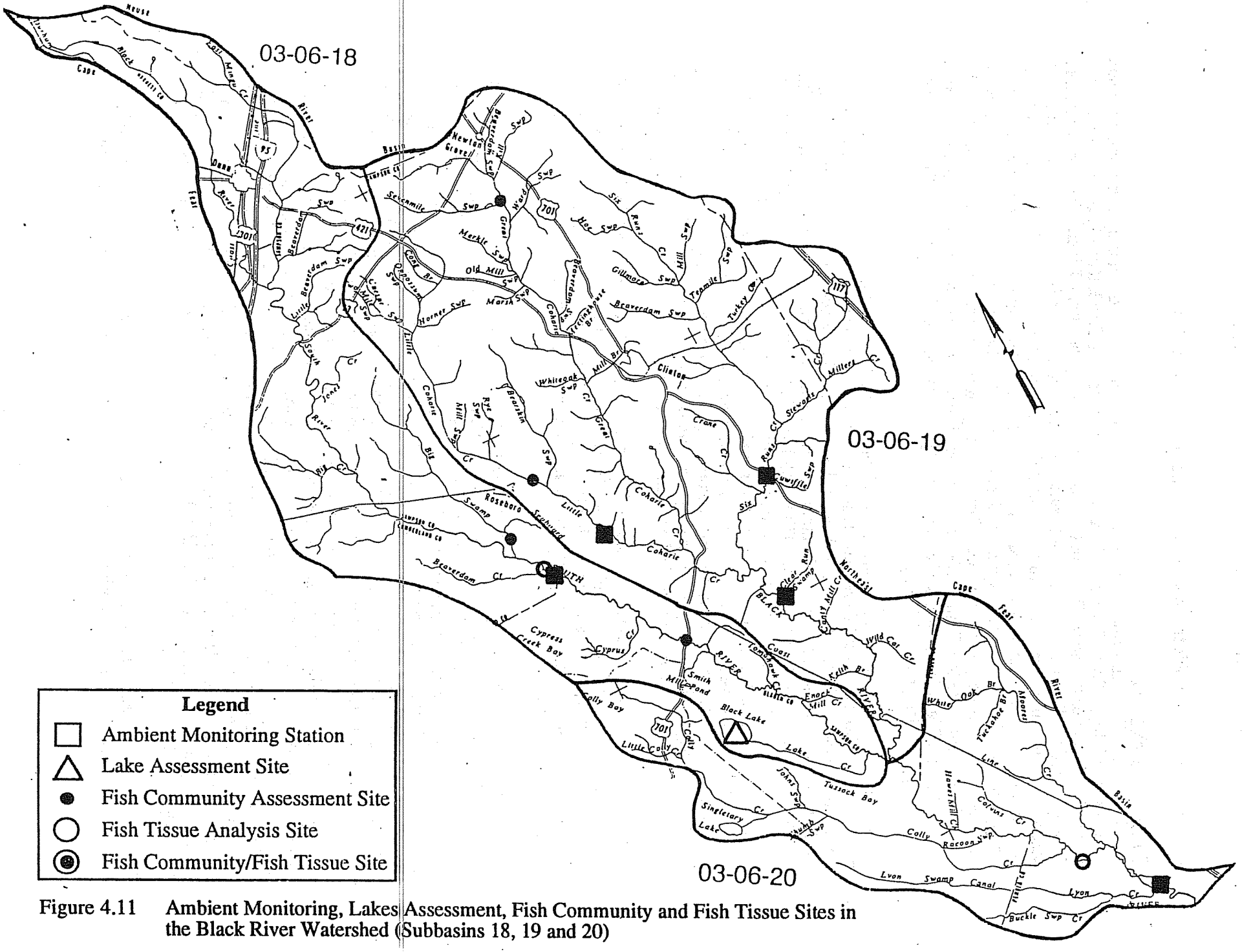


Figure 4.11 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sites in the Black River Watershed (Subbasins 18, 19 and 20)

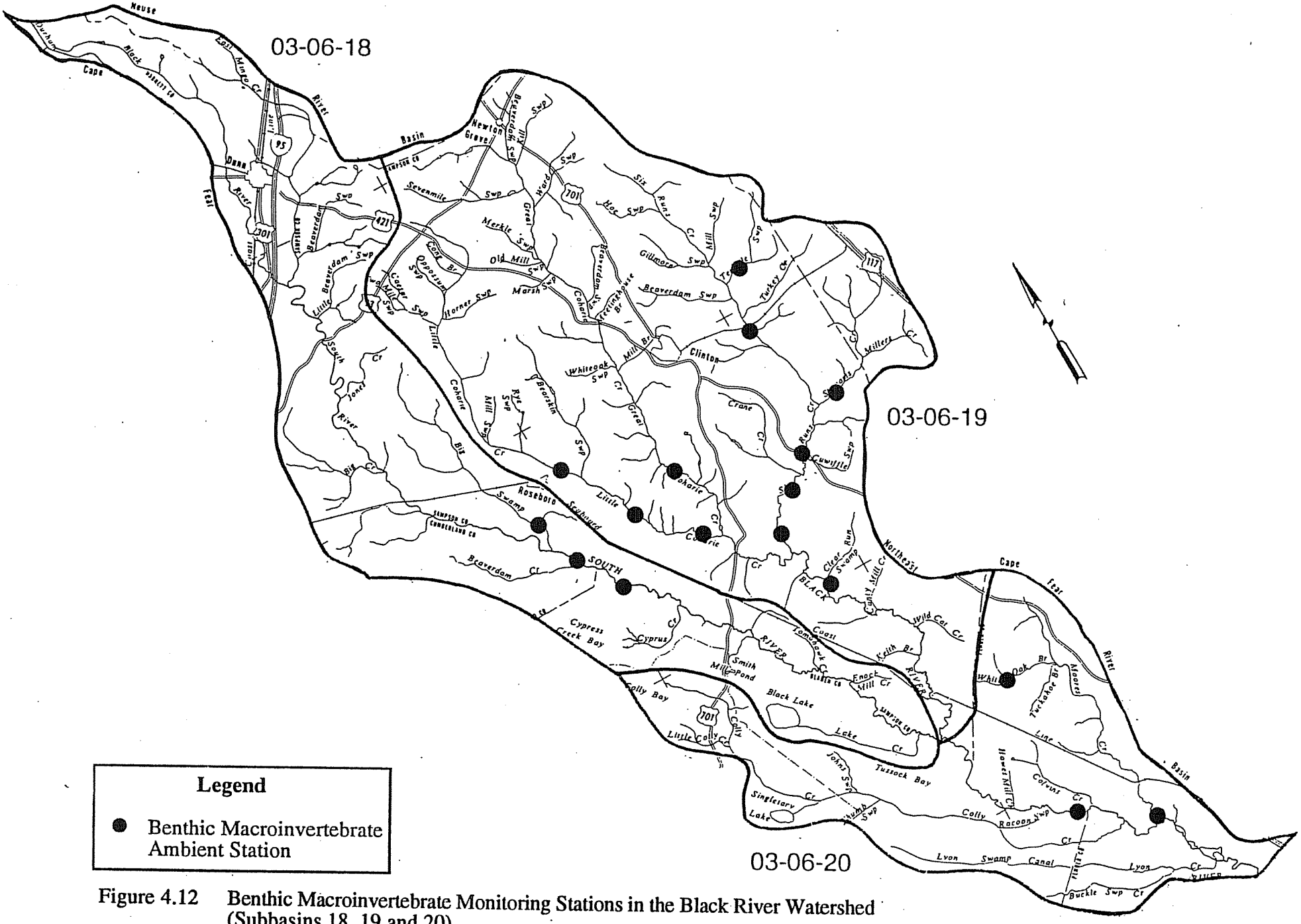


Figure 4.12 Benthic Macroinvertebrate Monitoring Stations in the Black River Watershed (Subbasins 18, 19 and 20)

Table 4.9 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Black River Watershed (83-93)

Subbasin 18

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
South R, NC 13, Sampson	108/B-1	18-68-12(0.5)	10/89	-/5	-/5.78	Fair
South R, nr Parkersburg, NC 242, Sampson	-/B-2	18-68-12(0.5)	10/89	-/26	-/3.91	Excellent
South R, SR 1502, Bladen	K/B-3	18-68-12(0.5)	8/93	75/25	5.29/3.75	Excellent
			6/87	84/29	5.44/3.85	Excellent
			9/85	94/30	5.43/3.90	Excellent
			7/83	76/25	5.49/4.12	Good
Black R, NC 421, Harnett	107/B-4	18-68-12-1	10/89	-/11	-/5.47	Fair
Black R, nr Dunn, SR1780, Harnett	53/B-5	18-68-12-1	7/84	53/13	6.79/5.93	Fair
Big Swamp, SR1246, Sampson	109/B-6	18-68-12-8	12/89	-/14	-/5.38	Good-Fair

Subbasin 19

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
Great Coharie Cr, SR 1214, Sampson	55/B-1	18-68-1	8/93	77/26	5.49/4.35	Good
			10/89	-/19	-/4.53	Good
			9/88	69/20	5.89/4.47	Good
			7/83	62/19	5.53/3.66	Good
Little Coharie Cr, NC 24, Sampson	-/B-2	18-68-1-17	8/93	-/20	-/4.69	Good
Little Coharie Cr, SR 1214, Sampson	110/B-3	18-68-1-17	8/93	-/17	-/4.08	Good-Fair
			10/89	-/23	-/3.86	Good
Little Coharie Cr, SR 1207, Sampson	110/B-4	18-68-1-17	9/88	-/17	-/3.94	Good-Fair
Six Runs Cr, SR 1004, Sampson	112/B-5	18-68-2	12/89	-/21	-/3.78	Good
Six Runs Cr, SR 1960, Sampson	-/B-6	18-68-2	8/93	-/28	-/3.54	Excellent
Six Runs Cr, SR 1130, Sampson	111/B-7	18-68-2	10/89	-/26	-/3.39	Excellent
Six Runs Cr, SR 1003, Sampson	-/B-8	18-68-2	9/88	-/25	-/4.07	Excellent
Tenmile Swamp, SR 1740, Sampson	54/B-9	18-68-2-4	12/86	58/6	7.65/5.92	Fair
Stewarts Cr, SR 1943, Sampson	113/B-10	18-68-2-10	12/89	-/17	-/4.73	Good/Fair
Black R, nr Tomahawk, NC 411, Sampson	L/B-11	18-68(3.5)	8/93	96/31	5.47/3.90	Excellent
			10/89	-/31	-/3.67	Excellent
			7/88	107/37	5.51/4.25	Excellent
		9/85	94/30	5.33/4.01	Excellent	

Subbasin 20

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
Black R, 3 Sisters Area nr NC 11, Bladen	-/B-1	18-68-(11.5)	9/88	72/22	5.60/4.07	Good
Black R, nr Atkinson, NC 11, Bladen	M/B-2	18-68-(11.5)	8/93	73/28	5.47/4.15	Excellent
			9/91	100/28	5.76/4.16	Good
			8/90	48/18	6.19/4.67	Good-Fair
			10/89	-/28	-/3.89	Excellent
			6/86	78/23	6.18/4.71	Good
White Oak Br, SR 1209, Pender	77/B-3	18-68-18-5	12/87	-/7	-/5.01	Fair

oxygen during the summer is not unusual in a slow moving system such as this one. Though the Black River does continue to flow throughout the year, other large tributaries such as Colly Creek and Moores Creek have periods of no flow. Fish tissue samples from the Black River in 1986 did indicate elevated levels of mercury in some pickerel and bowfin.

4.3.5 Northeast Cape Fear Watershed (Subbasins 21, 22 and 23)

Northeast Cape Fear River

The last downstream major tributary of the Cape Fear River is the Northeast Cape Fear River, which originates near Mt. Olive in southern Wayne County and Duplin County. Its drainage area is about 1,750 square miles. Chemical monitoring of the Northeast Cape Fear below Mt. Olive shows a stream undergoing stress. Brine discharges from Mt. Olive Pickle Company elevate conductivity values. Nutrients also tended to be high at the ambient site. Median Total Phosphorus was almost 0.3 mg/l with several values in the 1.0 - 1.5 mg/l range. Since 1988, however, phosphorus levels each year have declined from the previous year. Metals were also higher here than anywhere else on the Northeast Cape Fear River.

Benthos data indicate Good-Fair water quality in Buck Marsh Branch, which may be typical of many tributaries to the Northeast Cape Fear River. Many of the streams in this watershed stop flowing during parts of the year so bioclassifications may indicate more impact than expected by the severity of anthropogenic disturbance. Poor water quality was found in Barlow Branch and upper portions of the Northeast Cape Fear River. This Poor water quality is due to brine discharges from Mt. Olive Pickle Company, although recent upgrades at Mt. Olive have significantly reduced both the severity and extent of the impacts. Recovery from the discharge now appears to be complete four miles downstream of Barlow Branch. Mt. Olive Pickle has been under an SOC since 1992.

Benthos data indicates Good to Excellent water quality in the middle portion of the Northeast Cape Fear River with the section of the river between Muddy Creek and Rockfish Creek classified as High Quality Waters. Most of the tributaries, Goshen Swamp, Stockinghead Creek and Rockfish Creek, are rated Fair or Good-Fair, usually due to nonpoint sources of pollution. In addition to nonpoint sources, water quality in Panther Branch and part of Goshen Swamp appears to be degraded by Charles F. Cates and Sons, though not nearly as badly as before upgrades, and Persimmon Branch appears to be impacted by the Beulaville WWTP. Cabin Creek was impacted by he House of Raeford chicken processing plant in 1987, and Rockfish Creek was shown to be impacted by Wallace WWTP and also possibly Stevecoknit Fabrics in 1993. Charles F. Cates and Sons and Stevecoknit are under SOCs.

Grove Creek was rated Good-Excellent, Limestone Creek was rated Good, Halls Marsh Run was rated Fair, and Herrings Marsh Run was rated Poor-Fair based on fish community samples.

Data from the most downstream ambient site, the Northeast Cape Fear River at US 117 at Castle Hayne, indicates all parameters fall within normal ranges of a tidally influenced freshwater system. Benthos data indicate Good-Fair water quality at this site. Many tributaries draining the Holly Shelter Game Refuge appear to be unimpacted, however, most of the streams outside the wildlife refuge are subject to nonpoint sources of pollution. Many of these streams stop flowing during parts of the year. Water quality in Burgaw Creek was reported to be degraded by the Burgaw WWTP discharge in 1987. Cypress Creek, a low diversity swamp stream, was given a Fair NCIBI rating and Burgaw Creek was given a Poor-Fair rating at two sites below the WWTP in 1985.

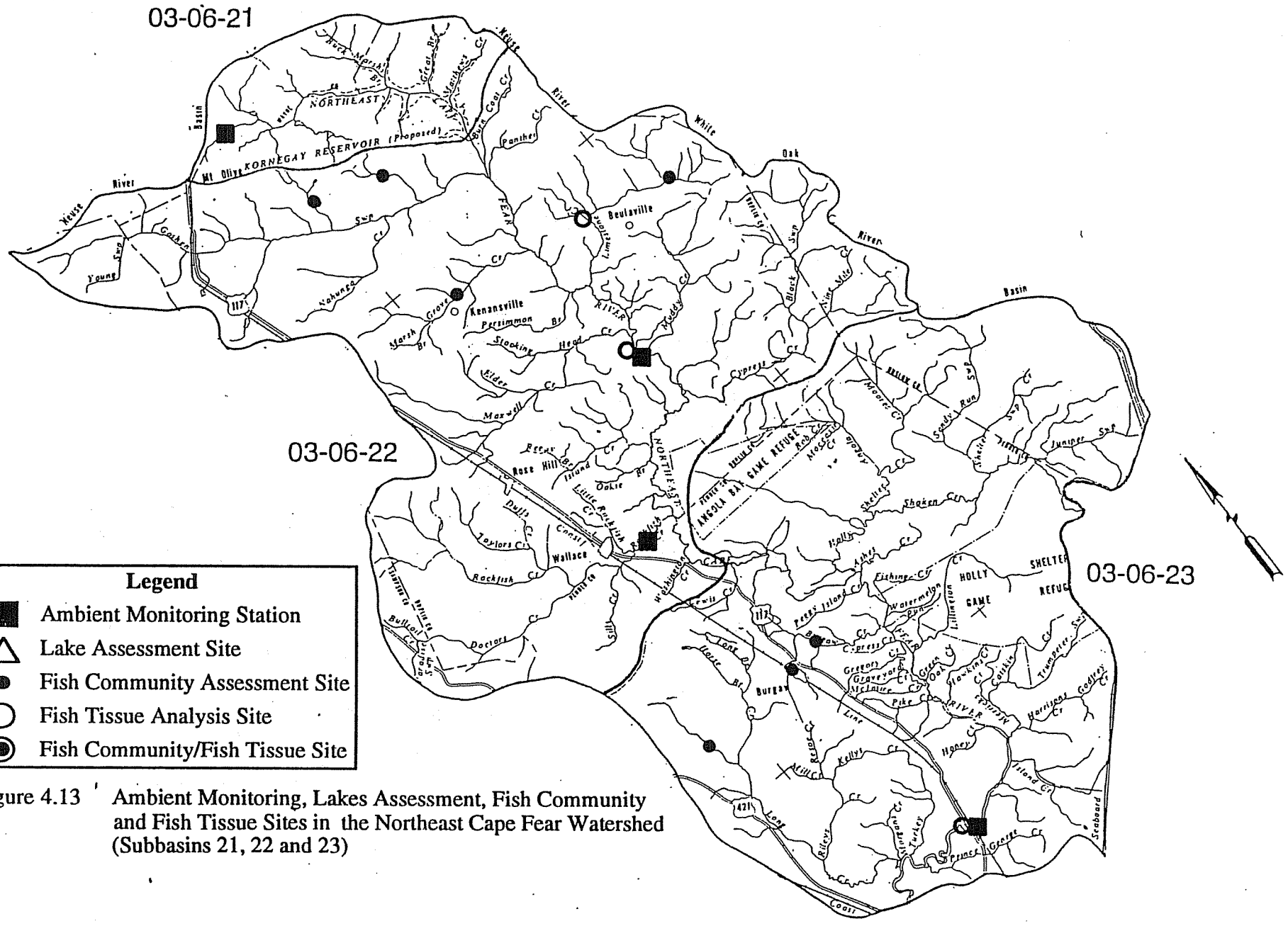


Figure 4.13 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sites in the Northeast Cape Fear Watershed (Subbasins 21, 22 and 23)

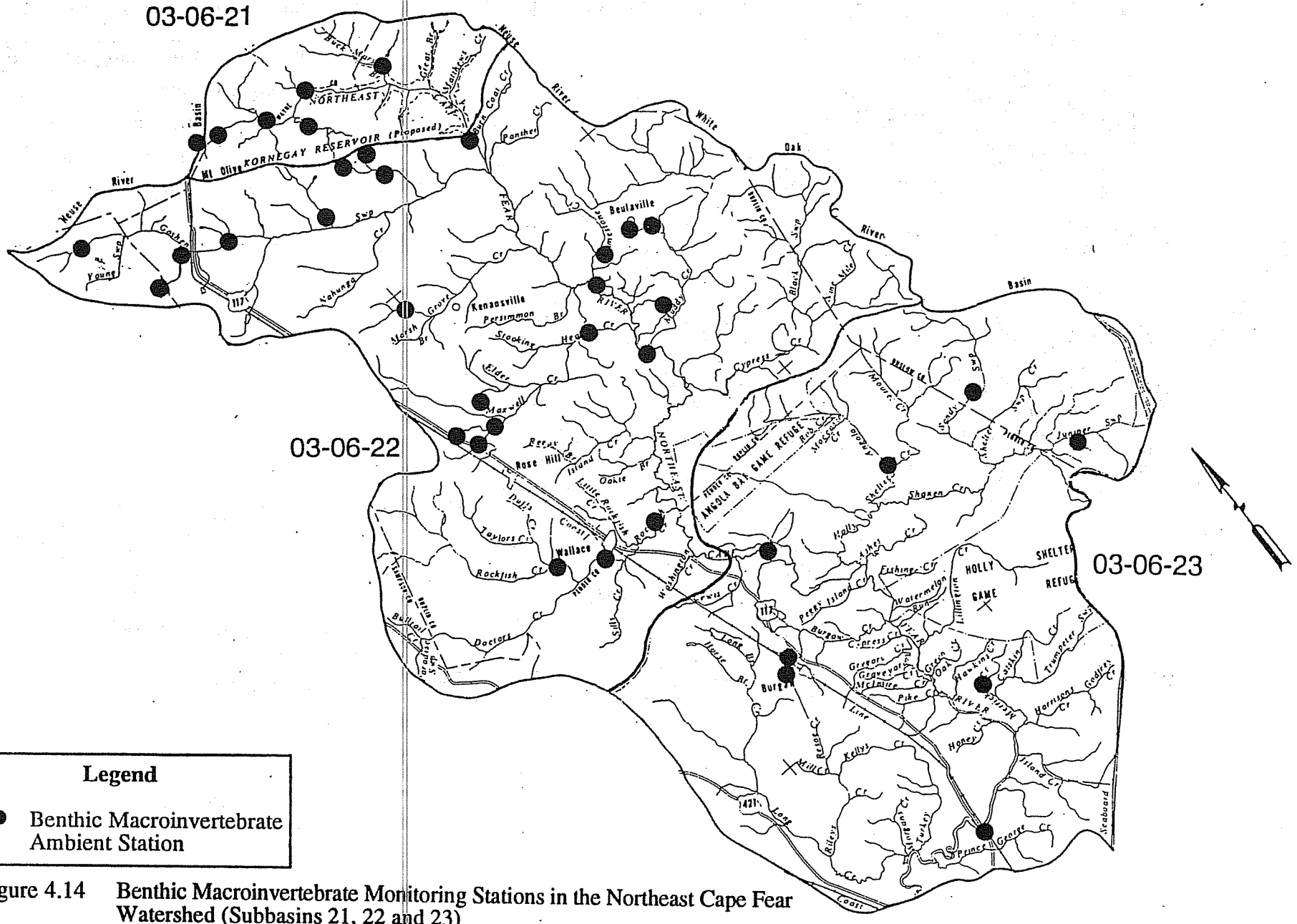


Figure 4.14 Benthic Macroinvertebrate Monitoring Stations in the Northeast Cape Fear Watershed (Subbasins 21, 22 and 23)

Table 4.10 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Northeast Cape Fear River Watershed (83-93)

Subbasin 21

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
NE Cape Fear R, SR 1558, Duplin	61/B-1	18-74-(1)	5/93	54/4	8.15/6.87	Poor
			6/86	13/0	8.08/ -	Poor
NE Cape Fear R, NC 403, Duplin	-/B-2	18-74-(1)	5/93	68/13	7.26/5.27	Fair
NE Cape Fear R, SR 1948, Duplin	-/B-3	18-74-(1)	5/93	67/15	6.46/4.88	Good-Fair
Barlow Br, Bell St in Faison, Duplin	63/B-4	18-74-2	5/93	26/0	9.18/ -	Poor
			6/86	8/0	9.63/ -	Poor
Polly Run Cr, SR 1501, Duplin	60/B-5	18-74-5	7/86	67/11	6.71/5.52	Fair
Buck Marsh Br, NC 111, Duplin	-/B-6	18-74-8	8/93	-/16	-/3.84	Good-Fair

CPF 22

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
NE Cape Fear R, NC 11/903, Duplin	62/B-1	18-74-(1)	8/93	78/23	5.33/3.89	Excellent
			6/86	32/8	5.47/4.34	Good-Fair
NE Cape Fear R, NC 41 nr Chinquapin, Dup.	N/B-2	18-74-(25.5)	8/93	82/22	5.41/4.52	Excellent
			10/89	85/28	5.89/4.06	Good
			8/89	83/30	5.37/4.13	Excellent
			9/85	89/31	5.65/4.00	Excellent
Goshen Swp, SR 1302, Wayne	-/B-3	18-74-19	5/93	62/8	6.98/5.30	Fair
Goshen Swp, NC 117, Duplin	-/B-4	18-74-19	5/93	51/11	6.98/5.44	Fair
Goshen Swp, NC 403, Duplin	-/B-5	18-74-19	5/93	56/10	7.00/5.57	Fair
Panther Br, NC 50, Duplin	-/B-6	18-74-19-3	12/86	64/11	6.79/5.10	Fair
Panther Br, be Faison UT, Duplin	57/B-7	18-74-19-3	5/93	35/1	8.51/6.22	Poor
			12/86	10/0	8.25/ -	Poor
Halls Marsh Run, SR 1306, Duplin	151/B-8	18-74-19-11	9/93	68/12	6.53/5.27	Good-Fair
			9/92	69/9	6.30/4.98	Good-Fair
			9/91	53/7	6.48/4.80	Fair
			9/90	68/11	6.51/4.92	Good-Fair
UT Herrings Marsh Run, SR 1508, Duplin	-/B-9	18-74-19-16	9/93	-/0	- / -	Poor
			9/92	-/7	- /5.22	Fair
			9/91	-/2	- /5.68	Poor
Herrings Marsh Run, SR 1508, Duplin	-/B-10	18-74-19-16	9/93	-/8	- /4.89	Fair
			9/92	-/8	- /4.94	Fair
			9/91	-/14	- /4.43	Good-Fair
Herrings Marsh Run, SR 1306, Duplin	150/B-11	18-74-19-16	9/93	71/15	6.94/5.45	Good-Fair
			9/92	72/13	6.60/5.13	Good-Fair
			9/91	67/11	6.20/4.87	Good-Fair
			9/90	74/10	6.77/5.63	Fair
			1/90	-/13	-/5.08	Fair
UT Grove (Maple) Cr , SR 1376, Duplin	152/B-12	18-74-21	9/90	62/15	6.29/4.61	Good-Fair
Limestone Cr, NC 24, Duplin	-/B-13	18-74-23	4/86	35/1	7.47/6.23	Poor
Limestone Cr, SR 1702, Duplin	-/B-14	18-74-23	8/93	-/25	-/4.52	Excellent
Stockinghead Cr, SR 1956, Duplin	-/B-15	18-74-24	8/93	-/13	-/4.59	Good-Fair
Maxwell Cr, SR 1921, Duplin	59/B-16	18-74-24-1	6/85	55/5	6.93/5.52	Fair
UT Beaverdam Cr, SR 1916, Duplin	74/B-17	18-74-24-1-1	4/87	49/4	7.35/5.05	Fair
Cabin Br, SR 1911, Duplin	72/B-18	18-74-24-1-1-1	4/87	37/0	8.46/ -	Poor
			6/85	48/2	8.74/8.94	Poor
Cabin Br, SR 1915, Duplin	73/B-19	18-74-24-1-1-1	4/87	20/0	9.41/ -	Poor
			6/85	38/0	8.93/ -	Poor
Muddy Cr, NC 41, Duplin	-/B-20	18-74-25	8/93	-/4	- /5.59	Good-Fair
Persimmon Br, ab Beulaville, Duplin	-/B-21	18-74-25-1	9/90	45/4	6.98/6.62	Fair
Persimmon Br, be Beulaville, Duplin	-/B-22	18-74-25-1	9/90	31/0	7.53/ -	Poor
Rockfish Cr, NC 41 at Wallace, Duplin	T/B-23	18-74-29	7/88	79/17	6.46/4.84	Good-Fair
Rockfish Cr, SR 1165, Duplin	-/B-24	18-74-29	8/93	81/14	6.38/4.79	Good-Fair
Rockfish Cr, I-40, Duplin	-/B-25	18-74-29	8/93	64/12	6.84/5.26	Fair

CPF 23

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
NE Cape Fear R, nr Watha, Pender	-/B-1	18-74-(1)	7/83	44/5	7.29/4.81	Fair
NE Cape Fear R, US 117, New Hanover	-/B-2	18-74-(1)	8/93	38/7	6.93/4.84	NR
			6/90	45/7	6.51/5.26	NR
			6/87	41/6	7.32/5.34	NR
			8/85	42/5	7.05/4.46	NR
Sandy Run Swp, NC 50, Onslow	-/B-3	18-74-33-2	8/93	31/0	7.51/ -	NR
			5/93	42/5	6.78/4.89	NR
			3/93	39/8	6.63/4.86	NR
Angola Cr, NC 53, Pender	-/B-4	18-74-33-3	8/93	52/11	6.01/4.42	NR
			5/93	68/17	6.23/4.93	NR
			2/93	61/18	6.13/5.18	NR
Juniper Swp, NC 50, Onslow	-/B-5	18-74-33-4-1	8/93	25/1	7.68/4.46	NR
			5/93	34/2	7.17/5.90	NR
			2/93	44/5	7.19/5.85	NR
Burgaw Cr, at old RR track, Pender	75/B-6	18-74-39	12/87	37/0	8.93/ -	NR
Burgaw Cr, US 117, Pender	76/B-7	18-74-39	12/87	14/0	9.44/ -	NR
Merrick's Cr, NC 210, Pender	-/B-8	18-74-49-2	5/93	51/13	6.23/4.42	NR
			2/93	52/15	6.39/5.23	NR

4.3.6 Lower Cape Fear River and Coastal Waters Watershed (Subbasins 16, 17 and 24)

This watershed area includes the mainstem of the Cape Fear River from the confluence with Grays Creek in Cumberland County (several miles upstream from the Bladen County line and Lock and Dam #3) down to mouth. It also includes the Intracoastal Waterway and its tributaries. The drainage area of the mainstem Cape Fear River is about 6,605 square miles. At its mouth, the river empties directly into the Atlantic Ocean, and much of this estuarine area has salinities high enough for the waters to be classified as shellfish waters (SA). Ambient and biological monitoring sites are presented in Figures 4.15 and 4.16.

Cape Fear Mainstem (Grays Creek to Livingstone Creek - subbasins 16 and 17)
As the Cape Fear River flows into the inner coastal plain it carries a large silt load, and much silt settles out in this portion of the river. The 1993 benthos data indicated a Good-Fair rating for the Cape Fear River near Duarte, below Lock and Dam #2 and at SR 1730 in Bladen County, although prior data (1984-1987) had assigned Fair ratings to this segment of the river. This improvement in bioclassification may be partly related to increased flow and better collecting techniques. Biological data from above and below Federal Paperboard Company on the Cape Fear River found low taxa richness at both sites which may have been influenced by sampling conditions, poor habitat, the influence of tides, and/or point source discharges. Some degradation below this facility was noted in the macroinvertebrate community, with bioclassification changing from Good-Fair above to Fair below. Currently Federal Paperboard Company is operating under a Special Order by Consent.

In subbasin 16, the Cape Fear River becomes flat and there is limited reaeration. The series of Lock & Dams slow the river down and create lake-like conditions under prolonged low flow events. In addition, the river receives significant point and nonpoint source loading with cumulative impacts to the river. In examining the ambient water quality data for the mainstem, concentrations of dissolved oxygen gradually drop from upstream to downstream as depicted in Figure 4.17 (see Figure 4.3 for interpretation of box and whisker plots). Though the monthly ambient data indicate no dissolved oxygen standard violations upstream of Hale Point Landing near Phoenix, special studies indicate that there are pronounced DO sags upstream of each dam. While usually meeting the 4.0 mg/l instantaneous dissolved oxygen standard, it is important to note that the ambient data are collected monthly at fixed stations and are best used for screening and long-term trend analysis. Intensive water quality characterizations and subsequent predictive modeling may suggest other critical locations and time periods that dissolved oxygen might be reduced to problematic levels. For example, self-monitoring data provided by dischargers show a number of locations where dissolved oxygen concentrations have dipped below the instantaneous standard of 4.0 mg/l (Figure 4.18). In subbasin 17, below Lock and Dam 1, dissolved oxygen becomes influenced by additional point source loads, swamp water from the Black River and tidal action. As a result, there are occurrences of dissolved oxygen concentrations falling below the 4 mg/l instantaneous standard above Wilmington during summer conditions.

Harrison Creek was assigned a Fair rating by both fish and benthic macroinvertebrates, but this rating may have been affected by very low pH (4.5). Other tributaries had better water quality ratings, including Ellis Creek (Good-Fair, benthos) and Browns Creek (Good, fish).

Estuarine Area
Large portions of this area have been classified as Outstanding Resource Waters, including Turkey Creek, Howard Channel, Long Point Channel, Green Channel, Cedar Snag Creek, Butler Creek, Nixon Channel and Howe Creek. ORW areas also include portions of Stump Sound, Everett Bay, Middle Sound, Masonboro Sound and the Intracoastal Waterway. Two High Quality Waters areas

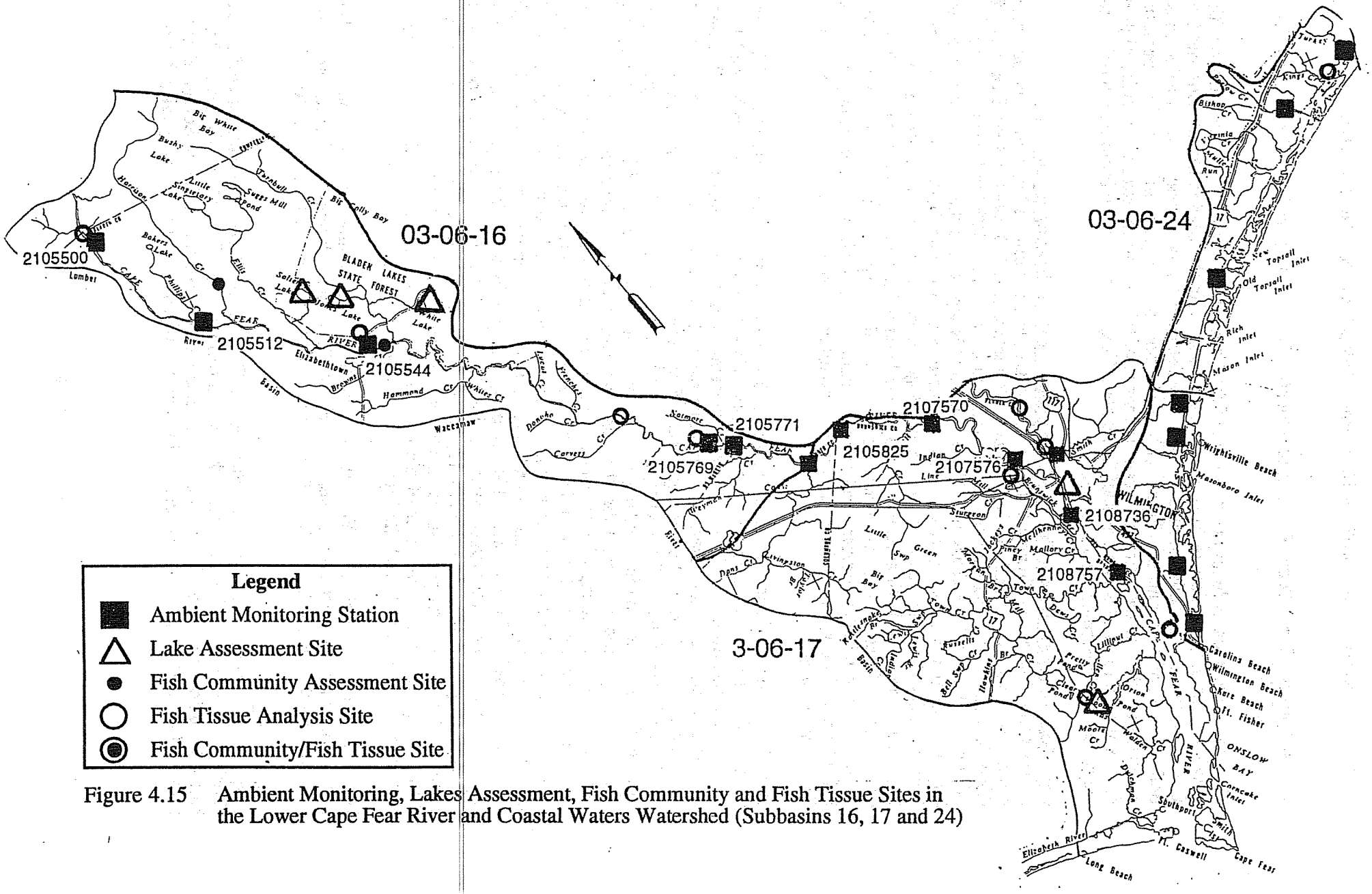


Figure 4.15 Ambient Monitoring, Lakes Assessment, Fish Community and Fish Tissue Sites in the Lower Cape Fear River and Coastal Waters Watershed (Subbasins 16, 17 and 24)

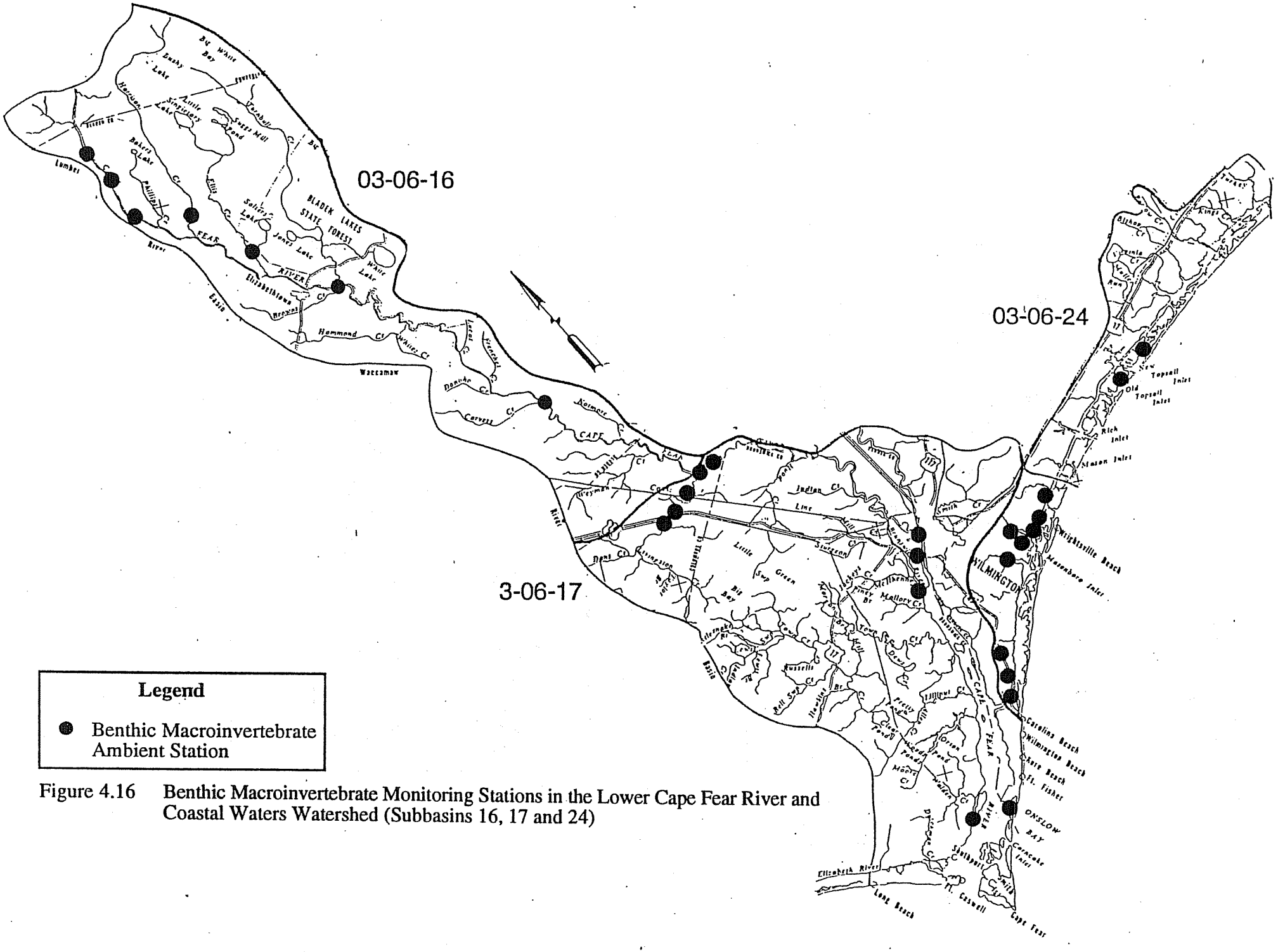


Figure 4.16 Benthic Macroinvertebrate Monitoring Stations in the Lower Cape Fear River and Coastal Waters Watershed (Subbasins 16, 17 and 24)

Figure 4.17 Box Plots of Dissolved Oxygen Concentrations at Ambient Monitoring Stations on the Cape Fear River Mainstem (1988 to 1993)

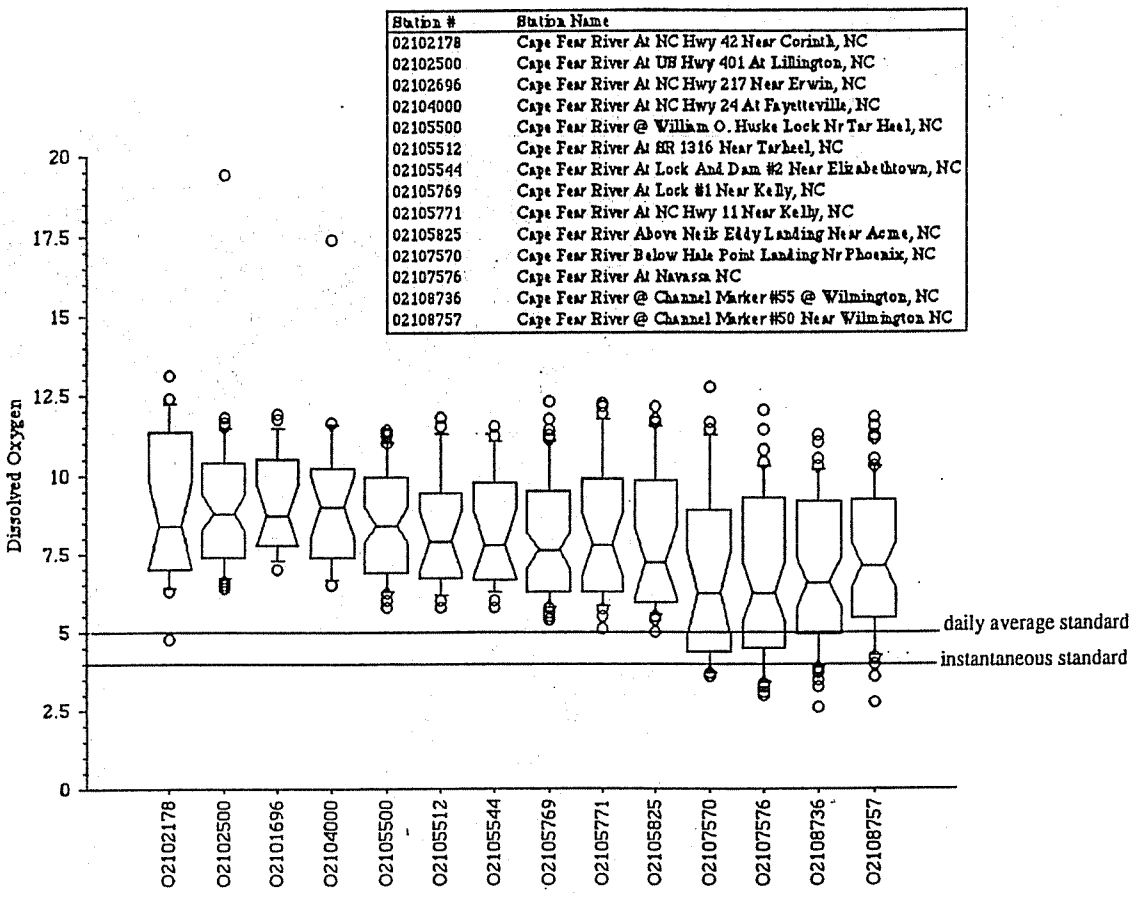


Figure 4.18 Dissolved Oxygen Concentrations for the Cape Fear River from Discharger Self-monitoring data (April - October, 1993 & 1994) Buckhorn Dam to Wilmington (160 miles)

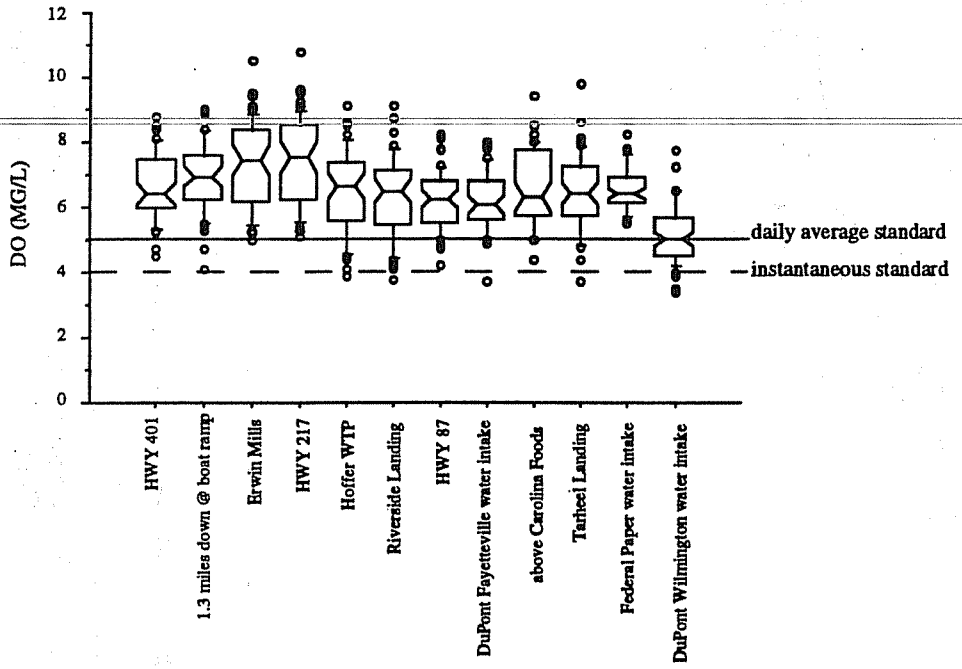


Table 4.11 Benthic Macroinvertebrate Sampling Sites and Data Summary for the Lower Cape Fear River and Coastal Waters Watershed (83-93)

Subbasin 16

Site	Old/New DWQ #	Index #	Date	S/EPT S	BI/BIEPT	Bioclass
Cape Fear R, nr Duarte, Bladen	-/B-1	18-(26)	08/93	50/10	6.37/4.69	Good-Fair
Cape Fear R, ab Carolina Foods, Bladen	-/B-2	18-(26)	09/92	47/15	6.18/4.70	Good-Fair
Cape Fear R, be Carolina Foods, SR 1316, Cumberland	Q/B-3	18-(26)	09/92	45/11	6.56/4.88	Good-Fair
			06/87	41/7	7.24/5.22	Fair
Cape Fear R, below Lock 2, Bladen	-/B-4	18-(26)	08/93	53/15	6.74/5.24	Good-Fair
Ellis Cr, NC 53, Bladen	-/B-5	18-44	08/93	-/16	-/3.88	Good-Fair
Harrison Cr, SR 1318, Bladen	-/B-6	18-42	08/93	-/11	-/3.61	Fair
Cape Fear R, at Kelly, SR 1730, Bladen	J/B-7	18-(53.5)	08/93	48/11	6.51/4.74	Good-Fair
			08/90	44/12	7.42/4.28	Fair
			07/88	69/12	7.14/6.35	Fair
			06/86	51/6	7.25/6.83	Fair
			06/84	52/7	7.20/5.66	Fair

Subbasin 17

Site	Old/New DWQ#	Index#	Date	S/EPTS	BI/BIEPT	Bioclass
Cape Fear R, ab Federal Paper, Columbus	-/B-1	18-(59)	8/93	45/8	6.61/5.31	Good-Fair
Cape Fear R, be Federal Paper, Columbus	-/B-2	18-(63)	8/93	32/5	7.21/5.34	Fair
Livingston Cr, NC 74, Columbus	-/B-3	18-64	8/93	68/9	7.32/5.50	Fair
Livingston Cr, off SR 1878, Columbus	-/B-4	18-64	8/90	39/4	7.65/4.22	NR
Livingston Cr, off SR 1878, Columbus	-/B-5	18-64	8/90	24/0	8.73/-	NR
Cape Fear R, at Wilm. Docks, New Han.	-/B-6	18-(71)	6/93	9/0	1.0*	NR
Cape Fear R, at Wilm. Southside WWTP	-/B-7	18-(71)	6/93	20/0	1.5*	NR
Brunswick R, nr mouth, New Hanover	-/B-8	18-77	6/93	26/0	1.8*	NR
Cape Fear R, at Snow's Marsh, Brunswick	-/B-9	18-(87.5)	6/93	63/0	2.0*	NR
			6/93	17/0	2.0*	NR
			7/85	38/0	2.1*	NR
The Basin, at Zeke's Island, New Hanover	-/B-10	18-88-8-1	7/85	61/0		NR

Subbasin 24

Site	Old/New DWQ #	Index #	Date	Total S	Biotic Index*	Bioclass
Topsail Sound, nr Marker 5, Onslow	-/B-1	18-87-10	6/93	46	2.0	NR
Black Mud Channel, Onslow	-/B-2	18-87-13.5	6/93	24	2.8	NR
Howe Cr, New Hanover	-/B-3	18-87-23	2/93	28	2.7	NR
			5/93	14	2.1	NR
ICWW, N of US 74, New Hanover	-/B-4	18-87-24	6/93	5	1.9	NR
ICWW, Bridgetender Marina, New Hanover	-/B-5	18-87-24	6/93	17	1.2	NR
Bradley Cr, Bradley Cr Marina, New Hanover	-/B-6	18-87-24-4-(2)	2/93	37	1.7	NR
			5/93	30	1.9	NR
Bradley Cr, nr No Wake Sign, New Hanover	-/B-7	18-87-24-4-(2)	2/93	35	1.9	NR
Hewletts Cr, New Hanover	-/B-8	18-87-26	2/93	42	2.0	NR
			5/93	17	1.6	NR
Carolina Inlet Marina, New Hanover	-/B-9	18-87-(30.5)	6/93	27	1.5	NR
ICWW, Marker 156, New Hanover	-/B-10	18-87-(30.5)	6/93	21	1.9	NR
ICWW Spur, S of Snows Cut, New Hanover	-/B-11	18-87-31.2	6/93	11	1.2	NR

* The estuarine Biotic Index is a 1-5 scale (freshwater BI is 0-10) and higher values indicate more intolerant taxa.

NR=Not Rated

have also been designated in this subbasin based on their use as primary nursery areas: King Creek and Bradley Creek above US 17/74/76. Because of the large number of ORW areas in this subbasin, water quality can be inferred to be generally Good to Excellent due largely to good tidal flushing. Most water quality problems in this subbasin are related to urban nonpoint runoff and large marinas.

Seven ambient sites are located along the Intracoastal Waterway in this subbasin. It appears that water quality is generally good in this estuarine area, with most water quality problems coming

from outside the subbasin. To the south, Snow's Cut brings in lower salinity, nutrient enriched (high Total Phosphorus and Nitrate/Nitrite-Nitrogen) water from the Cape Fear River. This mostly affects Carolina Beach Harbor, but some effects can also be seen at Everetts Creek. In the north, water from the New River (NSW) is sometimes blown southwest to the Goose Bay station and occasionally as far as Morris Landing, bringing with it elevated levels of Total Phosphorus and Total Kjeldahl Nitrogen.

Much of the benthos data in collected in 1993 was aimed at the lower sections of the Brunswick River and Cape Fear River near, and south of Wilmington (Table 4.11). Only one benthos site has prior data which indicates there has been little degradation in the water quality in the lower Cape Fear River since 1985.

4.4 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.4.1 Introduction to Use Support

Determining the *use support* status of a waterbody, that is how well a waterbody supports its designated uses, is another important method of interpreting water quality data and assessing water quality. Use support assessments are presented in Section 4.5 using figures, tables and maps for freshwater streams, lakes and estuaries within the Cape Fear River Basin.

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

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

4.4.2 Interpretation of Data

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

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

The data are not intended to provide precise conclusions about pollutant budgets for specific watersheds. Since the assessment methodology is geared toward general conclusions, it is important to not manipulate the data to support policy decisions beyond the accuracy of these data.

For example, according to this report, nonpoint source pollution is thought to be the most widespread source of the impairment of water quality. However, this does not mean that there should be no point source control measures. As discussed in previous sections of this chapter, and in Chapter 6, many stream miles in the basin are impacted by point source discharges, but the degree of impact has not resulted in a partial or nonsupport rating. What is clear from the plan is that all categories of point and nonpoint source pollution have the potential to cause significant water quality degradation if proper controls and practices are not utilized.

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

4.4.3 Assessment Methodology - Freshwater Bodies

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

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

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

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

Another valuable source of data used for the report was biological rankings from 1983 through 1992 as determined from benthic macroinvertebrate surveys discussed in section 4.2. The most recent report on these surveys (NCDEHNR, DWQ 1994) is available from DWQ's Environmental Sciences Branch. Data from North Carolina's Biological Monitoring Ambient Network (BMAN), in addition to special macrobenthic studies were ranked on a five point scale. This scale is based on taxa richness for the three pollution intolerant groups of Ephemeroptera, Plecoptera and Trichoptera (EPT).

Collected specimens are identified to the lowest possible taxonomic level. Total species (or taxa) richness values for the EPT groups are calculated and biological classifications assigned to each station (Excellent, Good, Good-fair, Fair or Poor). Higher species richness values are associated with better water quality. For ranking purposes, stations classified as "Poor" with regard to biological data are rated not supporting (NS) and stations classified as "Fair" are rated partially

supporting (PS). Stations classified as "Good-Fair" are rated as support-threatened (ST) and those having a Good to Excellent bioclassification are rated as supporting (S) their designated uses.

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

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

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

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

Once all monitored and evaluated information was located on water basin maps, remaining "unassessed" streams and segments were evaluated to have the same use-support if they were a direct or indirect tributary to monitored or evaluated segments rated supporting and support-threatened. Partially and nonsupporting segments were not extended. US Geological Survey (USGS) 7.5 minute topographic maps (1:26,000 scale) and orthophotoquads were used to determine probable sources for all impaired streams when other sources, such as WWTP compliance data, were insufficient.

4.4.4 Assessment Methodology - Saltwater Bodies

Saltwater Classifications

All tidal saltwaters are classified for their best usage with the following class descriptions:

Class SC - Secondary Recreation and Aquatic Life
Class SB - Primary Recreation plus SC uses
Class SA - Shellfishing for Market Purposes plus SC/SB uses

Supplemental classifications, such as swamp water (Sw), high quality waters (HQW), outstanding resource waters (ORW), or nutrient sensitive waters (NSW) may also be applied. Water quality standards for saltwater bodies were developed to protect these best uses.

Data Sources

When determining the Use Support Ratings for estuarine waters, (depending on the availability of the data,) all or a combination of the following sources of data are used: ambient monitoring data (physical/chemical data), NCDEHNR Division of Environmental Health's Shellfish Sanitation s Unit's sanitary surveys, and phytoplankton data.

Ambient monitoring data for saltwater bodies is interpreted using a program in 4thDimension. This program compares the ambient data to the appropriate numerical standards and determines the percent of violations. This information is used in the use support process as follows:

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

Within the NCDEHNR Division of Environmental Health, the Shellfish Sanitation Unit is responsible for determining the status of the shellfishing waters and maintaining a historical record of the opening and closing of designated shellfishing waters. The Shellfish Sanitation Unit has divided the saltwater bodies by area, and sanitary surveys are conducted on these areas every three years to evaluate factors that affect the sanitary quality of a shellfish growing area.

Prolific growths of phytoplankton may result in blooms which are deleterious to water quality, causing fish kills, anoxia, taste and odor problems. Criteria used to determine blooms are as follows: an algae sample with a biovolume larger than 5,000 mm3/m3, density greater than 10,000 units/ml or chlorophyll-a concentration approaching the 40 microgram/l standard. The magnitude and duration of bloom are also considered when using this information in the use support process. No coastal waters in the Cape Fear River Basin have been found to be impaired based on the above bloom criteria.

Assigning Use Support Ratings

When assessing estuarine or saltwater bodies, they are divided by the Shellfish Sanitation unit areas. All available data is reviewed for each area, and each area is assigned a rating. The use classification is also considered for each area, and data is reviewed according to the appropriate standards. If an area has sections that have different use classifications, the use support ratings assigned to that area may differ according to the classification. For example, if an area is divided into two sections, with one section classified as SC and the other is SA, and the only available data is the sanitation survey which indicates that the entire area is closed to shellfishing, the area classified as SA would be rated as PS and the area classified as SC would be rated as S. The entire

area is not rated PS because only the commercial shellfishing harvest use (as defined with the SA classification) is impaired. All of the uses associated with the SC classification are still fully supporting. If several sources of data are available in an area, all of the data are reviewed, and the rating is based on the combination of these data sources.

4.5 USE SUPPORT RATINGS FOR THE CAPE FEAR RIVER BASIN

Use Support ratings for all monitored and evaluated surface waters in the basin are presented on color coded maps in Figure 4.19 (3 pages). Use support ratings and background information for all monitored stream segments are presented in Table 4.12 (five pages).

4.5.1 Freshwater Streams and Rivers

Freshwater Streams and Rivers

Of the 6204 miles of freshwater streams and rivers in the Cape Fear basin, use support ratings were determined for 90% or 5601 miles with the following breakdown:

SUPPORTING 72%
- Fully supporting (38%)
- Support-threatened (34%)

IMPAIRED 18%
- Partially supporting (15%)
- Not supporting (3%)

NOT EVALUATED: 10%

Table 4.13 and Figure 4.20 summarize the use support determinations for freshwater streams for 23 of the basin's 24 subbasins. In subbasins 01 through 04, 06, 07, 09, 10 and 12 through 23, the total of the miles rated supporting and support-threatened accounted for more than 50% of the stream mileage for each basin. Subbasins 05, 08 and 11 had a larger percentage of streams which were rated as impaired (ie., partially supporting or not supporting).

Probable causes and sources of impairment were determined for about 76% of the impaired streams with the information summarized in Tables 4.14 (sources of impairment) and 4.15 (causes of impairment). When a stream segment had more than one cause or source listed, the total stream segment information was added to each cause or source. This means that the miles of stream impaired by the combination of all sources or all causes may be more than the total miles of partially and not supporting streams presented in Table 4.13. As an example, if a 10-mile long stream segment was determined to be impaired as a result of both point sources and urban development, then 10 miles would be entered under both the urban column and point source column in Table 4.14. Where the sources of impairment could not be identified, no mileage for that segment was entered into Table 4.14. Sediment was the most widespread cause of impairment throughout the basin, followed by turbidity, pH, metals, fecal coliform bacteria and ammonia.

Information on sources of impairment for stream miles rated partially or not supporting indicated that 870 stream miles were impaired by nonpoint sources, and 181 stream miles were impaired by point sources. Agriculture was the most widespread nonpoint source, followed by urban runoff and construction. Subbasins 03, 11, 18 and 22 each had more than 40 miles of streams impaired by agricultural sources. Subbasins 02, 05, 15 and 17 had the highest number of stream miles impaired by urban runoff while subbasins 05, 08, 15 and 17 had the highest number of stream miles impaired by construction.

4.5.2 Salt (Estuarine) Waters

Use support determinations were made for all of the 39,200 acres of saltwater in the Cape Fear Basin. Approximately 73 percent of the saltwaters were rated as fully supporting and the remaining 27 percent were rated partially supporting. Table 4.16 presents the use support determinations by Division of Environmental Health (DEH) area. It also includes probable causes and sources of use support impairment. A map of DEH areas is shown in Figure 4.21.

Fecal coliform bacteria was the most widespread probable cause of impairment followed by low dissolved oxygen. Elevated levels of fecal coliform bacteria are an indicator of water quality degradation that requires the closure of shellfishing areas. Approximately 18,732 acres of open waters in the basin have been closed to shellfish harvesting by the DEH Shellfish Sanitation Branch. Of this total, however, approximately 4,800 acres are classified as SA (shellfish) waters by DWQ. This smaller figure is the number used by DWQ for determining the acreage of impaired coastal waters based on fecal coliforms/closed shellfish waters. DEH has also indicated that all of the remaining 18,732 acres of open waters not permanently closed to shellfish harvesting may at time be closed on a temporary basis. The 3505 acres of open waters in areas B1 and B9 are conditionally open and they regularly close after a 1-1/2 inch rain. Other waters have closed after extraordinarily heavy rains or high river flows. Closures may run from several days to several weeks. DEH staff regularly monitor fecal coliform levels in the waters and when the levels are considered safe the waters are reopened.

Nonpoint source pollution is estimated to be the primary pollution source in 77% of the impaired waters, with the remaining 23% impaired due to point sources. Waters were impacted primarily by multiple nonpoint sources including agriculture, urban runoff, septic tanks and marinas.

4.5.3 Lakes

Thirty-six lakes in the Cape Fear basin totaling 32,475 acres were monitored and assigned use support ratings (Table 4.17). Ratings were determined based on criteria presented in Table 4.18. The number of lakes falling into each use support category are presented below:

SUPPORTING 34
Fully supporting: 18%
Fully supporting but threatened: 16%

IMPAIRED 2
Partially supporting: 1%
Not supporting: 1%

The majority of the lakes rated as support-threatened were given this rating due to elevated nutrients, although several also had problems with aquatic weeds. Of the impaired lakes, Black lake was rated partially supporting because a fish consumption advisory was issued due to certain fish containing mercury at levels of concern. Greenfield lake was rated not supporting due to ongoing problems with nuisance filamentous algal blooms, fish kills and aquatic macrophytes.

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 1 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
SUBBASIN 01															
02093250	Haw River near Oak Ridge, SR-2109	C NSW	16-(1)a	7.2	S					F			PS	Jul-92	NP,P
0209331280	Haw R at US 29A near Benaja, Rockingham Co	C NSW	16-(1)b	20.0	S					G- F		Sed	ST	Jul-92	NP
02093599	Haw River near Altamahaw, NC 87, Ambient at SR1561	C NSW	16-(1)c	15.8	PS		F			G		Turb(14)	S	Jul-92	NP,P
	Brooks Lake Trib, Scout Camp, Guilford	B NSW	16-4-1-(1)	1.2			Ex						S	Jul-92	NP
	Candy Cr, SR 2700, Guilford Co.	C NSW	16-5	3.6			F						PS	Jul-92	NP
	Troublesome Cr, SR 2422, Rockingham	WS-III NSW CA	16-6-(0.7)	5.8						G- F	Pr	Sed	PS	Jul-92	NP
	Little Troublesome Cr, Reidsv. WWTP	C NSW	16-7a	2.9					F				PS	Mar-90	NP
02093423	Little Troublesome Cr, incl SR 2598 station & SR 2600.	C NSW	16-7b	6.5	PS					Pr		Turb(13)	NS	Mar-90	P
SUBBASIN 02															
02096500	Haw River at Haw River, NC 49	C NSW	16-(1)d	13.9	PS							Turb(20),Cd(16),Fecal	PS	Jul-92	NP,P
	Haw River at NC 54 at Graham	C NSW	16-(1)e	3.1		G-F				G- F			ST	Jul-92	
02093800	Reedy Fork near Oak Ridge, SR-2128	WS-III NSW	16-11-(1)	12.4	S					G- F		Sed	ST	Mar-90	P
	Horsepen Cr at US 220, Guilford Co.	WS-III NSW	16-11-5-(0.5)	6.9						F			PS	Jul-92	NP
	UT Horsepen Cr, Friendly Rd, Guilford	WS-III NSW CA	16-11-5-1-(2)	2.9					Pr				NS	Jan-88	
02095681	Reedy Fork benthic: SR 2728 Guilford, fish: SR2719	C NSW	16-11-(9)a	11.5						G- F	G		S	Jan-88	NP
02095681	Reedy Fork at Ossippee, NC 87 Alamance	C NSW	16-11-(9)b	9.8	S	F				G- F			ST	Jan-88	NP,P
02095500	N. Buffalo Cr nr Greensboro, SR 2832; below WWTP	C NSW	16-11-14-1a	8.5	NS					Pr		NH3(47),Fecal	NS	Jul-92	NP, P
	S. Buffalo Cr at McLeansville; at US 70	C NSW	16-11-14-2a	18.6						F		Sed	PS	Jul-92	NP
02095091	South Buffalo Cr at SR 2821	C NSW	16-11-14-2b	4.3	NS					Pr		NH3(20),Cd(32)	NS	Jul-92	
	Stony Cr, SR 1100, Caswell	WS-II NSW	16-14-(1)	12.1						G			S	Jan-88	
0209622751	Jordan Cr at SR 1002, Near Union Ridge, Alamance Co.	WS-II NSW	16-14-6-(0.5)	10.9	S					G- F	G		S	Jan-88	NP
0209651840	Town Cr. SR 2109, near Graham, Alamance Co	C NSW	16-17	4.0	PS							Turb(13),Fecal	PS	Mar-90	
	Little Alamance Cr, SR 2309, Alamance	C NSW	16-19-11	12.3							F- G	Sed	ST	Jan-88	NP
	Haw Cr SR 2158	C NSW	16-20-(4)	3.6						G- F			ST	Jan-88	
SUBBASIN 03															
0209666850	Little Alamance Cr ambient: NC HWY 61 nr Whitsett, ben	WS-IV NSW CA	16-19-3-(4.5)	0.5	S					G		Sed	S	Jul-92	NP
	Big Alamance Cr, NC 49, Alamance	C NSW	16-19-(4.5)a	4.5						G- F			ST	Jan-88	P
02096813	Big Alamance Cr near Bellemont, SR-2309, ambient at 211	C NSW	16-19-(4.5)b	6.5	S	G/F							ST	Jan-88	P
	Stinking Quarter Cr at SR 1136, Alamance Co.	C NSW	16-19-8	5.1						G- F	G- Ex		S	Jul-92	
SUBBASIN 04															
0209666850	Haw River near Saxapahaw, SR-1005	C NSW	16-(1)i	6.9	PS	G/F	G- F			G- F		Turb(14)	ST	Jul-92	
	Cane Cr at SR 1114 & SR 1100, Orange Co	WS-II NSW CA	16-27-(2.5)	4.7						G- F			ST	Jan-88	
	Cane Cr NC 87 Alamance	C NSW	16-28b	15.2						G- F			ST	Jan-88	
	Collins Cr ab & be WWTP, Orange	C NSW	16-30-(1)	8.1				G- F				Sed	ST	Jan-88	NP,P
	Terrels Cr, NC 87 Chatham	WS-IV NSW	16-31-(2.5)a	4.0						G	F- G		S	Jul-92	
	Dry Cr, SR 1520 Chatham	WS-IV NSW	16-34-(0.7)	9.6						G			S	Jul-92	NP
02096960	Haw River near Pittsboro, US Hwy 64 and at 15/501	WS-IV NSW	16-(36.7)	3.4	PS		G			G		Turb(18)	S	Jul-92	
	Pokeberry Cr, SR 1711 Chatham	WS-IV NSW	16-37	8.1						G- F			ST	Jul-92	P
	Robeson Cr ab WWTP	WS-IV NSW	16-38-(3)a	0.9			Pr						NS	Jul-92	NP
02097189	Robeson Cr near Seaforth (also be WWTP)	WS-IV NSW	16-38-(3)b	4.7	PS		F					pH(12),Chla(20)	PS	Jul-92	NP
SUBBASIN 05															
	New Hope Cr, SR 1734, Orange	C NSW	16-41-1-(.5)	21.0						G			S	Mar-90	NP,P
02097299	Third Fork Cr near Blands, NC 751	WS-IV NSW	16-41-1-12-(2)	4.5	PS					Pr		Turb(18)	NS	Jul-92	NP
	Bolin Cr. SR 1777 and Village Rd, Orange (B2&B3)	C NSW	16-41-1-15-1-(.5)	9.0						G			S	Jan-88	
02097360	Bolin Cr at Chapel Hill, E. Franklin St. (benthci)	WS-IV NSW	16-41-1-15-1-(4)	1.0	S					F			PS	Jan-88	
	Northeast Cr at 1102, Durham	WS-IV NSW	16-41-1-17-(7)a	2.2						F	G		PS	Jan-88	NP
0209741955	Northeast Cr near Nelson/benthic at SR 1100 Durham	WS-IV NSW	16-41-1-17-(7)b	1.8	PS					F		Turb(14),Cu(14),Sed	PS	Mar-90	NP, P
	Northeast Cr at SR 1731, Chatham	WS-IV NSW	16-41-1-17-(7)c	4.4						F	Pr- F	Sed	PS	Jan-88	NP
	White Oak Cr. NC 751, Chatham	WS-IV NSW CA	16-41-6-(3.5)	0.5						F		Sed	PS	Jul-92	NP,P
02098198	Haw River below Jordan Dam near Moncure, NC	WS-IV	16-(42)	4.2	S								S	Jul-92	NP

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 2 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating 89-93	<------ Biological Ratings------> Benthic Macroinvertebrates 1989	1990	1991	1992	1993	Fish 1993	Problem Parameters	Overall Use Support	Date Rated	Major Source
SUBBASIN 06															
	Morgan Cr at NC 54, Orange Co.	WS-II NSW	16-41-2-(1)	6.7						Ex	F		S	Jul-92	
	Pritchards Mill Cr, Damascus Rd, Orange	WS-II NSW CA	16-41-2-3-(2)	0.5						G- F			ST	Jan-88	
	Morgan Cr Botanical Trail, ab and below OWASA Dischar	WS-IV NSW	16-41-2-(5.5)	8.0			F			F		Sed	PS	Jul-92	NP,P
	Meeting of the Waters Cr, Laurel Hill Rd, Orange	WS-IV NSW	16-41-2-7	1.6						Pr			NS	Jan-88	NP
02097521	Morgan Cr near Farrington, SR 1726, Chatham	WS-IV NSW CA	16-41-2-(9.5)	0.6	S		F			F			PS	Jul-92	
SUBBASIN 07															
02102178	Cape Fear River at NC 42, Chatham Co.	WS-IV CA	18-(4.5)	0.5	S								S	Jul-92	NP
	Gulf Cr off SR 1916	WS-IV	18-5-(1)	5.1							Pr- F	Sed	NS		NP
02102192	Buckhorn Cr. near Corinth	C	18-7-(3)	9.4	S							Sed	S	Jul-92	
	Parkers Cr, SR 1450 Harnett, SR 1418, Harnett	C HQW	18-9	8.4						G			S	Mar-90	
	Hector Cr. SR 1412, Harnett Co.	WS-IV HQW	18-15	9.7							F		ST	Mar-90	
	Neills Cr. SR 1441, Harnett	WS-IV	18-16-(.7)	2.4						F		Sed	PS	Mar-90	
	Kenneth Cr. SR 2772, Be F-V Wake Co	WS-IV	18-16-1-(2)a	1.0			Pr						NS	Jul-92	NP,P
	Kenneth Cr SR1441 Harnett	WS-IV	18-16-1-(2)b	5.5						F	Pr		PS	Jul-92	NP
	UT to Kenneth Cr at SR 1447, Harnett Co.	C	18-16-1-1	0.8				G					S	Jul-92	P
02102500	Cape Fear River at NC 401, Harnett Co.	WS-IV	18-(16.7)	8.9	S		G			G			S	Jul-92	NP
SUBBASIN 08															
02099000	UT E Fork Deep R, I-40 Guilford, and SR 1541	WS-IV	17-2-(.3)	6.5	PS				F			Turb(11)	PS	Jul-92	NP,P
	W Fk Deep R, SR 1850, Guilford	WS-IV	17-3-(.3)	5.2						G- F			ST	Mar-90	
	W Fk Deep R, SR 1818, Guilford	WS-IV CA	17-3-(.7)	3.1									ST	Mar-90	
	Deep River at SR-1113, Guilford Co.	C	17-(4)a	2.0									PS	Jul-92	NP
02099500	Deep River near Randleman, SR-1921	C	17-(4)b	6.8	PS	F	F					Turb(14)	PS	Mar-90	NP
	Deep R, Randeleman, NC 220 Bus, Randolph	C	17-(4)c	9.0						G- F			ST	Jan-88	NP
02100219	Deep R, SR 2122, Randolph	C	17-(4)d	2.3	PS							Turb(13),Cu(13), Hg(13),Fecal	PS	Mar-90	NP
02099484	Richland Cr at SR 1145 near High Point, NC	C	17-7	9.1	PS					F		Turb(11),Cu(16)	PS	Jul-92	NP,P
	Hickory Cr, SR 1131, Guilford	C	17-8-3	6.5						F			ST	Mar-90	
	Muddy Cr at SR 1929, Randolph Co.	C	17-9	10.9						G- F	G- F		ST	Jul-92	NP
SUBBASIN 09															
02100500	Deep River at Ramseur, NC	C	17-(4)f	5.3	PS	G- F				G- F		Turb(25)	ST	Jul-92	P
02100747	Deep River at SR-1461, Moore Co. (also = 1456)	C HQW	17-(4)h	16.6	S					Ex			S	Mar-90	NP
	Polecat Cr at NC 220 Bus.	WS-III	17-11-(1)a	0.7			G						S	Jul-92	
	Polecat Cr at SR 2113, Randolph Co.	WS-III	17-11-(1)b	13.0						G			S	Jul-92	P
	UT Polecat Cr, nr SR 3430, Guilford	WS-III	17-11-2-(2)	1.4			Pr						NS	Jan-88	
	Little Polecat Cr at SR 2108 & SR 2113,Randolph Co	WS-III CA	17-11-3	6.3						Ex			S	Jan-88	NP
	Hasketts Cr, SR 2149, and be SR 2149	C	17-12a	5.5			F						PS	Jul-92	
0210029550	Hasketts Cr at SR-2128, Randolph Co	C	17-12b	2.3	NS		F					Cu(33)	PS	Jul-92	NP
	Sandy Cr. SR 2261 Randolph	WS-III	17-16-(1)a	12.1		G/F						Sed	ST	Jul-92	NP
	Sandy Cr. at SR 2481, Randolph	WS-III	17-16-(1)b	10.2		G				G	G		S	Jul-92	
	Mt Pleasant Cr, SR 2442, Randolph	WS-III	17-16-3	7.0		G							S	Mar-90	
	Richland Cr SR 2873, Randolph	C	17-22	15.8						G			S	Jul-92	NP
	Brush Cr at SR 1102 Chatham	C	17-23a	11.0			G						S	Jan-88	NP
	Brush Cr at NC 22, Randolph Co.	C	17-23b	13.3			Ex			G- F			ST	Jan-88	NP
	UT to Little Brush Cr SR 1100, Chatham Co.	C	17-23-2a	6.6			G						S	Jul-92	NP
	UT to Little Brush Cr at SR 1005, Randolph Co.	C	17-23-2b	5.2			G- F						ST	Jul-92	NP
	Flat Cr. SR 2886 Randolph	C	17-24	9.5						F			PS	Jul-92	NP
	Fork Cr. SR 2873 Randolph	C	17-25	15.7						G- F			ST	Mar-90	NP
SUBBASIN 10															
021012530	Deep River at NC 22, Moore Co.	C HQW	17-(25.7)	12.8	S	G							S	Mar-90	NP,P
	Cabin Cr SR 1400 Moore Co	WS-III	17-26-5-(1)a	7.1						G			S	Jan-88	NP

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 3 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
	Cabin Cr SR 1281	WS-III	17-26-5-(1)b	2.6					G- F			Sed	ST	Feb-88	NP
	Cabin Cr SR 1275 Moore	WS-III	17-26-5-(1)c	12.2					G				S	Jan-88	NP
	Cotton Cr. at SR 1372	WS-III	17-26-5-3-(1)a	0.3					F				PS	Mar-90	NP,P
	Cotton Cr. at SR 1370	WS-III	17-26-5-3-(1)b	6.5					F				PS	Jul-92	NP
	Mill Cr nr SR 1275	WS-III	17-26-5-4	10.5						G			S	Jan-88	
	Wet Cr NC 24, Moore	WS-III	17-26-5-5	10.6						G			S	Jan-88	
02101001	Bear Cr at Robbins, NC Hwy 705	C	17-26-(6)	6.3	S					G- F	G- Ex		S	Jul-92	
	Falls Cr SR 1606 Moore	C	17-27	11.6						F		Sed	PS	Jan-88	NP
	Buffalo Cr NC 22 Moore	C	17-28	16.4						G- F		Sed	ST	Feb-88	NP
02101402	Deep River NC 42, Chatham	WS-IV HQW	17-(28.5)	14.4	S								ST	Jan-88	NP
	Mclendons Cr. at SR 1628 Moore Co	C	17-30b	20.1						F			PS	Jul-92	
	Richland Cr, SR 1640 Moore County	C	17-30-5-(2)	12.8							F		PS	Jan-88	
	Big Gov Cr. SR 1625 Moore Co	WS-IV	17-32-(.7)	9.5						Pr			NS	Jan-88	
SUBBASIN 11															
	Indian Cr SR 2306, Chatham	WS-IV	17-35	8.2						Pr		Sed	NS	Jan-88	NP
	Deep River at SR 1007, Lee Co.	WS-IV	17-(36.5)	11.2						G			ST	Jul-92	
	Little Pocket Cr, NC 42, Lee	C	17-37-4	12.4						F			PS	Jan-88	NP
	Cedar Cr. SR 2142, Chatham	C	17-39	7.9						F		Sed	PS	Mar-90	NP
	Big Buffalo Cr. SR 1403, Lee	C	17-40	8.3						Pr	G	Sed	S	Jan-88	NP
	Georges Cr. SR 2142	C	17-41	8.7						F			PS	Mar-90	
02101577	Deep River at NC 87, Lee Co. (15/501)	WS-IV	17-(41.5)a	1.1	PS					G		Turb(13)	ST	Jul-92	P
02102049	Deep R. CSX RR bridge at Moncure, Chatham	WS-IV	17-(41.5)b	10.8	S								S	Jul-92	
	Little Buffalo Cr SR 1420, Lee	WS-IV	17-42	9.8						Pr		Sed	NS	Feb-88	NP
SUBBASIN 12															
	Rocky River at NC 64 Chatham	C	17-43-(8)a	4.2		F				F			PS	Mar-90	
	Rocky River at SR 2170	C	17-43-(8)b	4.8		F				G- F			ST	Mar-90	
	Rocky River at NC 902	C	17-43-(8)c	6.8		G							S	Mar-90	
02101946	Rocky River at NC 15-501	C	17-43-(8)d	9.5	S		G			G			S	Mar-90	
	Loves Cr. above WWTP nr SR 2203, Chatham Co.	C	17-43-10a	5.5		F							PS	Mar-90	NP
	Loves Cr. below WWTP nr SR 2203, Chatham Co.	C	17-43-10b	0.9		Pr							NS	Mar-90	NP,P
	Tick Cr at NC-421	C	17-43-13	15.6							G		S	Jul-92	
	Landrum Cr. NC 902, Chatham	C	17-43-14	10.0			G/F						ST	Jan-88	
	Harlands Cr, NC 902, Chatham	C	17-43-15	10.2			G/F						ST	Mar-90	NP
	Bear Cr. at SR 2333, SR 2189, Chatham Co.	C	17-43-16a	14.9				F				Sed	PS	Jul-92	
	Bear Cr. at SR 2155, Chatham	C	17-43-16b	9.8			G- F					Sed	ST	Jul-92	
SUBBASIN 13															
	Upper Little River at SR-1222, Harnett Co.	C	18-20-(8)a	2.4						G- F			ST	Jul-92	
	Upper Little River at NC 27, Harnett Co.	C	18-20-(8)b	22.0						G			S	Jul-92	
	Barbeque Cr SR 1209	C	18-20-13	11.6						G- F			ST	Mar-90	NP
	Upper Little River SR-2016, ab Becker, Harnett Co.	WS-IV	18-20-(23.5)a	15.6				G					S	Jul-92	
	Upper Little River SR-2016, be Becker, Harnett Co.	WS-IV	18-20-(23.5)b	0.5				G- F					ST	Jul-92	
02102634	Upper Little River near Erwin, SR-2021, Harnett Co.	WS-IV	18-20-(23.5)c	5.3	PS			G		G		pH(11)	S	Jul-92	
02102696	Cape Fear River, NC 217 near Erwin, Harnett Co.	WS-V	18-(20.7)	12.2	S					Ex			S	Jul-92	NP,P
SUBBASIN 14															
	Nicks Cr, NC 22, Moore Co.	WS-III	18-23-3-(3)	2.3						G- F			ST	Mar-90	NP
02102897	Little River (Lower) at SR 2023, Moore Co.	WS-III HQW	18-23-(10.7)	12.8	NS		Ex			Ex		pH(64)	S	Jul-92	
	James Cr Near SR 2023, Hoke Co.	WS-III	18-23-13a	0.7			G						S	Jul-92	
	Horse Cr, Manchester Rd. , Hoke Co.	WS-III	18-23-14	3.4			G- F						ST	Jul-92	
02102980	Flat Cr, Manchester Rd. , Hoke Co.	WS-III	18-23-15	6.3	NS		G					pH(94)	S	Jul-92	
	Mill Cr, Manchester Rd., Hoke Co.	WS-III	18-23-17-1	3.2			G- F						ST	Jul-92	NP
	Jumping Run Cr, Manchester Rd., Hoke Co.	WS-III	18-23-20	4.0			G- F					Sed	ST	Jul-92	NP

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 4 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
	McPherson Cr at Manchester Rd., Cumberland Co.	WS-III	18-23-25	4.8			G- F						ST	Jul-92	
02103000	Little River (Lower) Manchester Rd, NC - NC 87/24	C	18-23-(24)a	3.0	PS		G- F			G		pH(12)	S	Jul-92	NP
	Little River (Lower), NC 401 Cumberland	C	18-23-(24)b	25.3						Ex			S	Jul-92	NP
	Jumping Run Cr, NC 210 Cumberland	C	18-23-29	8.5						G- F			ST	Mar-90	NP
	Anderson Cr SR 2031, Harnett	C	18-23-32	5.5						F		Sed	PS	Mar-90	NP
SUBBASIN 15															
02104000	Cape Fear R. at NC HWY 24 Fayetteville, Cumberland	C	18-(26)b	2.0	S					G			S	Jul-92	
	Cross Cr ab & be UT, Cumberland Co.	WS-IV	18-27-(1)	9.0			F					Sed	PS	Jul-92	
02103997	Cross Cr at Fayetteville, NC Hwy 301, & 87/210, Cumberla	C	18-27-(3)	3.6	PS					F		Pb(13)	PS	Jan-88	NP
	Little Cross Cr above Bonnie Doone, Cumberland Co.	WS-IV	18-27-4-(1)	7.0			Pr						NS	Mar-90	
	Rockfish Cr at Plank Rd, Hoke	C	18-31-(1)	14.8			G- F						ST	Jan-88	NP
	Juniper Cr at Plank Rd., Hoke Co.	C	18-31-10	8.2			G						S	Jul-92	
	Pedler Branch at NC 20, NC401, Hoke Co.	C	18-31-16	2.6			Pr						NS	Jul-92	NP
02104380	Beaver Cr at Cumberland, SR-1141	C	18-31-17	7.9	S								S	Jan-88	NP
0210426450	Rockfish Cr SR 1432 near Raeford, Hoke Co.	B	18-31-(18)a	0.3	NS		G- F			Ex		pH(51)	S	Jul-92	NP
	Rockfish Cr at SR 1115, Cumberland Co.	B	18-31-(18)b	14.3			G- F						ST	Jul-92	
	Puppy Cr at Plank Rd., Hoke Co.	C	18-31-19	10.7			G- F					Sed	ST	Jul-92	NP
02104500	Rockfish Cr US 301, I-95, NC 87, Ambient at I-95.	C	18-31-(23)	9.1	PS		Ex			Ex		pH(14)	S	Jul-92	NP
	Little Rockfish Cr, Plank Rd, Hode	C	18-31-24-(1)	12.0			G/F						ST	Feb-88	NP
	UT#1 to Bones Cr below Sunset MHP, Cumberland Co.	C	18-31-24-2a	0.0			Pr						NS	Jul-92	
	UT#2 to Bones Cr at SR-1400, Cumberland Co.	C	18-31-24-2b	0.0			G- F						ST	Jul-92	
	Little Rockfish Cr NC 59 Cumberland	C	18-31-24-(4)	3.6						G			S	Feb-88	NP
	Little Rockfish Cr at SR 1131 be lake, Cumberland Co.	C	18-31-24-(7)	2.2			G- F						ST	Jul-92	NP
SUBBASIN 16															
02105500	Cape Fear River ab Carolina Foods, (Huske Lock, SR 1355	C	18-(26)d	11.0	S				G- F	G- F			ST	Jul-92	P
02105512	Cape Fear be Carolina Foods, SR 1316, Bladen	C	18-(26)e	7.6	S				G- F				ST	Jan-88	
02105544	Cape Fear at Lock & dam #2 near Elizabethtown, Bladen	C	18-(26)f	27.4	S					G- F			ST	Jan-88	P
02105520	Harrisons Cr at White Oak, SR-1320	C	18-42	20.5	NS					F		pH(100), Sed	PS	Jul-92	NP
	Ellis Cr, NC 53, Bladen	C	18-44	13.7						G- F			ST	Jan-88	
	Browns Cr, NC 87, Bladen Co.	C	18-45	9.0							G	Sed	S	Jan-88	NP
0210563128	Turnbull Cr near Elizabethtown, NC Hwys 41/53	C	18-46	27.2	NS							pH(100), Sed	PS	Jul-92	NP
	Cape Fear at Kelly, SR 1730, Bladen	WS-IV	18-(53.5)	13.4			F			G- F			ST	Jul-92	NP
	Cape Fear ab Federal Paper	WS-IV Sw CA	18-(62.5)	0.5						G- F			ST	Jul-92	NP
SUBBASIN 17															
02105825	Cape Fear R Above Neils Eddy Landing near Acme, Colum	C Sw	18-(63)a	2.1	S					F			PS	Mar-90	P
02107570	Cape Fear R. below Hale Point Landing near Phoenix, Brun	C Sw	18-(63)b	23.5	S								S	Mar-90	
	Livingston Cr, NC 74, Columbus	C Sw	18-64a	14.5						F			PS	Mar-90	
02105814	Livingston Cr, SR 1878, Columbus	C Sw	18-64b	7.7	PS		Pr					NH3(13)	NS	Mar-90	
SUBBASIN 18															
	South River at NC-13, Sampson Co.	C Sw	18-68-12a	7.2		F							PS	Jul-92	
	South River at NC 242, Sampson Co.	C Sw	18-68-12b	29.5		Ex							S	Jul-92	
	Black river at NC 421, Harnett	C Sw	18-68-12-1a	20.0		F						Sed	PS	Jul-92	NP
02107000	South River nr Parkersburg, SR-1502 Bladen & NC 701, Sa	C Sw ORW +	18-68-12-(8.5)	42.0	S					Ex	G		S	Jul-92	
	Big Swamp, SR 1246, Sampson	C Sw	18-68-12-8	9.0		G- F							ST	Jan-88	
SUBBASIN 19															
02106500	Black River near Tomahawk, NC Hwy 411	C Sw ORW +	18-68-(0.5)	5.0	S	Ex				Ex			S	Jul-92	NP
	Great Coharie Swamp at SR-1214, Sampson Co.	C Sw	18-68-1b	45.2		G				G	F- G		S	Jul-92	P
	Great Coharie Swamp at SR-1636, Sampson Co.	C Sw	18-68-1a	0.9							F		ST	Jul-92	P
02106000	Little Coharie Cr at SR 24 near Roseboro, Sampson	C Sw	18-68-1-17a	25.0	S					G			S	Jul-92	
	Little Coharie Cr at SR 1214 and 1207, Sampson Co.	C Sw	18-68-1-17b	13.7		G				G- F	Pr- F		ST	Jul-92	
	Six Runs Cr at SR 1004, Sampson Co.	C Sw	18-68-2a	19.7		G							S	Jul-92	

Table 4.12 Use Support Information for Monitored Freshwater Stream Segments in the Cape Fear Basin (Sheet 5 of 5)

Station Number	Station Location	Classification	Index Number	Miles	Chemical Rating	<------ Biological Ratings------>						Problem Parameters	Overall Use Support	Date Rated	Major Source
						Benthic Macroinvertebrates					Fish				
					89-93	1989	1990	1991	1992	1993	1993				
0210643010	Six Runs Cr at SR 1960, Sampson Co.	C Sw	18-68-2b	6.3	S					Ex			S	Jul-92	
	Six Runs Cr at SR 1130 and 1003, Sampson Co.	C Sw	18-68-2c	10.3		Ex							S	Jul-92	
	Stewarts Cr at SR 1943, Sampson Co.	C Sw	18-68-2-10	13.7		G/F						Sed	ST	Jul-92	
SUBBASIN 20															
	Black River at Turlingtons, Pender	C Sw ORW +	18-68-(11.5)a	10.1									S	Jul-92	
02017229	Black River near Atkinson, NC 11	C Sw ORW +	18-68-(11.5)b	3.7	S	Ex	G/F	G		Ex			S	Jul-92	
0210756250	Black R. downstream Raccoon Is. near Huggins, NC	C Sw ORW +	18-68-(11.5)c	20.6	S								S	Jul-92	
SUBBASIN 21															
02107586	NE Cape Fear River near Mount Olive, SR-1937(Wayne Co	C Sw	18-74-(1)a	3.3	NS					Pr		DO(39),NH3(15),Cl(20)	NS	Mar-90	
	NE Cape Fear R, NC 403, Duplin	C Sw	18-74-(1)b	2.6						F		Sed	PS	Jan-88	NP
	NE Cape Fear R, SR 1948, Duplin	C Sw	18-74-(1)c	3.5						G- F		Sed	ST	Jan-88	NP
	NE Cape Fear at NC-11, Duplin Co.	C Sw	18-74-(1)d	12.3						Ex			S	Jan-88	NP
	Barlow Br at Faison, Duplin	C Sw	18-74-2	1.1						Pr			NS	Jan-88	NP,P
	Buck Marsh Br, NC 111, Duplin Co	C Sw	18-74-8	5.1						G- F		Sed	ST	Jan-88	NP
SUBBASIN 22															
02108000	NE Cape Fear River near Chinquapin, NC Hwy 41	C Sw	18-74-(1)e	22.6	S	Ex				Ex			S	Jan-88	P
	Goshen Swamp at SR 1302 Wayne, NC 117 and NC 403 D	C Sw	18-74-19	32.6						F		Sed	PS	Jul-92	NP
	Panther Cr Below Faison Ut, Duplin Co.	C Sw	18-74-19-3b	3.0						Pr			NS	Mar-90	P
	Halls Marsh at SR 1306, Duplin Co.	C Sw	18-74-19-11	4.1			G- F	F	G- F	G- F	F		ST	Jul-92	
	Herrings Marsh Run at SR 1508, Duplin Co.	C Sw	18-74-19-16	1.8				G- F	F	F			PS	Jul-92	
	Herrings Marsh Run at SR 1306 , Duplin Co.	C Sw	18-74-19-16b	3.9			F	G- F	G- F	G- F	Pr- F		ST	Jul-92	
	UT to Grove Cr at SR 1376, Duplin Co.	C Sw	18-74-21a	0.0			G- F				G- Ex		S	Jul-92	
	Limestone Cr nr Hadley, nr NC Hwy 24	C Sw	18-74-23	7.5							G	Sed	PS	Feb-88	NP
	Limestone Cr SR 1702, Duplin	C Sw	18-74-23	3.0						Ex		Sed	S	Feb-88	NP
02107985	Stockinghead Cr, SR 1956, Duplin	C Sw	18-74-24	9.5	S					G- F			ST	Jul-92	
	Muddy Cr, NC 41, Duplin	C Sw	18-74-25	10.5						G- F		Sed	ST	Mar-90	NP
	Persimon Br ab WWTP	C Sw	18-74-25-1a	1.5			F						PS		
	Persimon Br be WWTP	C Sw	18-74-25-1b	0.8			Pr						NS		
	Rock Fish Cr, SR 1165, Duplin	C Sw	18-74-29b	4.9						G- F		Sed	ST	Mar-90	NP
01208563	Rock Fish Cr, I-40 near Wallace	C Sw	18-74-29c	7.2	PS					F		Cu(16),Sed	PS	Mar-90	NP,P
SUBBASIN 23															
02108585	Angola Cr near Maple Hill, NC Hwy 53	C Sw	18-74-33-3	8.9	S								S	Mar-90	NP
	Burgaw Cr at US 117 and SR 1624 Pender Co	C Sw	18-74-39b	10.7							Pr- F	Sed	NS	Mar-90	NP
02108619	Northeast Cape Fear R, US Hwy 117 at Castle Hayne, New	B Sw	18-74-(47.5)	15.8	S		G- F			G- F			ST		
	Cypress Cr SR 1216 Pender Co	C Sw	18-74-55-2	8.0							F		PS	Jan-88	NP

EXPLANATION OF COLUMN HEADINGS

Station Number - Ambient water quality monitoring station location number (see Section 4.2.7)

Station Location - Narrative site locations for all ambient, benthic macroinvertebrate and fish community sites (see Figures 4.5 to 4.16 for locations by subbasins)

Stream Classifications - See Section 2.6 and Appendix I for explanations

Index Number - Identification number used by DEM to identify specific stream segments

Miles - Length of stream segment being rated

Chemical Rating - Use support ratings based on water quality data collected at ambient monitoring sites Ratings based on parameters shown in Table 4.1. See Section 4.4 for rating methodology.

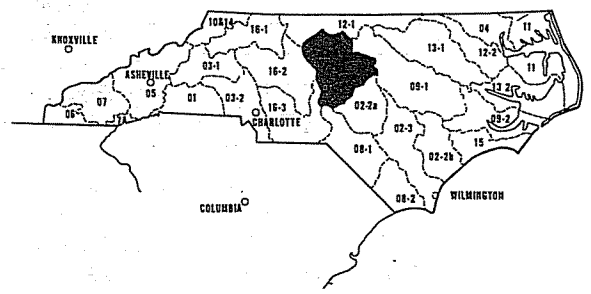
Biological Ratings - Water quality ratings based on benthic macroinvertebrate (aquatic insect larvae) sampling (see Section 4.2.1) and fish community assessments (Section 4.2.2).

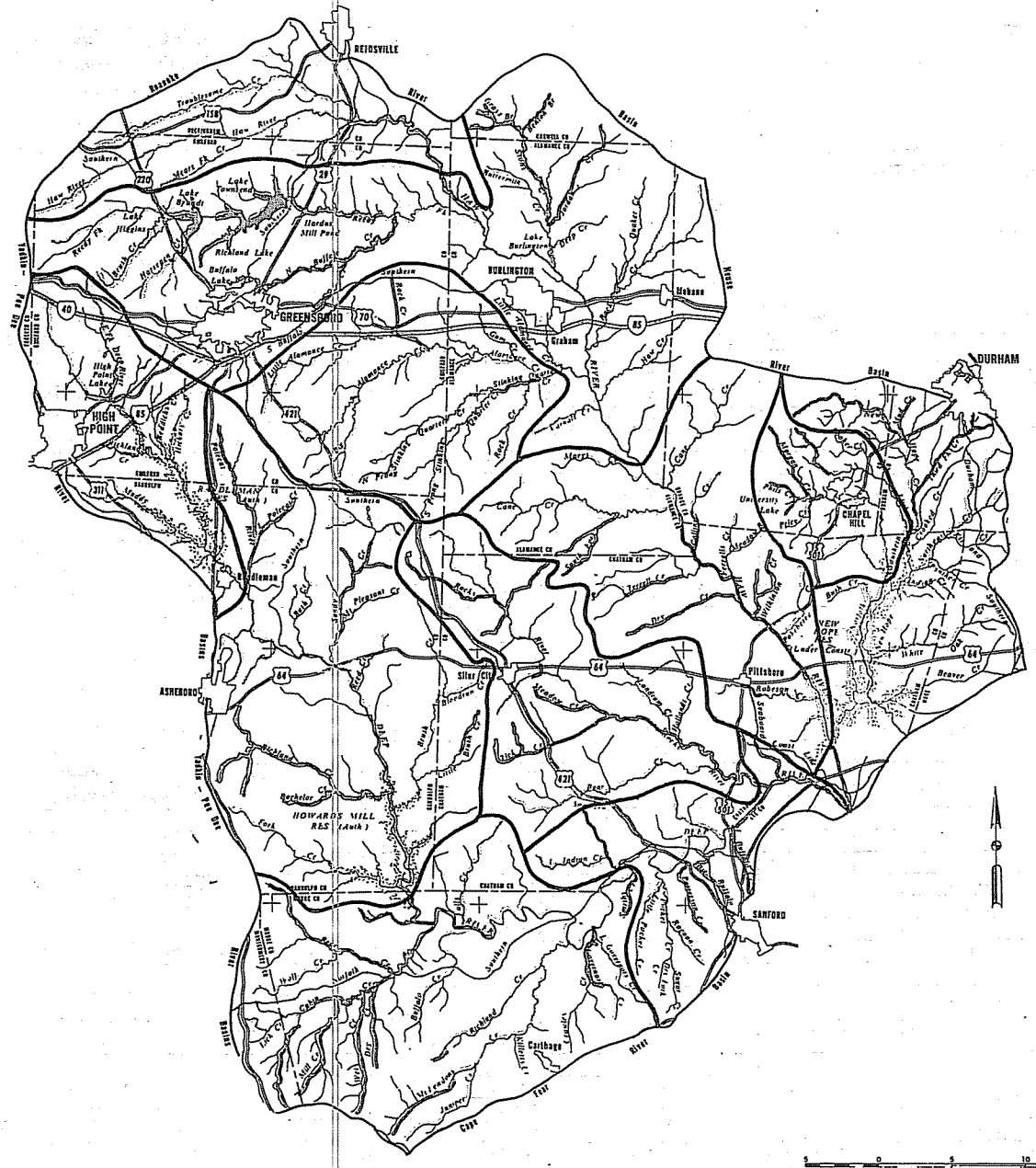
Overall Use Support - Use support rating based on both chemical and biological water quality data. (Section 4.4)

ABBREVIATIONS

Cd	Cadmium
Chla	Chlorophyll-a
Cu	Copper
Do	Dissolved oxygen
Ex	Excellent biologcial rating
Fecal	Fecal coliform bacteria
G	Good biological rating
G-F	Good-Fair biological rating
Hg	Mercury
NH3	Mercu.mmonia
NP	Nonpoint sources of pollution (e.g., pollution from stormwater runoff)
P	Point source pollution (e.g., from wastewater treatment plant discharges)
Pb	Lead
pH	Indicates that waters are sometimes found to be too acidic (<6 pH)
Pr	Poor biological rating
Sed	Sedimentation
Turb	Turbidity

Cape Fear River Basin #1





- Supporting
- Supporting - threatened
- Partially Supporting
- Not Supporting

Cape Fear River Basin #1

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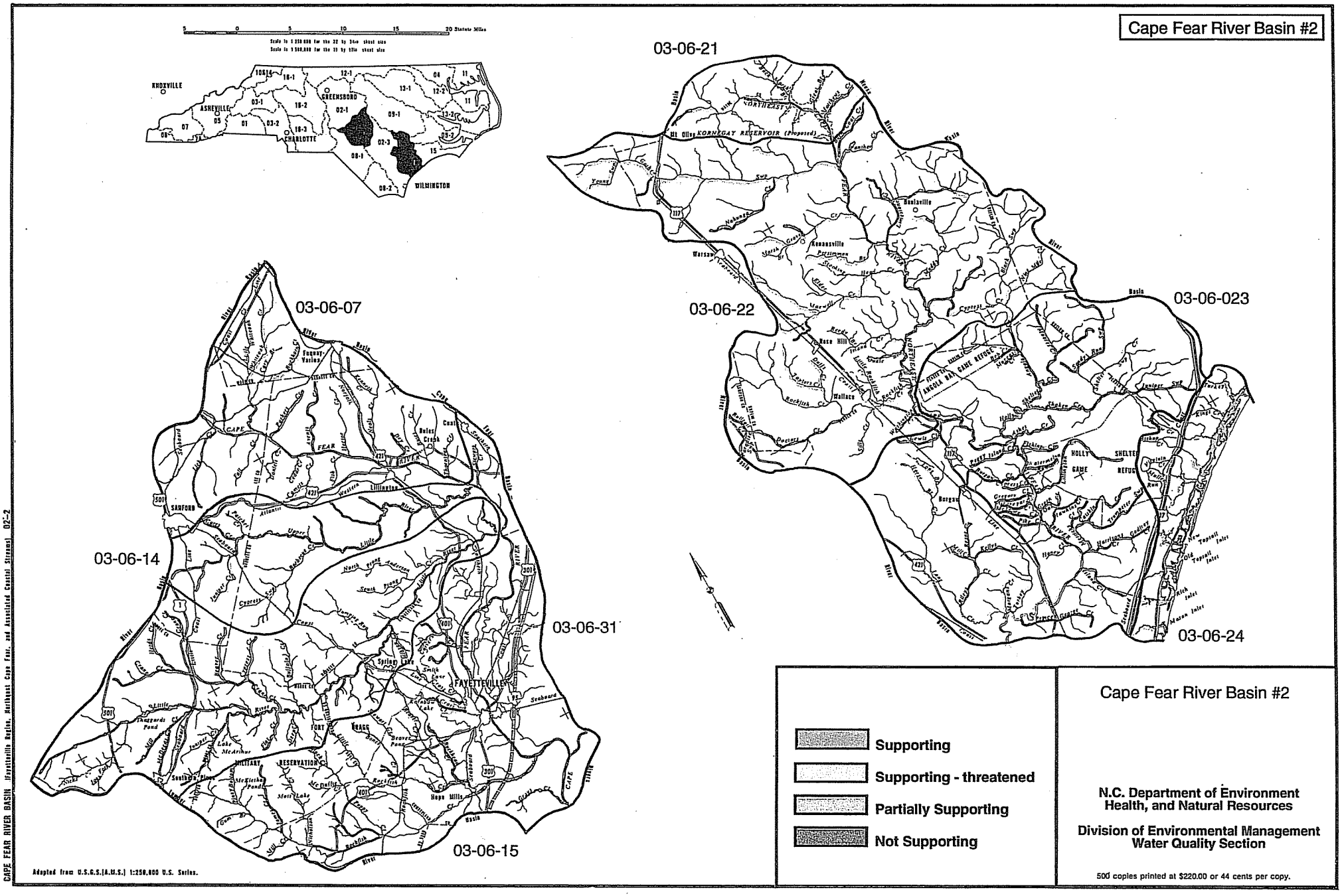
Cape Fear River Basin #2
03-06-21
03-06-22
03-06-023
03-06-24
03-06-07
03-06-14
03-06-31
03-06-15
KNOXVILLE
ASHEVILLE
GREENSBORO
CHARLOTTE
WILMINGTON
KORNEGAY RESERVOIR (Proposed)
ANGOLA BAY GAME REFUGE
HOLLY GAME
SHELTER REFUGE
SANFORD
FAYETTEVILLE
FORT BRAGG
MILITARY RESERVATION
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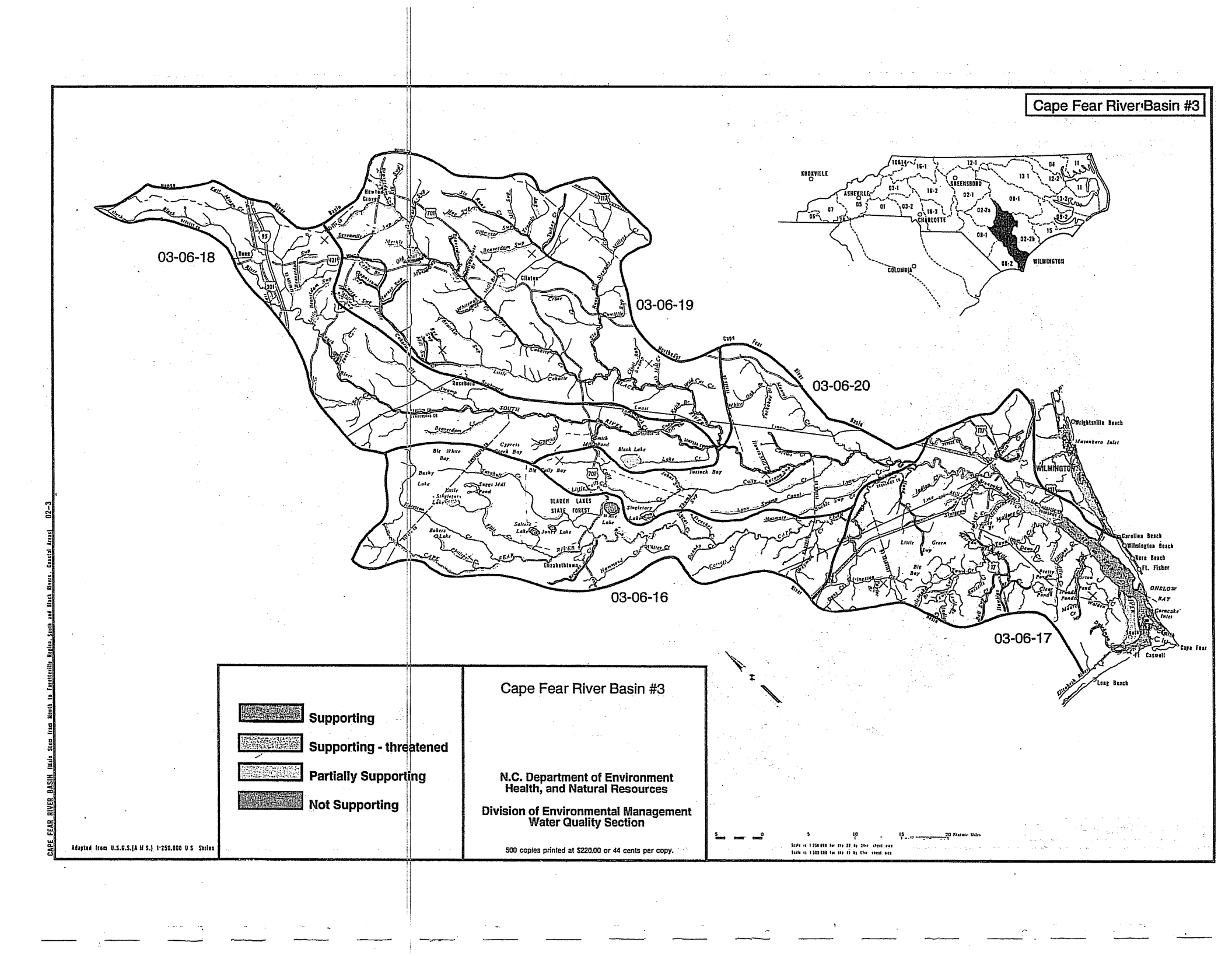
Cape Fear River Basin #3
03-06-18
03-06-19
03-06-20
03-06-16
03-06-17
KNOXVILLE
ASHEVILLE
GREENSBORO
CHARLOTTE
COLUMBIA
WILMINGTON
Cape Fear River Basin #3
Supporting
Supporting - threatened
Partially Supporting
Not Supporting
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Table 4.13 Use Support Ratings for Freshwater Streams by Subbasin

USE SUPPORT STATUS FOR FRESHWATER STREAMS (MILES) (1989-1993)						
Subbasin	S	ST	PS	NS	NE	Total Miles
30601	24.4	34.5	39.4	6.5	12.5	117.3
30602	89.5	223.2	63.3	37.2	40.7	453.9
30603	19.1	107.4	43.6	0	17.2	187.3
30604	70.1	103.8	36.1	4.8	36.3	251.1
30605	65.4	48.1	57.4	29.7	50.3	250.9
30606	17.2	11.4	11	3.2	11.5	54.3
30607	120.9	80.3	44.4	8.1	22.7	276.4
30608	2.7	55.3	39.5	3.3	22.4	123.2
30609	146.2	137.8	23.5	1.4	1.8	310.7
30610	151.1	78.8	56.5	9.5	19.9	315.8
30611	40.2	17.8	60.7	18	10.5	147.2
30612	70.8	67.6	24.6	0.9	11.2	175.1
30613	151.7	64.2	16.4	0	7.8	240.1
30614	294.4	70.2	17.8	0	34.6	417
30615	149.1	119.9	45.5	31.9	21.1	367.5
30616	20.9	211.1	54.2	0	39.1	325.3
30617	120.6	100.2	56.4	25.5	80	382.7
30618	94.6	70.1	51.3	0	42.5	258.5
30619	249.2	147.9	33.9	0	14	445
30620	65.5	131.1	19.8	0	6.3	222.7
30621	37.7	34.4	6.5	4.4	3.3	86.3
30622	135.1	75.8	103.8	6.6	81.9	403.2
30623	217	116.3	24.4	19.1	15.7	392.5
TOTAL	2353.4	2107.2	930	210.1	603.3	6204
PERCENTAGE	38	34	15	3	10	

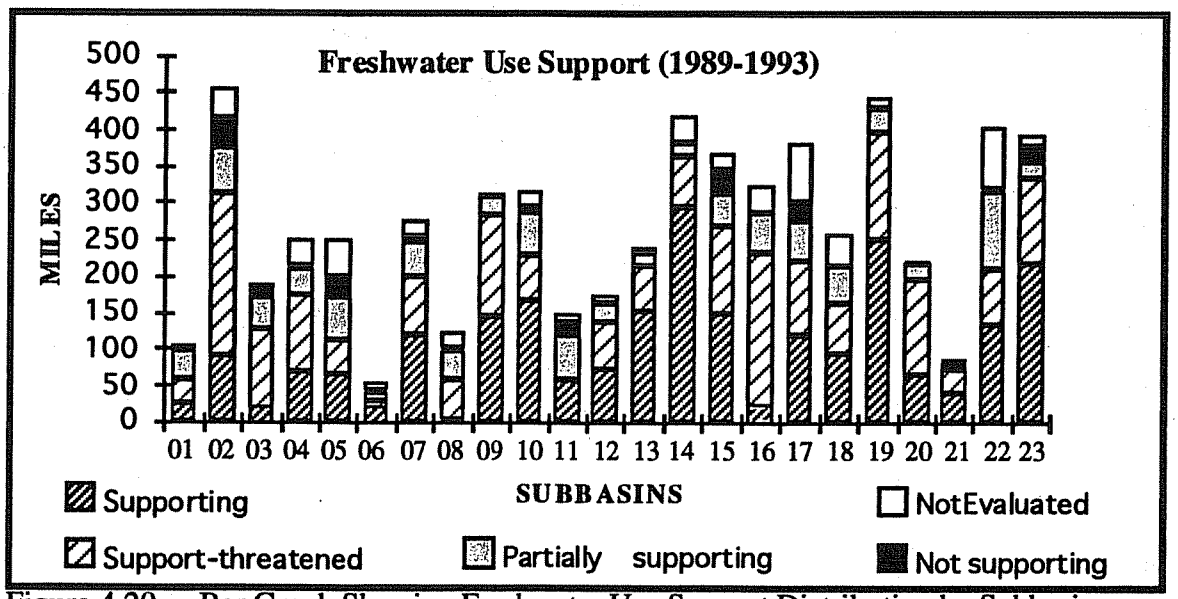

Figure 4.20 Bar Graph Showing Freshwater Use Support Distribution by Subbasin

Table 4.14 Sources of Use Support Impairment in Freshwaters of the Cape Fear River Basin

Subbasin	Nonpoint Source	Point Source	Agric	Forestry	Const	Urban Runoff	Mining	Land Disposal	Hydro-mod	Not known	Other
03-06-01	39.4	33.6	30.7	0	0	0	0	0	0	0	0
03-06-02	67.2	34.7	19.9	0	0	43.8	8.5	0	0	0	8.5
03-06-03	43.6	36.7	43.6	0	6.9	0	0	0	0	0	0
03-06-04	21.1	0	17.2	0	0	5.6	0	0	0	0	0
03-06-05	72.3	5.8	11.9	0	35.9	29.8	0	8.9	0	0	0
03-06-06	11.2	8.6	0	0	0	9.6	0	0	0	0	0
03-06-07	48.4	5.2	20.1	0	8.5	0	5.3	0	0	14.9	0
03-06-08	39.2	25.7	15.6	2.3	16.9	6.8	10.1	9.1	0	0	0
03-06-09	18	0	9.5	9.5	6.2	6.2	0	0	0	0	0
03-06-10	20.7	0.3	18.1	0	0	6.5	0	0	0	2.3	0
03-06-11	64.8	0	47.1	0	0	9.8	9.8	0	0	0	0
03-06-12	6.4	0.9	0.9	0	0	0	0	0	0	0	0
03-06-13	16.4	0	14.4	0	0	0	0	0	0	2	0
03-06-14	17.8	0	10.1	0	0	0	0	0	0	7.7	0
03-06-15	44.1	0	5.9	0	18.1	40.8	0	16.5	0	0	13.9
03-06-16	54.2	0	32.2	0	0	0	0	0	0	22	0
03-06-17	57.6	18.6	3.4	11.7	48.7	13	0	16.5	3.4	4.2	11.7
03-06-18	44.1	0	44.1	0	0	0	0	0	0	0	0
03-06-19	33.9	0	21.2	0	0	0	0	0	0	12.7	0
03-06-20	14.3	0	14.3	0	0	0	0	0	14.3	0	0
03-06-21	3.7	1.1	0	0	0	1.1	0	0	0	0	2.6
03-06-22	87.6	10.2	73	0	0	7.7	0	14.6	7.5	0	0
03-06-23	43.5	0	8.4	0	8.4	19.1	0	27.1	8.4	16.4	0
Total Miles	869.5	181.4	461.6	23.5	149.6	199.8	33.7	92.7	33.6	82.2	36.7
% PS & NS	76	16	40	2	13	18	3	8	3	7	3

Table 4.15 Major Causes of Use Support Impairment in Freshwaters in the Cape Fear River Basin

SUBBASIN	NH3	Sediment	pH	Turbidity	Metals	Fecal Coliform
01	0	25.7	0	6.5	0	0
02	12.8	30.9	0	17.9	18.2	26.4
03	0	23.5	0	0	0	0
04	0	3.9	4.7	0	0	0
05	0	37.9	0	6.3	1.8	0
06	0	9.6	0	0	0	0
07	0	44	0	0	0	0
08	0	0	0	24.7	11.4	0
09	0	0	0	0	2.3	0
10	0	13.9	0	0	0	0
11	0	57.6	0	0	0	0
12	0	14.9	0	0	0	0
13	0	6.4	0	0	0	0
14	0	10.1	0	0	0	0
15	0	49.5	0	0	3.6	0
16	0	54.2	47.7	0	0	0
17	7.7	52.1	0	0	0	0
18	0	31	0	0	0	0
19	0	27.1	0	0	0	0
20	0	14.3	0	0	0	0
21	3.3	2.6	0	0	0	0
22	0	68.4	0	0	7.2	0
23	0	35.5	0	0	0	0
Total Miles	23.8	613.1	52.4	55.4	44.5	26.4
% of PS & NS	2	54	5	5	4	2

Table 4.16 Estuarine Use Support Status for Division of Environmental Health (DEH) Shellfish Growing *Areas (acres)

	Total	DEH	Overall Use Support				Major Causes			Major Sources		
Area Name	Acres	*Area	S	ST	PS	NS	Fecal	DO	Chl-a	Point	NPS	Sources of impairment
Southport	1,325	B1	695	0	630	0	630			290	340	WWTP, ag, septic tanks, urban runoff
Buzzard Bay	2,850	B2	2,735	0	5	0	115				115	marina
The Basin	275	B3	274	0	1	0	1				1	marina
Cape Fear	20,000	B4	12,500	0	7,500	0	2,500	5,000		1,939	5,561	WWTP, ag, urban runoff, industry
Myrtle Sound	2,300	B5	2,075	0	225	0	225				225	urban runoff, septic tanks, marinas
Masonboro Snd	1,600	B6	1,318	0	282	0	282			80	202	WWTP, urban runoff, septic tanks, marinas
Wrightsville Bch	2,150	B7	1,563	0	5872	0	587				587	urban runoff, septic tanks, marinas
Topsail Sound	5,700	B8	5,290	0	410	0	410				410	ag, urban runoff, septic tanks, marinas
Stump Sound	3,000	B9	2,800	0	200	0	190	10		50	150	WWTP, ag, urban runoff, septic tanks
Acres	39,200		29,251	0	9,804	0	4,939	5,010	0	2,118	7,590	
Percent (%)	100.0		74.6	0.0	25.9	0.0	49.6	51.1	0.0	23.7	76.3	

Key to Abbreviations

S	Supporting uses	Fecal	Fecal coliform bacteria
ST	Support-threatened	DO	Dissolved Oxygen
PS	Partially supporting uses	Chl-a	Chlorophyll *a*
NS	Not supporting uses	ag	Agriculture

* Shellfish growing areas for the Cape Fear River Basin are shown in figure 4.21

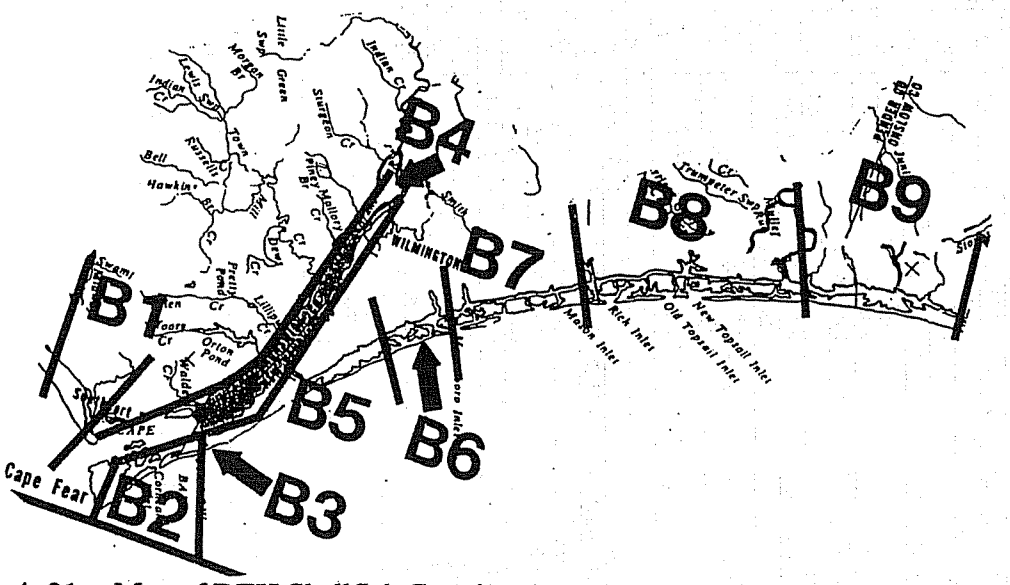

Figure 4. 21 Map of DEH Shellfish Growing Areas in the Cape Fear River Basin

Table 4.17 Use Support Ratings for Lakes in the Cape Fear River Basin

LAKE NAME	COUNTY NAME	SUBBASIN	SIZE (acres)	CLASS	OVERALL USE	FISH CONSUMP.	AQ. LIFE & SECONDARY CONTACT	SWIMMING	DRINKING WATER	TROPHIC STATUS	PROBLEM PARAMETERS
LAKE HUNT	ROCKINGHAM	03-06-01	180	WS,B-NSW	S	S	S	S	S	Mesotrophic	
REIDSVILLE LAKE	ROCKINGHAM	"	700	WS-NSW	S	S	S	n/a	S	Mesotrophic	
BURLINGTON RES. (LAKE CAMMACK)	ALAMANCE	03-06-02	750	WS-NSW	ST	S	ST	n/a	S	Eutrophic	Elevated TN (1.51 mg/l)
GRAHAM-MEBANE RESERVOIR	ALAMANCE	"	650	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE BRANDT	GUILFORD	"	710	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE BURLINGTON (STONY CREEK RES.)	ALAMANCE	"	137	WS-NSW	ST	S	ST	n/a	S	Eutrophic	Elevated TP, TN
LAKE HIGGINS	GUILFORD	"	287	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE TOWNSEND	GUILFORD	"	1610	WS-NSW	S	S	S	n/a	S	Eutrophic	
RICHLAND LAKE (LAKE JEANETTE)	GUILFORD	"	260	WS-NSW	S	S	S	n/a	S	Mesotrophic	
LAKE MACKINTOSH	ALAMANCE	03-06-03	1150	WS-NSW	S	S	S	n/a	S	Eutrophic	
CANE CREEK RESERVOIR	ORANGE	03-06-04	700	WS-NSW	S	S	S	n/a	S	Mesotrophic	
JORDAN LAKE	CHATHAM	"	14300	WS,B-NSW	ST	S	ST	S	S	Eutrophic	Elev. TP, TN
PITTSBORO LAKE	CHATHAM	"	38	C-NSW	ST	S	ST	n/a	n/a	Eutrophic	Algal Blooms, Aquat. weeds
UNIVERSITY LAKE	ORANGE	03-06-06	213	WS-NSW	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
HARRIS LAKE	CHATHAM	03-06-07	4150	B	ST	S	ST	S	n/a	Mesotrophic	Elev. TN
LOWER MOCCASIN LAKE	LEE	"	19	B	ST	S	ST	S	n/a	Eutrophic	Elev. TP, TN
UPPER MOCCASIN	LEE	"	34	B	ST	S	ST	S	n/a	Eutrophic	Elev. TP, TN
HIGH POINT LAKE	GUILFORD	03-06-08	300	WS	S	S	S	n/a	S	Eutrophic	
HIGH POINT RES. (OAK HOLLOW LAKE)	GUILFORD	"	720	WS	ST	S	ST	n/a	S	Mesotrophic	Algal Blooms
SANDY CREEK RESERVOIR	RANDOLPH	03-06-09	125	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
CARTHAGE CITY LAKE	MOORE	03-06-10	8	WS	ST	S	ST	n/a	S	Oligotrophic	Aquatic Weeds
ROCKY RIVER RESERVOIR	CHATHAM	03-06-12	190	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
OLD TOWN RESERVOIR	MOORE	03-06-14	60	WS	S	S	S	n/a	S	Oligotrophic	
BONNIE DOON LAKE	CUMBERLAND	03-06-15	27	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
GLENVILLE LAKE	CUMBERLAND	"	26	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
HOPE MILLS NUMBER FOUR LAKE	CUMBERLAND	"	110	WS,B	S	S	S	S	S	Eutrophic	
KORNBOW LAKE	CUMBERLAND	"	57	WS	ST	S	ST	n/a	S	Mesotrophic	Elev. TN, TP
MINTZ POND	CUMBERLAND	"	17	WS	ST	S	ST	n/a	S	Eutrophic	Elev. TP, TN
MOTT LAKE	HOKE	"	150	C	S	S	S	n/a	n/a	Dystrophic	
JONES LAKE	BLADEN	03-06-16	225	B	S	S	S	S	n/a	Dystrophic	
SALTERS LAKE	BLADEN	"	315	C	S	S	S	n/a	n/a	Dystrophic	
WHITE LAKE	BLADEN	"	1050	B	S	S	S	S	n/a	Oligotrophic	
BOILING SPRINGS LAKE	BRUNSWICK	03-06-17	1120	B-SW	S	S	S	S	n/a	Dystrophic	
GREENFIELD LAKE	NEW HANOVER	"	115	C-SW	NS	S	NS	n/a	n/a	Hyper-Eutrophic	Nutrients, Nox. Aq. weeds, Urban runoff/Storm sewers
BAY TREE LAKE (BLACK LAKE)	BLADEN	03-06-18	1400	C-SW	PS	PS	S	n/a	n/a	Dystrophic	Mercury Fish Consump. Adv.
SINGLETARY LAKE	BLADEN	03-06-20	572	B-SW	S	S	S	S	n/a	Dystrophic	

Table 4.18 Criteria for Determining Lake Use Support Ratings.

USE	ASSESSMENT TYPE	FULLY SUPPORTING	THREATENED	PARTIALLY SUPPORTING	NOT SUPPORTING
Aquatic Life Support	Biological Community	No evidence of modification to aquatic life	(no criteria)	Some modification (including exotics)	Definite modification (including exotics)
	Chemical Standards (includes turbidity)	Any criterion exceeded in ≤10% of measurements	(no criteria)	Any criterion exceeded in 11-25% of measurements	Any criterion exceeded in >25% of measurements
	Trophic parameters*				
	Chl a	<40 ug/l	≥40 ug/l	≥40 ug/l	≥40 ug/l
	Total P	<0.05 mg/l	≥0.05 mg/l	≥0.05 mg/l	≥0.05 mg/l
	Total N	≤0.55 mg/l	>0.55 mg/l	>0.55 mg/l	>0.55 mg/l
	Secchi	>0.5 meters	≤0.5 meters	≤0.5 meters	≤0.5 meters
	DO	Meets standard as specified in state regulations	(no criteria)	(no criteria)	Does not meet standard as specified in state regulations
	Fish Consumption	No advisories or bans	(no criteria)	"Restricted consumption" advisory	"No consumption" advisory or ban on fishing
	Field Observations	(no criteria)	High algae, macrophytes, or siltation	High algae, macrophytes, or siltation	Severely high algae or dense macrophytes or severe siltation
Recreational Use: Swimming and Secondary Contact	Fecal coliform: geom. ≤200; single ≤ 400	Criterion exceeded in ≤10% of measurements	(no criteria)	Criterion exceeded in 11-25% of measurements	Criterion exceeded in >25% of measurements
	Field Observations	Beautiful or very minor aesthetic problems	Swimming and aesthetics slightly impaired	Swimming and enjoyment reduced	Swimming impossible
Drinking Water Supply	Chemical Standards	Mean or median of measurements < criterion	(no criteria)	(no criteria)	Mean or median of measurements > criterion

* For dystrophic lakes characterized by low pH and tannic colored waters, criteria may not apply

THREATENED waters are those that fully support their designated uses but that may not fully support uses in the future (unless pollution control action is taken) because of anticipated sources or adverse pollution trends.

LAKES WITH MULTIPLE USES:

Fully Supporting = All uses are fully supported.
Threatened = One or more uses are threatened and remaining uses are fully supported.
Partially Supporting = One or more uses are partially supported and remaining uses are fully supported.
Not Supporting = One or more uses are not supported.

1/14/94

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CHAPTER 5

EXISTING POINT AND NONPOINT SOURCE POLLUTION CONTROL PROGRAMS AND WATER SUPPLY LEGISLATION

5.1 INTRODUCTION

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

5.2 NORTH CAROLINA'S POINT SOURCE CONTROL PROGRAM

5.2.1 Introduction

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

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

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

5.2.2 NPDES Permit Review and Processing

Under the basinwide approach, all discharge permits within a given basin are set to expire and be renewed at about the same time. In the Cape Fear basin, for example, all of the existing permits will expire and be renewed between January 1996 and July 1996. The permitting schedule for the Cape Fear Basin is presented in Chapter 1 for each subbasin. Permits are issued with an effective life of not more than five years, thus basin plans are renewed at five-year intervals. New discharge permits issued during an interim period between cycles will be given a shorter expiration period in order to coincide with the next basin permitting cycle.

DWQ will not process a permit application until the application is complete. Rules outlining the discharge permit application and processing requirements are contained in Administrative Code

Section: 15A NCAC 2H .0100 - Wastewater Discharges to Surface Waters. Under this rule, all applications must include a summary of waste treatment and disposal options that were considered, and why the proposed system and point of discharge were selected. The summary should have sufficient detail to assure that the most environmentally sound alternative was selected from the reasonably cost effective options.

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

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

5.2.3 Establishing Discharge Permit Effluent Limitations/Wasteload Allocations

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

Wasteload allocations are performed by DWQ using models of varying scope and complexity, depending on the parameter (type of waste) of interest and the characteristics of the receiving waters. Model frameworks, which are discussed in more detail in Appendix IV, can range from simple mass balance analyses to 3-dimensional dynamic water quality models. Modeling fits into the basin plan by drawing on the current conditions within the basin and evaluating the effects of various management strategies. In general terms, modeling can be used to determine the fate and transport of pollutants, reduction goals for point and nonpoint sources of environmental contaminants, and to derive effluent limits for NPDES permits. More specifically, models can be used to predict concentrations of a parameter at a given site, such as instream DO or chlorophyll *a* in a lake, and can be used as a tool to determine what is needed to protect instream standards. Uncertainty analysis of water quality models expand the predictive capabilities and the confidence

in results, and can produce probabilities that an event would occur under a certain set of circumstances. Waste limits may vary from summer to winter for some parameters, such as nutrients and ammonia, with winter limits being somewhat less stringent than summer limits due to higher instream flows during the winter months.

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

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

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

5.2.4 Compliance Monitoring and Enforcement

Most dischargers are required to periodically sample the treated effluent from their discharge pipes. Also, many larger and more complex dischargers are required to sample points in the receiving waters both up and downstream from the discharge point. This process is called self-monitoring and it is typically required five days a week for some parameters (Monday through Friday) for major facilities. The sampling results (contained in a daily monitoring report or DMR) are then submitted each month to DWQ for compliance evaluations. If the limits are not being met, the state may issue a notice of violation, initiate enforcement action, place the facility on moratorium, and/or enter into a Special Order by Consent (SOC) to ensure compliance. An SOC is a legal commitment entered into by the state and the discharger that establishes a time schedule for bringing the wastewater treatment plant back into compliance. During this time period, interim waste limits may be assigned to the facility until the improvements can be made. These interim limits may be less stringent than those in the permit although they are still required to protect water quality in the receiving waters. In September 1995, eleven facilities were operating under SOC's in the basin.

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

5.2.5 Aquatic Toxicity Testing

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

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

Whole effluent toxicity limitations were implemented by North Carolina in February, 1987 through a policy to incorporate these limits in all major and complex minor permits. As of July 1994, there were 548 permitted NPDES discharges in North Carolina required to perform whole effluent toxicity monitoring, and over 10,000 individual toxicity analyses had been performed across the state. These limitations are developed to protect aquatic life from the discharge of toxic substances in toxic amounts as prescribed by 15 NCAC 2B. 0208 (i.e. so as not to result in chronic toxicity at permitted discharge flow and 7Q10 receiving flow volumes). Since the inception of the aquatic toxicity program a shift in observed WET has been seen from a time when approximately 25% of the facilities tested would be predicted to have been acutely toxic instream to a point now where less than 10% would be considered chronically toxic.

Aquatic toxicity testing, no less than any other complex analytical technique, requires a great deal of quality assurance and control to achieve reliable results. In 1988, North Carolina adopted regulations that initiated a program which required all laboratories performing NPDES analyses in North Carolina to be certified by the state as a biological laboratory. As of July 1994, 24 commercial, municipal, and industrial laboratories had achieved this certification in either aquatic toxicity analyses and/or aquatic population survey. The NC Biological Laboratory Certification Program, much like WET permitting in North Carolina, is looked at as a national leader in its field.

5.2.6 Pretreatment Program

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

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

5.2.7 Operator Certification and Training Program

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

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

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

5.2.8 Nondischarge and Regional Wastewater Treatment Alternatives

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

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

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

5.3 NONPOINT SOURCE CONTROL PROGRAMS

Land use control as well as technology-based best management practices (BMPs) are the two most widely used tools for controlling nonpoint source pollution and protecting designated uses of

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

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

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

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

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

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

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

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

Table 5.1 Examples of Nonpoint Source Programs

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

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

5.3.1 Agricultural Nonpoint Source (NPS) Control Programs

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

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

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

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

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

  The current annual statewide budget to cost share BMPs (75% - NCACSP / 25% landowner) with landowners is approximately $ 6.7 million. The budget to share the cost of providing technical assistance with Districts is approximately $ 1.3 million. Additional support for administration and staff is provided by local governments. In Cape Fear River Basin districts, approximately $8.7 million in BMP cost share dollars have been spent since the program was initiated. There is also federal assistance through ASCS for BMP implementation.

- **North Carolina Pesticide Law of 1971**
  In 1971 the General Assembly created and authorized the North Carolina Pesticide Board to regulate the use, application, sale, disposal and registration of pesticides for the protection

of the health, safety, and welfare of the people and for the promotion of a healthy and safe environment. Some of the responsibilities of the Pesticide Board and the North Carolina Department of Agriculture include registering all pesticides prior to distribution and sale in North Carolina, sampling pesticides to insure that all products are up to guaranteed analysis and unadulterated by any other pesticide, sampling pesticides at time of application to insure that the applicator is following label instructions, and training of applicators (both commercial and private), 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 (application of pesticides through irrigation systems) systems. These inspections are intended to encourage proper calibration and use of equipment in order to avoid excessive application rates and accidental spills from faulty systems. Stop use orders are issued for noncompliance with the regulations.

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

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

- **NCDA Pesticide Disposal Program**

In 1976, the North Carolina Pesticide Board adopted regulations governing the disposal of pesticides. These regulations make it illegal in North Carolina to dispose of hazardous waste (which includes certain pesticides) in sanitary landfills. While households and farms which generate less than 220 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 rule mandates that intensive animal operations operate so that animal waste is not discharged to waters of the state. This means that if criteria are met and no waste is discharged to surface waters, then an individual permit from DWQ is not required. The rule applies to new, expanding or existing feedlots with animal waste management systems designed to serve more than or equal to the following animal populations: 100 head of cattle, 75 horses, 250 swine, 1,000 sheep or 30,000 birds with a liquid waste system. These operations are deemed permitted if a signed registration and an approved waste management plan certification are submitted to DWQ by the appropriate deadlines.

  The deadline for submittal of registrations to DWQ for existing facilities was December 31, 1993. There were 2,090 registered or certified operations in the Cape Fear Basin as of October of 1996. All facility plans must be certified by a technical specialist designated by the Soil and Water Conservation Commission and submitted to DWQ by December 31, 1997. The standards and specifications of the USDA Natural Resources Conservation Service are the minimum criteria used for plan approval by the local Soil and Water Conservation Districts.

  In the past, DWQ inspected intensive animal operations mostly in response to third party complaints. However, with the passage of the above rules, plans are to be making more routine inspections to make sure that waste management systems are adequate and are being operated properly. Animal waste management systems that are determined to have an adverse impact on water quality may be required to obtain an approved animal waste management plan or to apply for and receive an individual nondischarge permit. An illegally discharging operation may also be designated as a concentrated animal feeding operation (CAFO), be fined up to $10,000 per day and be required to apply for a NPDES discharge permit.

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

  The NC Agricultural Research Service and the NC Cooperative Extension Service conduct broad research and education efforts that include areas such as variety development, crop fertilizer requirements, soil testing, integrated pest management, animal housing, animal waste management, machinery development, and irrigation. County Cooperative Extension agents work closely with farmers and homeowners, providing an excellent opportunity for dialogue and education in nonpoint source pollution control. In addition, CES has begun assisting DWQ in holding a series of public workshops in each river basin prior to DWQ's preparation of the draft basin plan. The October 21 and 25, 1994 workshops for this basin is discussed in the Executive Summary and in Appendix V.

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

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

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

- **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 if it has no cover. This rate is determined by the Natural Resources Conservation Service.

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

Sodbuster

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

Swampbuster

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

Conservation Easement

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

Wetland Reserve

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

Water Quality Incentive Program

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

5.3.2 NPS Programs for Urban and Developed Lands

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

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

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

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

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

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

- **Water Supply Protection Program**

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

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

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

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

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

  As of January 1995, 100% of the 55 local governments in the Cape Fear River basin required to submit a water supply protection ordinance for approval have done so. Statewide, the compliance rate for submittals is also 100%.

  The Water Supply Protection Program is administered by staff in the Planning Branch of the Water Quality Section in DWQ. These staff coordinate with the Division of Community Assistance (NCDCA) who helps local governments develop land-use ordinances, the Division of Environmental Health, which certifies that a proposed reclassification is

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suitable for a drinking water supply, and DEM staff in NCDEHNR regional offices who are responsible for water quality sampling in the proposed water supply.

- **ORW and HQW Stream Classifications**
  Outstanding Resource Waters (ORW) and High Quality Waters (HQW) have management strategies that address handling of urban stormwater. Controls for urban stormwater, either through development density limitations or stormwater treatment systems, are required by DEM. Some of these controls are outlined in Appendix I. Other NPS management agencies are expected to place priority on protecting these waters as well. For example, the NC Department of Transportation and the NC Division of Land Resources require more stringent sediment control on construction sites in ORW and HQW areas. See Chapter 3 for the amount of waters in the Cape Fear River Basin classified as HQW and ORW.

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

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

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

  In summary, the regulations which have an expanded areal coverage increases the annual number of projects affected from approximately 50 (original rules) to 500. This increase is coincident with a reduction in design storm that is comparable to requirements in other states. In addition, the low density option, retained from the original regulations, is

encouraged as operation and maintenance concerns associated with stormwater controls are not applicable.

- **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 DEM.

Summary of Changes Since 1989

- The N.C. DEM has developed programs for the administration of NPDES stormwater permits for industries and municipalities.
- The N.C. DEM 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. DEM 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)

5.3.3 Construction - Sedimentation and Erosion Control NPS Program

In 1973, the North Carolina General Assembly enacted the Sedimentation Pollution Control Act. The Act authorized the establishment of a sediment control program to prevent accelerated erosion and off-site sedimentation caused by land-disturbing activities other than agriculture, forestry, and

mining. The Land Quality Section of the Division of Land Resources is responsible for administration and enforcement of the requirements of the Act under the authority of the NC Sedimentation Control Commission.

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

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

There are a number of local municipal and county erosion and sedimentation control programs in the Cape Fear River Basin. These local programs are reviewed annually for compliance with the requirements of the Sedimentation Pollution Control Act. The Land Quality Section also conducts educational programs directed toward state and local government officials in order to strengthen the local programs. Persons engaged in land-disturbing activities and interested citizen groups are included in the educational effort.

The Sedimentation Control Commission has delegated to the Division of Highways of the North Carolina Department of Transportation (DOT) the authority to approve erosion and sedimentation control plans for land-disturbing activity conducted by that agency or by other persons under highway contracts with that agency. The DOT sedimentation control program has been reviewed by the Division of Land Resources under the authority of the Sedimentation Control Commission. DOT 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 DEM, has developed and adopted formal BMPs for protection of surface waters. These BMPs and other efforts are significant improvements in developing a proactive system at DOT toward environmental issues.

Summary Program of Changes Since 1989

- Televised "Keep NC Clean and Beautiful" Public Service Announcements.
- Conducted 12 Erosion and Sediment Control Workshops for local ordinances and enforcement agencies.
- Printed over 55,000 "Erosion Patrol" work packets for third grade students and 2,200 teachers' guides.
- Provided $22,500 in grants to State museums.
- Continue to publish newsletter that reaches over 2,000 people statewide on a quarterly basis.
- Conducted workshops for design professionals, contractors, developers, and DOT personnel in erosion and sedimentation control.
- Developed pocket guide for sedimentation and erosion control.
- Conducted three Construction Equipment Trade Shows and Erosion Control Seminars.
- Sponsored Resource Conservation Workshops with NRCS for high schools.
- Conducted three public awareness workshops for western North Carolina.
- Produced Erosion and Sediment Control Publications for State 4-H.
- Development and Production of "Erosion and Sediment Control Planning and Design Manual," "Inspector's Guide", "Field Manual," and "Video Modules".

- Provided a grant to develop a college course curriculum in erosion and sediment control.
- Provided a grant to Parks and Recreation to develop education materials for erosion and sedimentation to be used at state parks.
- Sponsored High School essay contest for 5 years.
- Sponsored six workshops for sediment control and pollution prevention in coastal NC.
- Created an intern position to assist in sedimentation projects.
- Sponsored evaluations of E & S Control Devices
- Will be conducting a National Symposium on turbidity and sedimentation.

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

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

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

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

5.3.5 Solid Waste Disposal NPS Programs

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

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

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

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

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

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

5.3.6 Forestry NPS Programs

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

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

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

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

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

5.3.7 Mining NPS Program

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

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

5.3.8 Wetlands Regulatory NPS Programs

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

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

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

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

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

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

- **Section 404 of the Clean Water Act**
  The U.S. Army Corps of Engineers administers a national regulatory program under Section 404 of the Clean Water Act aimed at controlling the discharge of dredged or fill material into waters of the United States. Section 404 applies to just the discharge of dredged or fill materials into waters of the United States and does not apply to dredging activities. Waters of the United States refers to navigable waters, their tributaries, and adjacent wetlands. Activities covered under Section 404 include dams, dikes, marinas, bulkheads, utility and power transmission lines and bank stabilization. Although the 404

program does not fully protect wetlands, it is nonetheless the only federal tool at this time for regulating wetland development statewide. State legislation has not been adopted to protect inland freshwater wetlands in North Carolina, as has been done for coastal wetlands, but DEM is in the process of drafting rules which will formalize the wetlands protection measures associated with the 401 Water Quality Certification review process.

- **Section 401 Water Quality Certification (from CWA)**
  The Division of Environmental Management is responsible for the issuance of 401 Water Quality Certifications (as mandated under Section 401 of the Clean Water Act). A 401 certification is required for the discharge of pollutants into surface waters and wetlands for projects that require a section 404 federal permit. The 401 certification indicates that the discharged pollutant will not violate state water quality standards. A federal permit cannot be issued if a 401 certification is denied. The 401 certification process is coordinated with the 404 and CAMA processes in the 20 counties of CAMA jurisdiction.

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

5.3.9 Hydrologic Modification

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

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

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

5.3.10 Water Supply Legislation in North Carolina

- **Water Supply Planning Law**
  The Water Supply Planning law (G.S. 143-355 (l) and (m)) was adopted in 1989 and amended in 1993. It requires all local governments that supply or plan to supply water to prepare a local water supply plan. In their plans, local governments are to include present and projected population, industrial development and water use within the service area, present and future water supplies, an estimate of technical assistance needs and other information that may be required by the Department. All local plans are to be approved

and submitted to DWR by January 1, 1995. Information in those local plans is to be included in a State Water Supply Plan. The State Plan will also investigate the extent to which the various local plans are compatible.

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

- **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 DEM, 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.

5.3.11 GROUNDWATER PROGRAMS

Although groundwater resources in North Carolina are generally of good quality, nonpoint sources of pollution can contaminate aquifers rendering the water unfit as a water supply source. More than 55 percent of the citizens rely on groundwater as a source of drinking water, and in some counties this number exceeds 90 percent. Many of these residents are dependent on individual, easily-contaminated, shallow wells for their water. The DEM Groundwater Section, Department of Environmental, Health, and Natural Resources, is the designated lead agency in the State for groundwater protection. The Section manages programs to prevent groundwater pollution, respond to contamination incidents, and to develop better tools to assess groundwater contamination risks.

To prevent pollution, groundwaters of the state have been classified and standards developed. Nonpoint source land and subsurface, nondischarge, waste disposal activities are regulated, and groundwater self-monitoring requirements imposed on any activity which has the potential to violate standards at a 250 foot compliance boundary. A Wellhead Protection Program assists local communities in establishing programs to delineate groundwater recharge areas surrounding water supply wells and protect these areas from nonpoint sources that could contaminate water supplies.

Over the past decade the biggest threat to groundwater has been leaking underground storage tanks. The Section manages both Federal and State trust funds to assist responsible parties in the cleanup of tank contaminants, and maintains an investigation team to determine the source of contamination at incident sites. To assess potential risks to groundwater resources, the Section is developing a series of groundwater vulnerability sites where the potential impacts of different types of nonpoint source pollutants on groundwater can be evaluated, and has conducted an extensive statewide assessment of pesticides in groundwater. Also, the Section is investigating the groundwater storage role upland wetlands play in maintaining low lying riverine wetlands.

Summary Program of Changes Since 1989

- State groundwater protection regulations (2L) regarding classifications and standards were significantly upgraded in 1993, establishing new protocols for cleanups at groundwater contamination sites.
- The Section developed and implemented an underground storage tank (UST) program and was delegated primacy for UST cleanups in the State.
- A State leaking underground storage tank (LUST) trust fund was established which included provisions for cleanup of non-commercial UST's.
- The Section developed and received EPA approval for its Wellhead Protection Plan to protect groundwater in the vicinity of community water-supply wells.
- A Generic State Management Plan to protect groundwater resources from pesticide contamination has been developed, and a major statewide assessment of pesticides in groundwater is nearing completion.

5.4 INTEGRATING POINT AND NONPOINT SOURCE POLLUTION CONTROLS STRATEGIES

Integrating point and nonpoint source pollution controls and determining the amount and location of the remaining assimilative capacity in a basin are key long-term objectives of basinwide management. The information can be used for a number of purposes including determining if and where new or expanded municipal or industrial wastewater treatment facilities can be allowed;

setting the recommended treatment level at these facilities; and identifying where point and nonpoint source pollution controls must be implemented to restore capacity and maintain water quality standards.

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

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

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

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

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

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CHAPTER 6

MAJOR WATER QUALITY CONCERNS AND RECOMMENDED MANAGEMENT STRATEGIES FOR THE CAPE FEAR BASIN

6.1 BASINWIDE MANAGEMENT GOALS

The Cape Fear basin has experienced significant population growth and development over the past 20 years, and that growth is expected to continue. This growth is viewed positively by businesses, local governments and others, but as the population continues to grow, so do the demands on the basin's water resources. For example, water usage through public water suppliers (e.g. local governments and water and sewer authorities) is predicted to double the 1992 usage by the year 2020. This will likely result in an attendant increase in the volume of wastewater that will need to be treated. In addition, land development accompanying population increases will generate additional nonpoint source pollution.

Chapter 4 has documented that many streams, lakes and estuarine areas in the basin are impaired or threatened. Excessive nutrients, sedimentation and limited waste assimilative capacity for oxygen-consuming wastes are major concerns. Continued population growth and development will only exacerbate these problems. Effective point and nonpoint source control measures are needed.

The long-range goal of basinwide management is to provide a means of addressing the complex problems of protecting uses of the Cape Fear Basin's surface waters while accommodating population increases and reasonable economic growth.

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

- identify and restore the most serious water quality problems in the basin (**Section 6.2.1**).
- protect those waters known to be of the highest quality or supporting biological communities of special importance (**Section 6.2.2**) and
- manage problem pollutants, particularly biochemical oxygen demanding wastes (BOD), nutrients, sedimentation and toxics in order to protect those waters currently supporting their uses and allow for reasonable economic growth. (**Sections 6.2.3 and 6.3 through 6.9**).

6.2 MAJOR WATER QUALITY CONCERNS AND PRIORITY ISSUES

6.2.1 Identifying and Restoring Impaired Waters

Identification and restoration of impaired waters is a primary goal of the state's water quality program and basinwide management approach. *Impaired waters* are those identified in Figure 4.19 of Chapter 4 as being rated partially supporting or not supporting their designated uses. Impairment may be based on monitored or evaluated data (see Section 4.4). *Monitored* streams are those based on biological or chemical data collected between 1989 and 1994. *Evaluated* streams are those that are based on data collected prior to 1989 or on best professional judgment. Monitored streams will receive higher priority for management strategy development and grant funding for nonpoint source controls than evaluated streams since the ratings are based on more

recent and reliable data. Where water quality problems have been identified but the source(s) is not evident, investigation of the source(s) will be necessary before any specific actions can be outlined.

Nonpoint Source Measures

Table 6.1 lists all monitored freshwater streams in the basin identified as impaired. Also included on the list are highly valued resource waters which are targeted for protection and discussed under Section 6.2.2, below. Together these streams comprise a list of nonpoint source (NPS) priority waters. The NPS Priority Waters listed in Tables 6.1 and 6.2 and depicted in Figures 6.1a, 6.1b and 6.1c indicate DWQ's recommended priority rating for nonpoint source management of waters under Section 319 of the federal Clean Water Act. Waters have been prioritized in the tables for NPS controls which may be implemented through programs such as Section 319, the NC Agriculture Cost Share Program, the Forest Practice Guidelines Related to Water Quality and many others. They may also be used by the NC Department of Transportation for targeting wetlands mitigation sites. A schedule of priority from high to medium has been established to help direct the resources of the programs so that nonpoint sources problems can be addressed and water can be protected from degradation.

High priority streams:

- monitored streams that have an overall use support rating of "nonsupporting,"
- monitored streams that have a "partial support" rating but have a predicted loading of one or more pollutants that is high,
- streams that are unusually sensitive as documented by special studies
  - High Quality Waters
  - Outstanding Resource Waters
  - Water Supply I; Water Supply II; Critical Areas of WS-II, WS-III, WS-IV
  - Shellfish Waters (Class SA) closed due to pollutants and that have a Significant Shellfish Resource (SSR) as identified by the Division of Environmental Health.

Medium priority streams:

Monitored streams that have an overall use support rating of "partially supporting." Shellfish Waters (Class SA) that are closed due to pollutants and that do not have a SSR are also considered medium priority streams.

The United States Fish and Wildlife Service has also identified Unique Aquatic Communities (UAC) that the Division has shown on the maps for NPS targeting. These areas usually encompass waters which provide habitat for threatened and endangered species.

Point Source Measures

Table 6.3 presents management strategies or TMDLs (total maximum daily loads - see Section 5.3) for streams identified as either being impaired by point sources, or streams in which impacts could be expected based on predictive computer modeling. This table presents two types of strategies:

1) those intended to correct existing problems in impaired waters and
2) those being recommended in waters supporting their uses to prevent violation of water quality standards resulting from new or expanding wastewater treatment plant discharges.

The table addresses three types of pollutants: biochemical oxygen demand (BOD), nutrients and toxicants. Streams are listed in upstream to downstream order. More detailed explanations for the rationales of the various strategies are presented in Section 6.3 for oxygen-consuming wastes, 6.4 for nutrients and 6.5 for toxicants. Locations of the recommended strategies listed in Table 6.3 are depicted in Figures 6.2a, 6.2b and 6.2c.

Table 6.1a Nonpoint Source Priority Ratings for Impaired Freshwater Monitored Streams (Page 1 of 2)

NPS Map No.	Name of Stream	Index No.	Miles	Problem Parameter	Potential Sources Subcategory	Reason For Priority *	NPS Priority
1	Little Troublesome Creek	16-7a	2.9	Turb	03	NS	High
3	**UT to Horsepen Creek**	16-11-5-1-(2)	**2.9**			**CA, NS**	**High**
4	North Buffalo Creek	16-11-14-1a	8.5	Fecal, NH3(47)	43,01,08, 03	NS	High
	North Buffalo Creek	16-11-14-1b	9.8				High
5	South Buffalo Creek	16-11-14-2b	4.3	NH3(20),Cd(32)		NS	High
	Mile Run Creek	16-11-14-2-4	2.8		43		High
13	Robeson Creek	16-38-(3)a	0.9		10,40	NS	High
14	Third Fork Creek	16-41-1-12-(2)	4.5	Turb(18)	32,40	NS	High
16	Meeting of the Waters	16-41-2-7	1.6		40	NS	High
21	**UT to Polecat Creek**	**17-11-2-(2)**	**1.4**			**CA, NS**	**High**
26	Big Governors Creek	17-32-(.7)	9.5			NS	High
27	Indian Creek	17-35	8.2	Sed	10	NS	High
29	Little Buffalo Creek	17-42	9.8	Sed	50,40	NS	High
31	Loves Creek	17-43-10b	0.9		03,10	NS	High
33	Gulf Creek	18-5-(1)	5.1	Sed	50	NS	High
37	Kenneth Creek	18-16-1-(2)a	1.0		10,30,02	NS	High
45	Little Cross Creek	18-27-4-(1)	7.0			NS	High
46	Pedler Branch	18-31-16	2.6		40,10	NS	High
47	UT#1 to Bones Creek	18-31-24-2a	0.0			NS	High
50	Livingston Creek	18-64b	7.7	NH3(13)		NS	High
52	Northeast Cape Fear River	18-74-(1)a	3.3	DO(39),NH3(15),Cl(20)		NS	High
53	Barlow Branch	18-74-2	1.1		40,01	NS	High
	Panther Creek below Faison UT	18-74-19-3b	3.0		0	NS	High
54	Persimon Branch	18-74-25-1b	0.8			NS	High
56	Burgaw Creek	18-74-39b	10.7	Sed	41,42,62	NS	High
57	HAW RIVER	16-(1)a	7.2		10,08	PS	Medium
58	HAW RIVER	16-(1)d	13.9	Fecal,Turb(20),Cd(16)	10,40,06	PS	Medium
59	Candy Creek	16-5	3.6		10	PS	Medium
60	Little Troublesome Creek	16-7a	2.9			PS	Medium
61	Horsepen Creek	16-11-5-(0.5)	6.9		55,84	PS	Medium
62	South Buffalo Creek	16-11-14-2a	18.6	Sed	43,	PS	Medium
63	Town Branch	16-17	4.0	Fecal,Turb(13)		PS	Medium
64	Robeson Creek	16-38-(3)b	4.7	pH(12),Chla(20)	10,40	PS	Medium
65	Bolin Creek	16-41-1-15-1-(4	1.0			PS	Medium
66	Northeast Creek	16-41-1-17-(7)a	2.2		30,40	PS	Medium
67	Northeast Creek	16-41-1-17-(7)b	1.8	Turb(14),Cu(14),Sed	43, 03	PS	Medium
68	Northeast Creek	16-41-1-17-(7)c	4.4	Sed	43	PS	Medium
69	Morgan Creek	16-41-2-(5.5)	8.0	Sed	43, 02	PS	Medium
70	East Fork Deep River	17-2-(.3)	6.5	Turb(11)	10,08	PS	Medium
71	DEEP RIVER	17-(4)a	2.0		40	PS	Medium
72	DEEP RIVER	17-(4)b	6.8	Turb(14)	10,30,40	PS	Medium
73	DEEP RIVER	17-(4)d	2.3	Turb(13),Cu(13),Hg(13), F	18,20	PS	Medium
74	Richland Creek	17-7	9.1	Turb(11),Cu(16)	62,02	PS	Medium
75	Haskett Creek	17-12a	5.5			PS	Medium
76	Haskett Creek	17-12b	2.3	Cu(33)	40	PS	Medium
77	Flat Creek	17-24	9.5		18,20	PS	Medium
78	Cotton Creek	17-26-5-3-(1)a	0.3		03,	PS	Medium
79	Cotton Creek	17-26-5-3-(1)b	6.5		10,40,	PS	Medium
80	Falls Creek	17-27	11.6	Sed	10	PS	Medium
81	McLendons Creek	17-30b	20.1			PS	Medium
82	Richland Creek	17-30-5-(2)	12.8			PS	Medium
83	Little Pocket Creek	17-37-4	12.4		11,12	PS	Medium
84	Cedar Creek	17-39	7.9	Sed	50	PS	Medium
85	Georges Creek	17-41	8.7			PS	Medium
86	Rocky River	17-43-(8)a	4.2			PS	Medium
87	Loves Creek	17-43-10a	5.5		10	PS	Medium
88	Bear Creek	17-43-16a	14.9	Sed		PS	Medium
89	Neill Creek (Neals Creek)	18-16-(.7)	2.4	Sed		PS	Medium
90	Kenneth Creek	18-16-1-(2)b	5.5		10,30	PS	Medium
91	Anderson Creek	18-23-32	5.5	Sed	10	PS	Medium
92	Cross Creek	18-27-(1)	9.0	Sed		PS	Medium
93	Cross Creek	18-27-(3)	3.6	Pb(13)	40	PS	Medium
94	Harrisons Creek	18-42	20.5	pH(100), Sed	90	PS	Medium
95	Turnbull Creek	18-46	27.2	pH(100), Sed	10	PS	Medium
	CAPE FEAR RIVER near Acme	18-(63)a	2.1		0	PS	
96	Livingston Creek	18-64a	14.5			PS	Medium
97	South River	18-68-12a	7.2			PS	Medium
98	Little Black River	18-68-12-1a	20.0	Sed	10	PS	Medium

Table 6.1a Nonpoint Source Priority Ratings for Impaired Freshwater Monitored Streams (Page 2 of 2)

NPS Map No.	Name of Stream	Index No.	Miles	Problem Parameter	Potential Sources Subcategory	Reason For Priority *	NPS Priority
99	Northeast Cape Fear River	18-74-(1)b	2.6	Sed	82,	PS	Medium
100	Goshen Swamp	18-74-19	32.6	Sed	10,16	PS	Medium
101	Herrings Marsh Run	18-74-19-16	1.8			PS	Medium
102	Limestone Creek	18-74-23	7.5	Sed	74,18	PS	Medium
103	Persimon Branch	18-74-25-1a	1.5			PS	Medium
104	Rock Fish Creek	18-74-29c	7.2	Cu(16),Sed	11,18,03	PS	Medium
105	Cypress Creek	18-74-55-2	8.0		65	PS	Medium

*REASON FOR PRIORITY		POTENTIAL SOURCES SUB CATEGORY CODES	
CA	Water Supply Watershed Critical Area	0 to 09	Point Sources (01=industrial, 02&03 municipal, 08 minor non-munic)
HQ	High Quality Waters	10 to19	Agriculture
NS	Nonsupporting waters based on monitored data	20 to 29	Silviculture
ORW	Outstanding Resource Waters	30 to 39	Construction
PS	Partially Supporting waters based on monitored data	40 to 49	Urban Runoff
UAC	USFWS Unique aquatic community	50 to 59	Resource Extraction (i.e., mining)
WS-I	Water Supply I Watershed	60 to 69	Land Disposal (Runoff/Leacheate from Permitted areas)
WS-II	Water Supply II Watershed	70 to 79	Hydrologic/Habitat Modification
BOLD	These streams identified for special emphasis	80/90	80=Other (82=waste storage/tank leaks, 84=spills) 90=unknown

Table 6.1b Priority Nonpoint Source Ratings of High Value Resource Waters in the Cape Fear Basin (Page 1 of 3)

NPS Map No.	Name of Stream	Index No.	Miles	Problem Parameter	Potential Sources Subcategory	Reason For Priority *	NPS Priority
1	Troublesome Creek WS	16-6-(0.7)	5.8	Sed	10	CA	High
	Glady Creek	16-6-1-(2)	0.5		90	CA	High
2	Reedy Fork WS	16-11-(3.5)	12.3	Sed	06	CA	High
	Brush Creek (Lake Higgins)	16-11-4-(2)	0.6		10	CA	High
3	**UT to Horsepen Creek**	16-11-5-1-(2)	2.9			**CA, NS**	**High**
	Horsepen Creek	16-11-5-(2)	1.6		55,84	CA	High
	Long Branch	16-11-6-(2)	0.5			CA	High
	Richland Creek	16-11-7-(2)	1.7			CA	High
	Squirrel Creek	16-11-8-(2)	2.3			CA	High
6	Stony Creek (Lake Burlington) WS	16-14-(1)	12.1			WS-II	High
	Grays Branch	16-14-2	4.1		11	WS-II	High
	Benton Branch	16-14-3	6.5		11	WS-II	High
	Toms Creek	16-14-4	5.7		11	WS-II	High
	Buttermilk Creek	16-14-5	9.6			WS-II	High
	Jones Creek	16-14-5-1	2.0			WS-II	High
	Laughin Creek	16-14-5-2	4.5			WS-II	High
	Whittie Creek	16-14-5-3	2.7			WS-II	High
	Stony Creek (Stony Cr Res.)	16-14-(5.5)	4.1			WS-II, CA	High
	Jordan Creek	16-14-6-(0.5)	10.9		11	WS-II	High
	Hughes Mill Creek	16-14-6-1	3.8		11	WS-II	High
	Owens Creek	16-14-6-2	6.7		11	WS-II	High
	Jordan Creek	16-14-6-(3)	0.7		11	WS-II, CA	High
	Mine Creek	16-14-7-(1)	3.7			WS-II	High
	Mine Creek	16-14-7-(2)	0.6			WS-II, CA	High
	Deep Creek	16-14-8-(1)	6.5			WS-II	High
	Deep Creek	16-14-8-(2)	0.7			WS-II, CA	High
7	Back Creek (Graham Lake) WS	16-18-(1)	8.0			WS-II	High
	Back Creek (Graham Lake)	16-18-(1.5)	5.7			WS-II, CA	High
	Stagg Creek	16-18-2-(0.5)	6.7			WS-II	High
	Frank Creek	16-18-2-1	2.5			WS-II	High
	Stagg Creek	16-18-2-(2)	0.5			WS-II, CA	High
	Mill Creek	16-18-3-(0.5)	4.2			WS-II	High
	Lake Michael	16-18-3-1	3.9			WS-II	High
	Mill Creek	16-18-3-(1.5)	0.8			WS-II, CA	High
	Unnamed Trib Forest Lake	16-18-3-2-(1)	1.0			WS-II	High
	Unnamed Trib Forest Lake	16-18-3-2-(2)	0.4			WS-II, CA	High
	Quaker Creek	16-18-4-(1)	6.3			WS-II	High
	Quaker Creek	16-18-4-(2)	0.6			WS-II, CA	High
	Scrub Creek	16-18-4-1-(1)	3.0			WS-II	High
	Scrub Creek	16-18-4-1-(2)	0.7			WS-II, CA	High
	Otter Creek	16-18-5-(1)	2.7			WS-II	High
	Otter Creek	16-18-5-(2)	0.8			WS-II, CA	High
8	Big Alamance Creek WS	16-19-(2.5)	9.7			WS-II, CA	High
	Little Alamance Creek	16-19-3-(4.5)	0.5	Sed	10	WS-II, CA	High
	Rock Creek	16-19-3-5-(2)	1.0		10	WS-II, CA	High
	Beaver Creek	16-19-4-(2)	0.7			WS-II, CA	High
9	Cane Creek WS	16-27-(1)	4.1			WS-II	High
	Hog Branch	16-27-2	1.6			WS-II	High
	Cane Creek	16-27-(2.5)	4.7			WS-II, CA	High
	Turkey Hill Creek	16-27-3-(1)	5.2			WS-II	High
	Turkey Hill Creek	16-27-3-(2)	0.3			WS-II, CA	High
	Watery Fork	16-27-4-(0.5)	2.1			WS-II	High
	Hudson Branch	16-27-4-1	0.7			WS-II	High
	Watery Fork	16-27-4-(2)	0.6			WS-II, CA	High
	Toms Creek	16-27-5-(1)	3.0			WS-II	High
	Toms Creek (Apple Pond)	16-27-5-(2)	0.9			WS-II, CA	High
	Caterpillar Creek	16-27-6-(1)	1.0			WS-II	High
	Caterpillar Creek	16-27-6-(2)	1.5			WS-II, CA	High
	Collins Creek	16-30-(1.5)	3.9	Sed	10	WS-IV, CA	High
10	HAW RIVER	16-(36.3)	0.5		10,40	CA	High
11	HAW RIVER	16-(37.3)	0.5			CA	High
12	HAW RIVER (Jordan Lake) WS	16-(37.5)	2.8			CA	High
13	Robeson Creek	16-38-(5)	0.3			CA	High
	Stinking Creek	16-39-(2)	0.8			CA	High
	Kirks Creek	16-40	3.2			CA	High
	New Hope River Arm of Jordan Lake	16-41-(0.5)	0.0			CA	High
14	New Hope Creek	16-41-1-(14)	4.8		43	CA	High
	Little Creek	16-41-1-15-(3)	0.7	Sed		CA	High
	Crooked Creek	16-41-1-16-(2)	0.7	Sed	10,30	CA	High

Table 6.1b Priority Nonpoint Source Ratings of High Value Resource Waters in the Cape Fear Basin (Page 2 of 3)

NPS Map No.	Name of Stream	Index No.	Miles	Problem Parameter	Potential Sources Subcategory	Reason For Priority *	NPS Priority
14	Northeast Creek	16-41-1-17-(4)	0.9	Sed	43	CA	High
	Indian Creek	16-41-1-18-(2)	0.6			CA	High
	Morgan Creek (including	16-41-2-(9.5)	0.6			CA	High
	Cub Creek	16-41-2-10-(2)	0.6		08		High
	Lick Creek	16-41-2.5-(2)	0.7			CA	High
	Folkner Branch	16-41-3-(2)	0.5			CA	High
	Bush Creek	16-41-4-(.7)	0.5			CA	High
	Hendon Creek	16-41-4-1-(2)	0.6			CA	High
	Overcup Creek	16-41-4-2-(2)	0.4			CA	High
	Beartree Creek	16-41-5-(2)	0.7			CA	High
	White Oak Creek	16-41-6-(3.5)	0.5	Sed	65,32,08	CA	High
	Rocky Ford Branch	16-41-6-4-(2)	0.6		10	CA	High
	Mill Branch	16-41-6-5-(2)	0.5		90	CA	High
	Parkers Creek	16-41-8-(2)	0.5			CA	High
	Windfall Branch	16-41-9-(2)	0.5			CA	High
	Beaver Creek	16-41-10-(2)	0.6	Sed		CA	High
	Little Beaver Creek	16-41-11-2-(2)	0.6			CA	High
	Weaver Creek	16-41-12-3-(2)	0.5			CA	High
15	Morgan Creek WS	16-41-2-(1)	6.7			WS-II	High
	Morgan Creek (University Lake)	16-41-2-(1.5)	1.3			WS-II, CA	High
	Phils Creek	16-41-2-2-(0.3)	5.0			WS-II	High
	Phils Creek	16-41-2-2-(0.7)	0.7			WS-II, CA	High
	Neville Creek	16-41-2-2-1-(1)	3.0			WS-II	High
	Neville Creek	16-41-2-2-1-(2)	0.5			WS-II, CA	High
	Mill Creek	16-41-2-3-(.5)	2.5			WS-II	High
	Cumbo Creek	16-41-2-3-1	0.8			WS-II	High
	Mill Creek	16-41-2-3-(2)	0.5			WS-II, CA	High
	Price Creek	16-41-2-4	0.4			WS-II, CA	High
	East Branch Price	16-41-2-4-1-(1)	2.4			WS-II	High
	East Branch Price	16-41-2-4-1-(2)	0.2			WS-II, CA	High
	West Branch Price	16-41-2-4-2-(1)	2.4			WS-II	High
	West Branch Price	16-41-2-4-2-(2)	0.3			WS-II, CA	High
18	DEEP RIVER WS	17-(1)	2.7		10,30,40,	CA	High
	East Fork Deep River	17-2-(.7)	0.6		10,08	CA	High
	Long Branch	17-2-1-(2)	0.6			CA	High
19	West Fork Deep River WS	17-3-(.7)	3.1			CA	High
	Hiatt Branch	17-3-1-(2)	0.6		11	CA	High
	Boulding Branch	17-3-2	3.7		30,40,11	CA	High
	West Fork Deep River	17-3-(3)	1.1			CA	High
	UT to West Fork Deep River	17-3-0.5b	3.3			CA	High
20	DEEP RIVER WS	17-(3.7)	1.3		40	CA	High
21	**UT to Polecat Creek**	**17-11-2-(2)**	**1.4**			**CA, NS**	**High**
22	Little Polecat Creek	17-11-3	6.3		32	HQW	High
23	Polecat Creek WS	17-11-(11.5)	2.2			CA	High
	Bull Run	17-11-4b	0.7			CA	High
24	Sandy Creek	17-16-(3.5)	0.6			CA	High
25	DEEP RIVER	17-(25.7)	12.8		11,03	HQW	High
	DEEP RIVER	17-(28.5)	14.4		11,12,31,32,43	HQW	High
28	DEEP RIVER	17-(36)	0.5			CA	High
30	Rocky River	17-43-(7.5)	0.6			CA	High
32	CAPE FEAR RIVER	18-(4.5)	0.5		11,12,31,32	CA	High
	Gulf Creek	18-5-(2)	0.2	Sed	50	CA	High
34	Parkers Creek	18-9	8.4			HQW	High
35	Avents Creek	18-13	8.1			HQW	High
36	Hector Creek	18-15	9.7			HQW	High
38	CAPE FEAR RIVER	18-(16.3)	0.5		11,12,31,32	CA	High
39	CAPE FEAR RIVER	18-(20.3)	0.6		11,12,31,32,03,	CA	High
40	Little River HQW	18-23-(1)	13.0			HQW	High
	Little River	18-23-(5)	1.7			HQW	High
	Little River	18-23-(8)	4.4			HQW	High
	Little River	18-23-(10.3)	0.6			CA, HQW	High
	Little River	18-23-(10.7)	12.8	pH(64)		HQW	High
41	Nicks Creek	18-23-3-(1.5)	0.6		90	CA	High
42	Little River	18-23-(23.5)	1.5		11	CA	High
43	CAPE FEAR RIVER	18-(25.5)	0.5		11,12,31,32	CA	High
44	Cross Creek	18-27-(2.5)	0.5	Sed		CA	High
	Little Cross Creek	18-27-4-(1.5)	0.5			CA	High
48	CAPE FEAR RIVER	18-(58.5)	0.6		90	CA	High
49	CAPE FEAR RIVER	18-(62.5)	0.5		90	CA	High
51	Black River ORW	18-68	63.1			ORW	High

Table 6.1b Priority Nonpoint Source Ratings of High Value Resource Waters in the Cape Fear Basin (Page 3 of 3)

NPS Map No.	Name of Stream	Index No.	Miles	Problem Parameter	Potential Sources Subcategory	Reason For Priority *	NPS Priority
	Six Runs Creek	18-68-2-(11.5)	10.3			ORW	High
	South River	18-68-12-(8.5)	42.0			ORW	High
55	Northeast Cape Fear River	18-74-(25.5)	17.3			HQW	High
106	Deep River from confluence with Haw					USFWS UAC	High
	River upstream to Coleridge,		THESE USFWS UAC AREAS ARE SUBJECT				
	including tributaries (with special		TO FUTURE MODIFICATION AND SHOULD				
	emphasis on Rocky River Subbasin		ONLY BE CONSIDERED DRAFT AT THIS POINT.				
	in Chatham Co. and Fork Cr in Randolph		(THEY WILL PROBABLY BE NARROWED DOWN)				
	Co.						
107	Haw River from Jordan lake to					USFWS UAC	High
	Saxapahaw						
108	University Lake in Chapel Hill and					USFWS UAC	Medium
	tributaries						
109	Orton Pond, Sand Hill Creek Pond and					USFWS UAC	Medium
	tributaries						
110	Town Creek and tributaries in					USFWS UAC	Medium
	Brunswick County						
111	Black and South River Subbasin					USFWS UAC	Medium

*REASON FOR PRIORITY		POTENTIAL SOURCES SUB CATEGORY CODES	
CA	Water Supply Watershed Critical Area	0 to 09	Point Sources (01=industrial, 02&03 municipal, 08 minor non-munic)
HQ	High Quality Waters	10 to19	Agriculture
NS	Nonsupporting waters based on monitored data	20 to 29	Silviculture
ORW	Outstanding Resource Waters	30 to 39	Construction
PS	Partially Supporting waters based on monitored data	40 to 49	Urban Runoff
UAC	USFWS Unique aquatic community	50 to 59	Resource Extraction (i.e., mining)
WS-I	Water Supply I Watershed	60 to 69	Land Disposal (Runoff/Leacheate from Permitted areas)
WS-II	Water Supply II Watershed	70 to 79	Hydrologic/Habitat Modification
BOLD	These streams identified for special emphasis	80/90	80=Other (82=waste storage/tank leaks, 84=spills) 90=unknown

Table 6.2 Targeted Estuarine Water Bodies for Nonpoint Source Management						
			Problem	Probable	Reason For	
Map Number	Area Name	DEH Area	Parameter	Sources	Priority *	NPS Priority
121	Southport Area	B1	Fecal	P,NP	PS	Medium
106	Polly Gully, Beaverdam,	B1			HQW	High
	Jump and Run, Calf Gully, and					
	Dutchman's Creek					
122	Cape Fear	B4	Fecal	P,NP	PS	Medium
107	Walden Creek	B4			HQW	High
123	Myrtle Sound Area	B5	Fecal	NP	PS	Medium
124	Masonboro Sound Area	B6	Fecal	P,NP	PS	High
108	Masonboro Sound	B6			ORW	High
114	**Whiskey Creek**	**B6**	**Fecal**	**NP**	**PS, SSR**	**High**
125	Wrightsville Beach	B7	Fecal	NP	PS	Medium
109	**Bradley Creek**	**B7**	**Fecal**	**NP**	**HQW, PS**	**High**
110	Topsail and Middle Sounds	B7/B8			ORW	High
115	**Howe Creek**	**B7**	**Fecal**	**NP**	**PS, SSR, ORW**	**High**
117	**Pages Creek**	**B7**	**Fecal**	**NP**	**PS, SSR**	**High**
118	**Futch Creek**	**B7**	**Fecal**	**NP**	**PS, SSR**	**High**
126	Topsail Sound	B8	Fecal	NP	PS	Medium
119	**Virginia Creek**	**B8**	**Fecal**	**NP**	**PS, SSR**	**High**
120	**Mill Creek**	**B8**	**Fecal**	**NP**	**PS, SSR**	**High**
127	Stump Sound	B9	Fecal	P,NP	PS	Medium
112	Stump Sound and Alligator Bay	B9			ORW	High
113	King's Creek	B9	Fecal	NP	HQW	High
^^ Reason For priority						
HQW= High Quality Waters						
ORW= Outstanding Resource Waters						
PS= Partially Supporting Waters						
SSR= Significant Shellfish Waters						
as identified by Division of Environmental Health						
Special Emphasis						

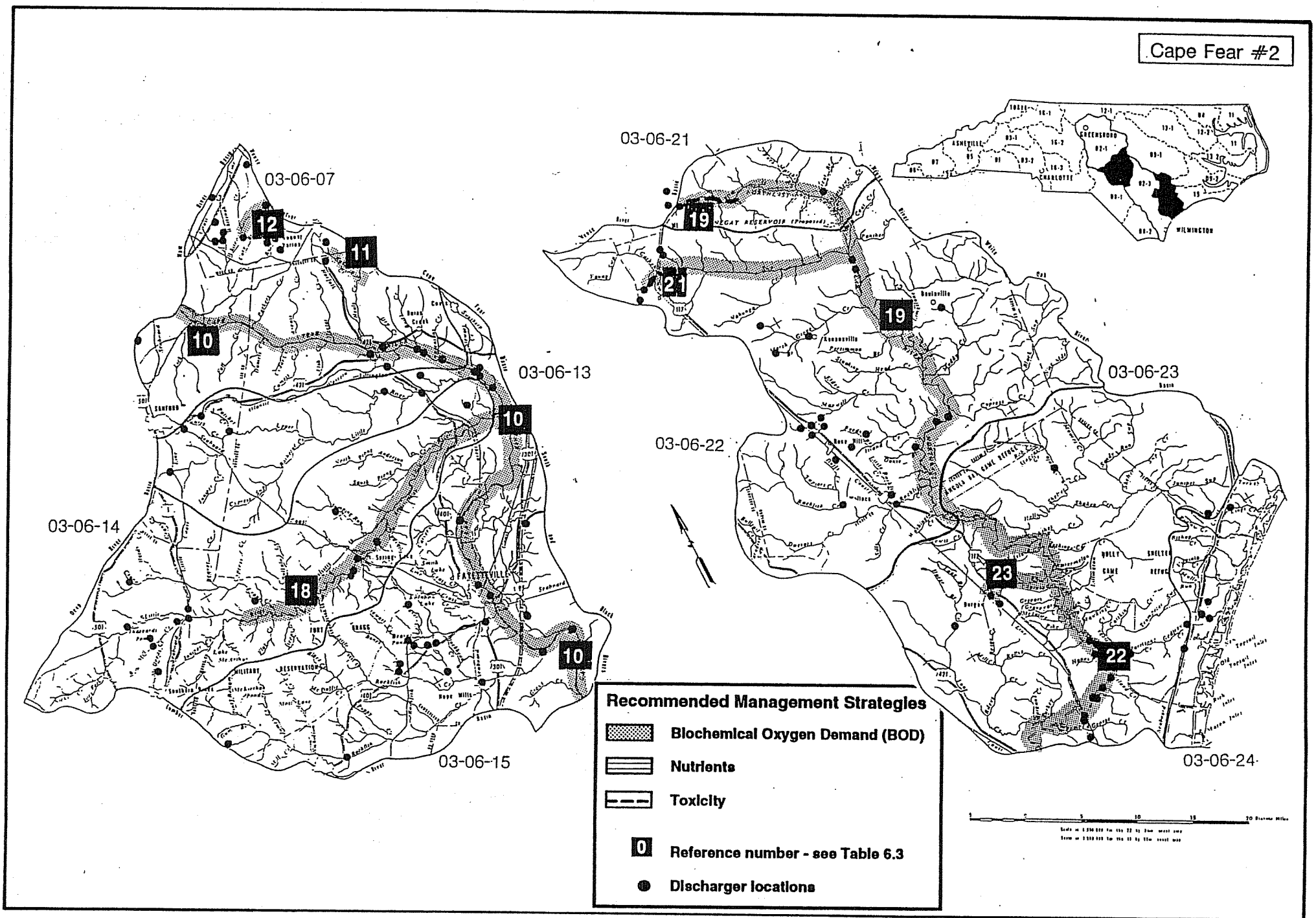

Figure 6.2b Map of Management Strategies for Addressing Biochemical Oxygen Demand (BOD), Nutrients and Toxicity in the Upper and Northeast Cape Fear Watersheds

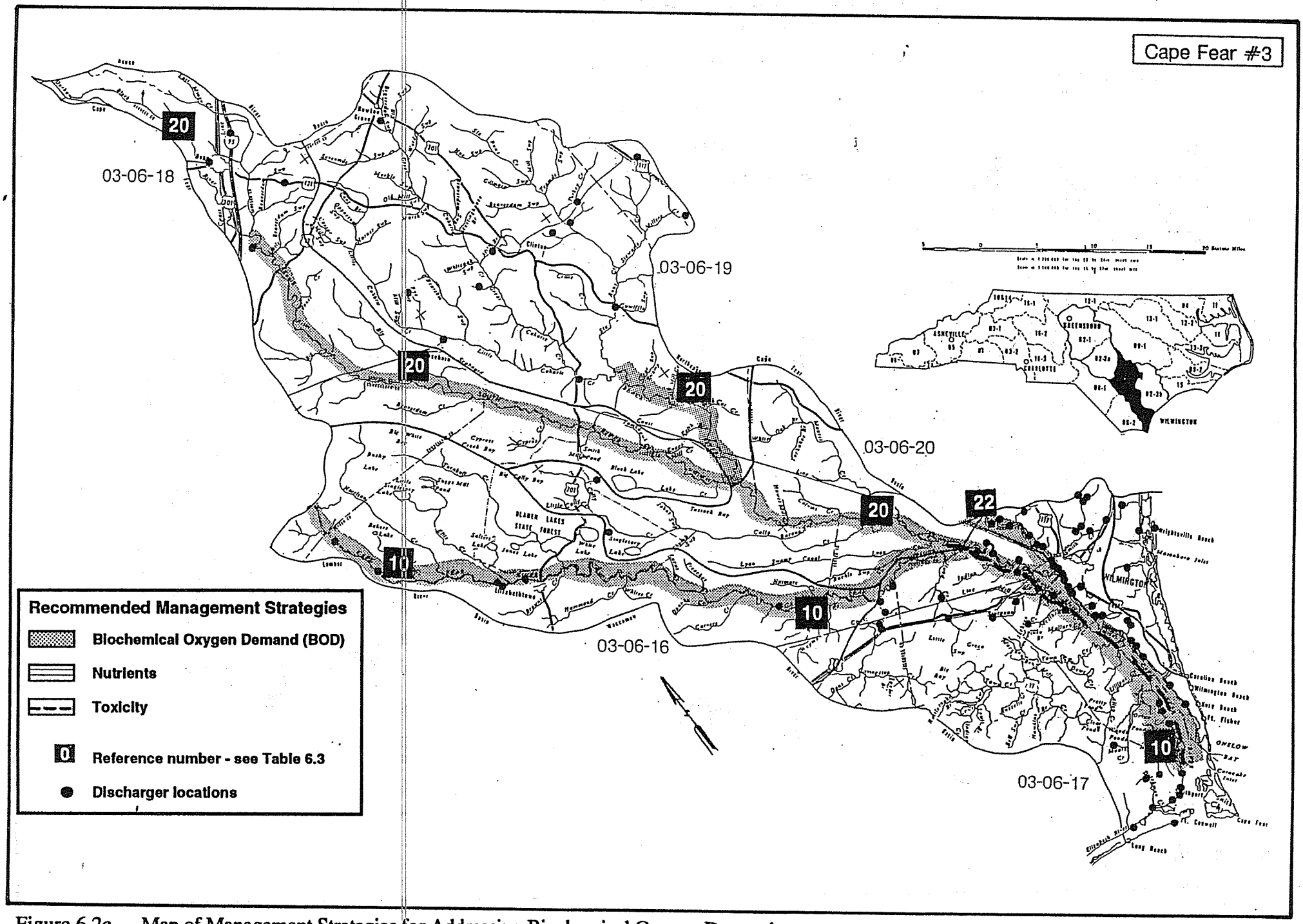

Figure 6.2c Map of Management Strategies for Addressing Biochemical Oxygen Demand (BOD), Nutrients and Toxicity in the Black and Lower Cape Fear Watershed

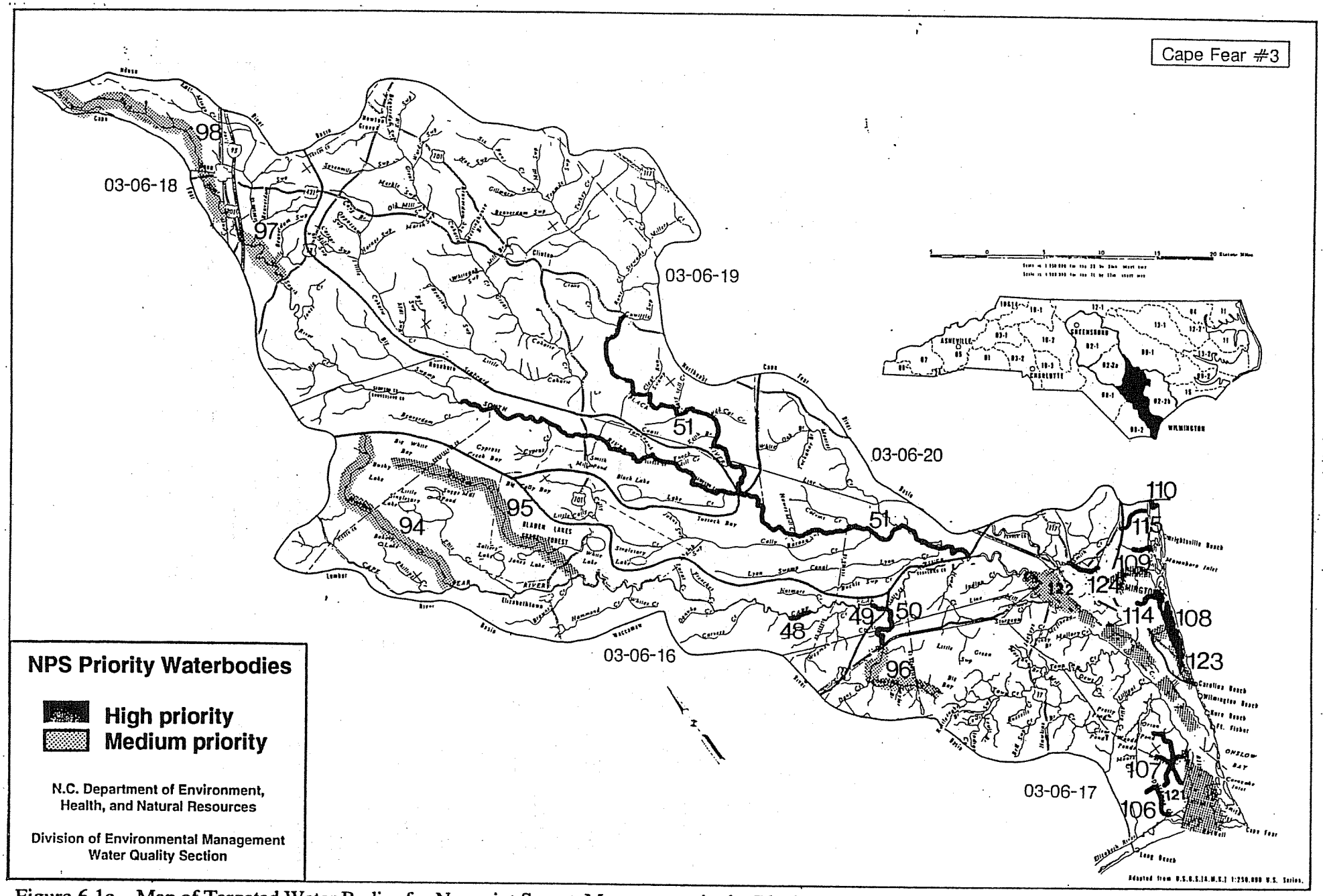

Figure 6.1c Map of Targeted Water Bodies for Nonpoint Source Management in the Black and Lower Cape Fear Watersheds

Table 6.3 Recommended and Existing Management Strategies for Addressing Biochemical Oxygen Demand (BOD), Nutrients and Toxicity

Subbasin	Receiving water	Parameter of Concern	Map Number (Figure 6.2)	Strategy
030601	Haw River	DO	1	C, NSW
	Little Troublesome Ck	DO, Toxics	2	A, NSW, TRE
030602	North Buffalo Ck	DO, Toxics, Nutrients	3	A, NSW, TRE
	South Buffalo Ck	DO, Toxics, Nutrients	3	A, NSW
	Buffalo Creek	DO, Toxics, Nutrients	3	A, NSW
	Reedy Fork	DO, Toxics, Nutrients	3	A, NSW
	Moadams Creek	DO	4	A, NSW
	Back Creek	DO	4	A, NSW
	Haw River	DO, Nutrients, Toxics	5	M, NSW, IN
	Haw Creek	DO	6	IS, NSW
030603	Alamance Creek tribs	DO	7	Z
030604	Robeson Creek	DO	8	IS, A, NSW
030605	New Hope Creek	DO, Nutrients	9	A, NSW
	Northeast Creek	DO, Nutrients	9	A, NSW
	Jordan Lake & tribs	Nutrients	9	NSW
030606	Morgan Creek	DO, Nutrients	9	A, NSW
030607	Cape Fear River	DO	10	E
	Kenneth Creek	DO	11	A
	Utley Creek	DO	12	M
030608	Deep River	DO, Nutrients	13	A, DAM
	East Fork Deep River	Stormwater		TMDL
	Richland Creek	DO, Nutrients	14	A
030609	Deep River	DO, Nutrients	13	D, DAM
	Hasketts Creek	DO	15	A
030610	Deep River	DO, Nutrients	13	D, DAM
	Cotton Creek	DO, Toxics, Fecal	16	Z, TMDL
030611	Deep River	DO, Nutrients	13	D, DAM
030612	Loves Creek	DO, Nutrients	17	A
	Rocky River	DO, Nutrients	17	A
030614	Lower Little River	DO	18	B
030615	Cape Fear River	DO	10	E
030616	Cape Fear River	DO	10	E
030617	Cape Fear River	DO, Toxics	10	E, Variance, IN
030617	Northeast Cape Fear R	DO	19	A
030618	South River	DO	20	ORW, C
030619	Black River	DO	20	ORW, C
030620	Black River	DO	20	ORW, C
030621	Northeast Cape Fear	DO, Toxics	19	A
	Barlow Branch	DO, Toxics	21	A, Variance
030622	Northeast Cape Fear	DO	19	HQW, C
	Panther Branch	DO, Toxics	21	A, Variance
	Goshen Swamp	Toxics	21	Variance
030623	Northeast Cape Fear	DO	22	C
	Burgaw Creek	DO	23	A
	Osgood Canal	DO	23	A

Legend for Table 6.3

Strategy	Description
A	Alternatives analysis required; if no alternatives, [1]advanced tertiary [2]limits for new/expanding.
B	Alternatives analysis required; if no alternatives, 10/4 [2]limits for new/expanding.
C	Alternatives analysis required; if no alternatives, 15/4 [2]limits for new/expanding.
D	Alternatives analysis required; if no alternatives, [1]advanced tertiary [2]limits for new/expanding major facilities above Carbonton Dam; no new discharges below Carbonton Dam.
E	Alternatives analysis required; if no alternatives, [1]advanced tertiary or BAT [2]limits for new/expanding major facilities; 12/2 [2]limits for new/expanding minor facilities.
M	Modeling study required if expansion pursued.
IS	Investigate sources
NSW	Nutrient Sensitive Waters management controls required.
DAM	Under new Dam Safety Regulations, a minimum release may be required to protect aquatic life.
TRE	Toxicity Reduction Evaluation required.
SOC	Special Order by Consent to resolve permit violations.
IN	Interaction between discharges of toxics will be evaluated.
HQW	High Quality Waters Regulations apply.
ORW	Outstanding Resource Waters regulations apply.
Z	Zero flow regulations.

Notes:

[1] *Advanced tertiary* is generally defined as 5 mg/l BOD_5 and 2 mg/l NH_3 although more stringent limits could be required for individual facilities where needed to address localized problems. Industries will be evaluated on a case-by-case basis.

[2] *Limits* refers to summer limits for BOD_5/NH_3

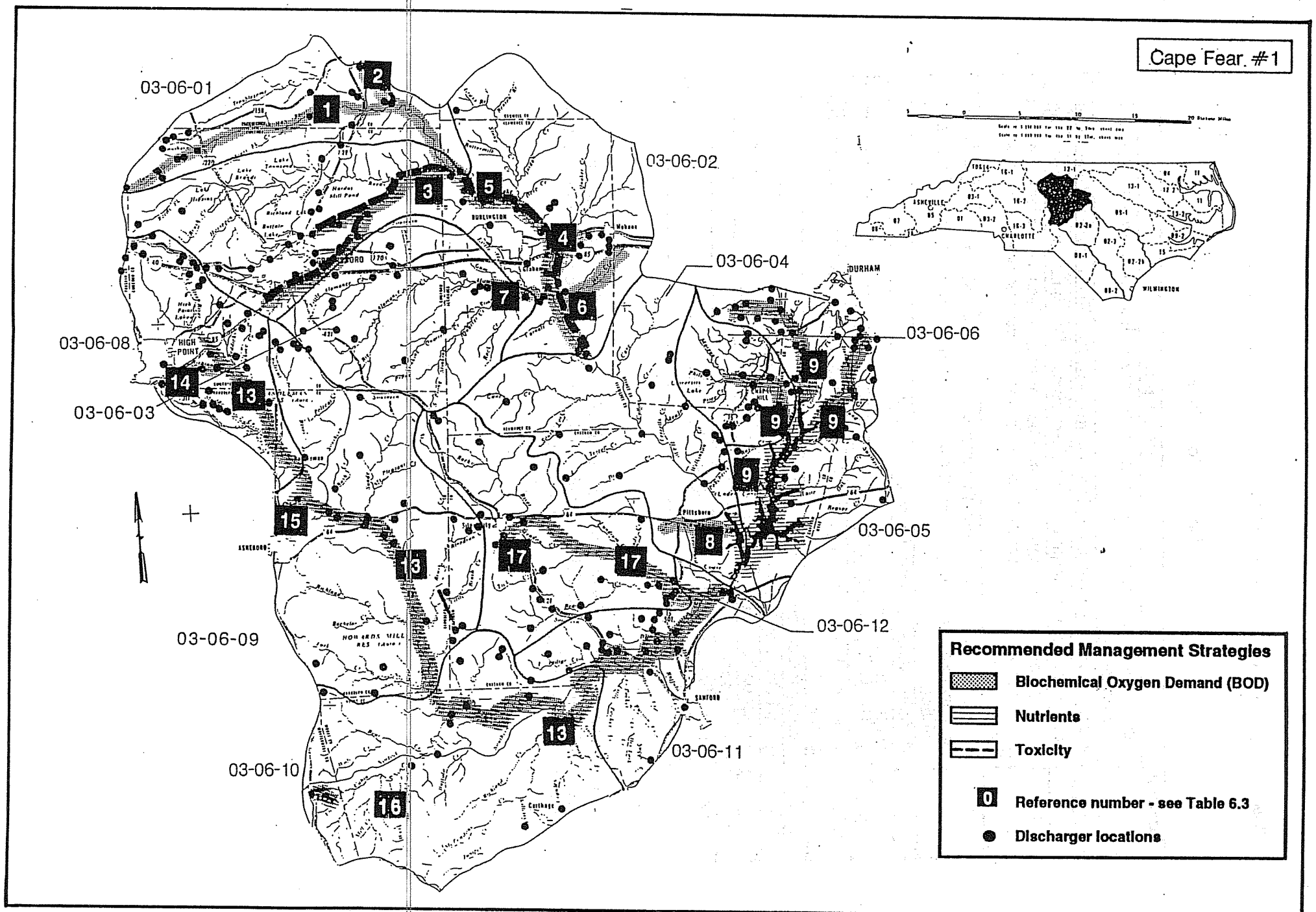

Figure 6.2a Map of Management Strategies for Addressing Biochemical Oxygen Demand (BOD), Nutrient and Toxicity in Haw and Deep River Basins

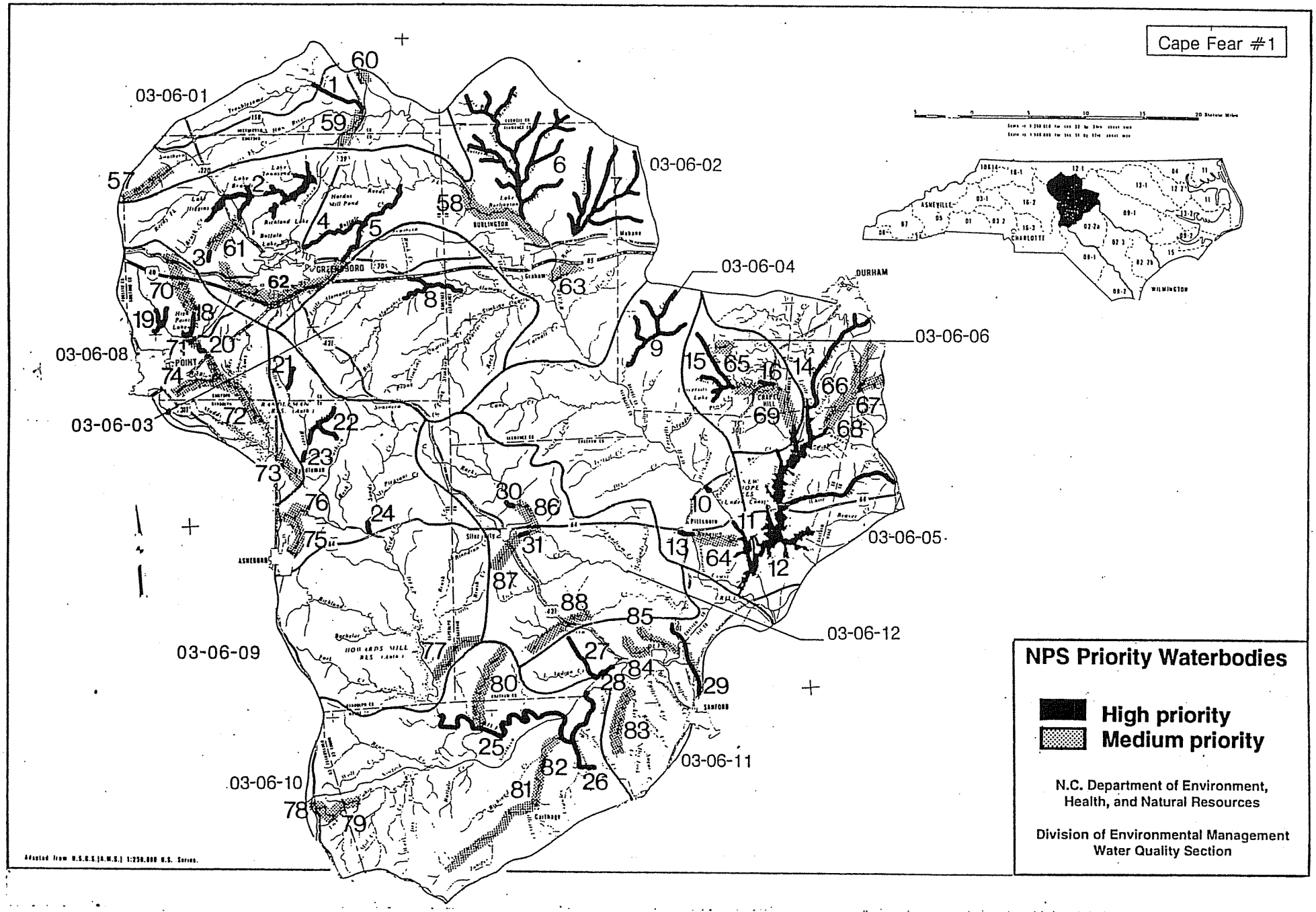

Figure 6.1a Map of Targeted Water Bodies for Nonpoint Source Management in the Haw and Deep River Watersheds

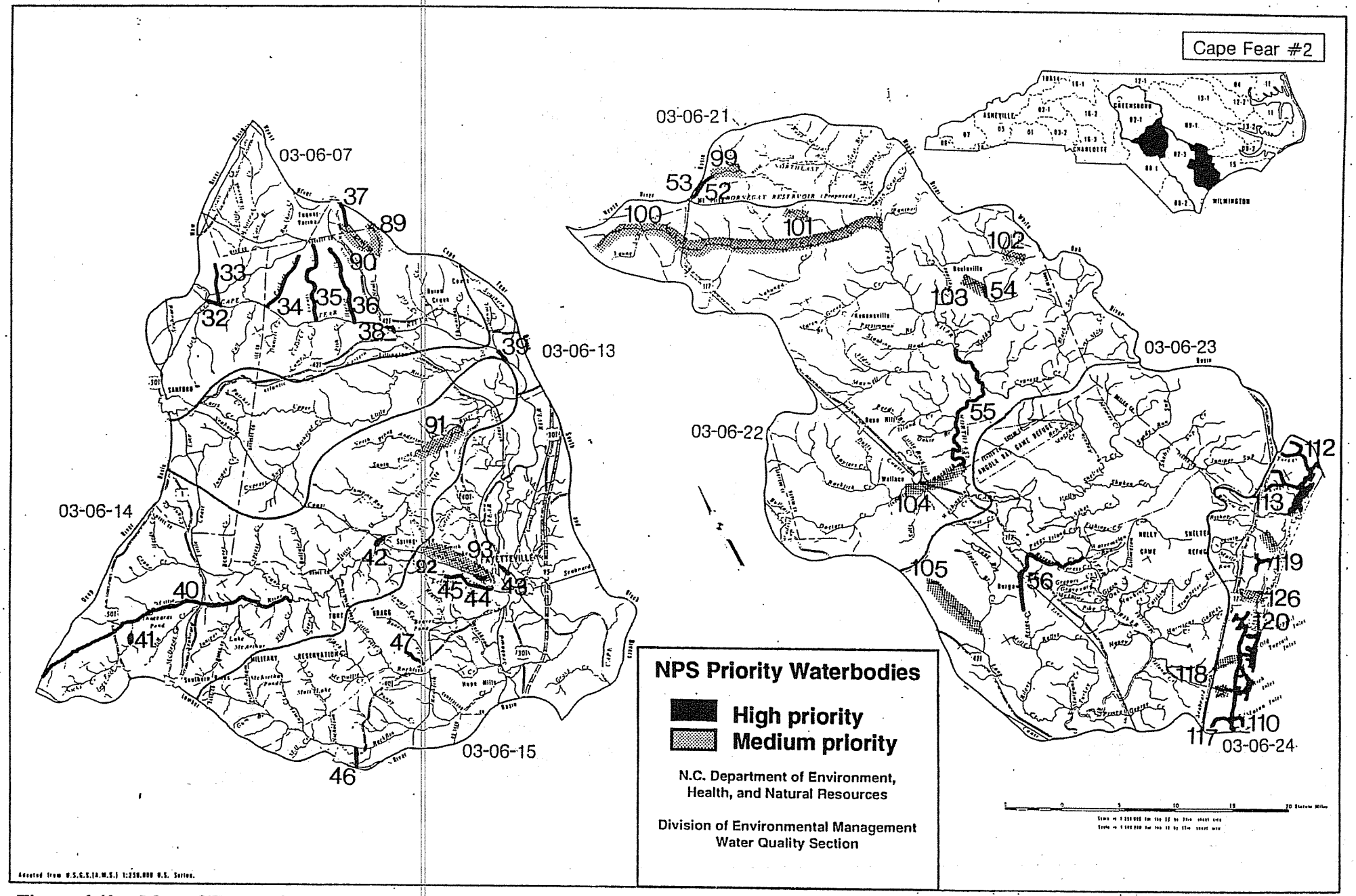

Figure 6.1b Map of Targeted Water Bodies for Nonpoint Source Management in the Upper Cape Fear and Northeast Cape Fear Watersheds

6.2.2 Identification and Protection of Highly Valued Resource Waters

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

Reclassification

Waters eligible for reclassification to HQW or ORW (see Appendix I) may include those approved for commercial shellfish harvesting (SA), designated primary nursery areas, designated critical habitat for threatened or endangered species (as designated by the NC Wildlife Resources Commission), waters having excellent water quality or those used for domestic water supply purposes (WS I and II). The HQW, ORW and WS classifications generally require more stringent point and nonpoint source pollution controls than do basic water quality classifications such as C or SC (Appendix I). Designated HQWs/ORWs in the Cape Fear basin are presented in Chapter 2.

Possible ORW/HQW candidates in the Cape Fear basin identified in the draft plan, based on water quality assessments presented in Chapter 4, included the following:

03-06-05: Morgan Creek upstream from NC 54 (above University Lake)
03-06-13: Cape Fear River at Erwin

DWQ has since reviewed the water quality data for these streams and determined not to pursue reclassification of Morgan Creek. Also, additional sampling on the Cape Fear River at Erwin will be needed to verify whether this stream segment has excellent water quality.

In addition to the streams listed above, the Environmental Management Commission (EMC) in 1990 considered reclassifying the lower Cape Fear River as High Quality Waters (HQW), as part of an initiative to implement the HQW supplemental classification adopted in 1989. The EMC expressed interest in having an alternative strategy developed for the lower Cape Fear River and remanded the reclassification request to the Hearing Officer for further consideration.

A Lower Cape Fear River Study Committee was subsequently established which was comprised of representatives of industry, academia, environmental interests and others. The Committee compiled all available data and information pertaining to the reclassification under consideration and endorsed an alternative management strategy. A Cape Fear River Program was also founded at the Center for Marine Science Research at UNC-Wilmington. The mission of the Cape Fear River Program is to develop an understanding of the processes which control and influence the river and to provide a mechanism for information exchange and public education. At their July 1993 meeting, the EMC voted to delay consideration of the alternative strategy and reclassification of the lower Cape Fear to HQW until after completion of the Cape Fear Basinwide Water Quality Management Plan. This would allow completion of the expanded monitoring that would take place as part of the basinwide process and through the Cape Fear River Program at UNC-W.

The Cape Fear River Program is currently seeking funding for conducting a basinwide, coordinated water quality monitoring program. In addition, the dischargers in the basin are in the process of developing a monitoring plan which will pool their resources and allow for a more comprehensive data coverage.

Consideration of any reclassification of the lower Cape Fear River will require additional information. This will allow the Section to evaluate and incorporate data and information that is produced as part of the Cape Fear River Program at UNC-W and the coordinated discharger

monitoring program and to then develop a management strategy that reflects the unique nature of the system.

NPDES Permitting

Until reclassification is reconsidered, permit limits will be established to protect water quality standards through wasteload allocation standard operating procedures rather than the point source restrictions in the HQW management strategy rules (15A NCAC 2B .0201).

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, if determined to be warranted based upon the need to protect a particular species, may include dechlorination or alternative disinfection, tertiary or advanced tertiary treatment, outfall relocation, backup power provisions to minimize accidental plant spills, and others. The need for special provisions will be determined on a case-by-case basis during review of individual permit applications and take into account the degree of impact and the costs of protection.

NPS Targeting

As discussed in Section 6.2.1, above, there are over 100 stream segments identified in Tables 6.1, 6.2 and Figure 6.1 of known highly valued resources waters which are targeted for priority nonpoint source management efforts.

6.2.3 Managing Problem Pollutants in Order to Protect Unimpaired Waters

In addition to restoring impaired waters, protection of waters which currently meet their standards and are considered supporting their uses is a goal of the State's water quality program. The basinwide management approach facilitates this goal through more efficient use and analysis of monitoring data and through predictive computer modeling. Careful analysis of water quality data on a basin by basin approach allows improved identification of threatened waters. Where water quality appears to be degrading, a red flag can be raised. More concentrated monitoring efforts can be initiated and the information can be brought to the attention of local interests and other resources agencies. As noted in Section 4.5, almost half of the freshwater streams in the Cape Fear Basin that are rated as supporting their uses are considered threatened.

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

The management strategies outlined in the following sections are the results of comprehensive evaluations of previously summarized data, and they incorporate the effects of interaction between impacts of point and nonpoint sources. It is the intention of DWQ that the following recommendations serve the public of North Carolina for long-term planning purposes. The management strategies are comprised of two major components: recommendations for point and nonpoint source control. General nonpoint source management strategies are discussed thoroughly

in Chapter 5. Point source controls are implemented through limiting wastewater parameters in NPDES permits.

6.3 RECOMMENDED MANAGEMENT STRATEGIES FOR OXYGEN-CONSUMING WASTES

Maintenance of dissolved oxygen is critical to the survival of aquatic life and to the general health of North Carolina's surface waters. While there are relatively few streams in the Cape Fear River basin that are experiencing significant impairment from low levels of dissolved oxygen, there are many miles of streams, including the mainstem of the river, in which DO levels are precariously low and where models predict that dissolved oxygen standards may be violated by new or expanding wastewater treatment plants.

The daily average dissolved oxygen standard for most waters in the state, and in the Cape Fear basin, is 5.0 mg/l. Waters classified as swamp waters may have naturally lower dissolved oxygen. The appropriate level of dissolved oxygen for swamp waters will vary from stream to stream. Biochemical oxygen demand (BOD) and ammonia nitrogen (NH_3) associated with wastewater treatment plants are generally the types of oxygen-consuming wastes of greatest

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concern. This is because the lowest concentrations of dissolved oxygen usually occur during summertime conditions when temperature is high and streamflow is low. During these periods point source discharges have their greatest impact, while nonpoint source pollution input, which results from rainfall events, is generally low. Therefore, NPDES permits for wastewater facilities generally limit BOD_5 (or $CBOD_5$) and NH_3 in point source discharge effluents to control the effects of oxygen depletion in receiving waters.

Modeling of the impacts of oxygen-consuming wastes from wastewater treatment plants on receiving waters is done to establish appropriate NPDES permit limits. Where the residual BOD from nonpoint sources is significant, management of nonpoint sources to reduce loading is recommended by implementation of best management practices. The choice of model, North Carolina's desktop empirical model or the field calibrated, QUAL2E model, is determined by the amount of data available for a given stream reach (Appendix III-A). The desktop empirical model is routinely used to determine wasteload allocations in the absence of intensive water quality studies of the discharge reach.

6.3.1. Discharges to Zero Flow Streams

The majority of the Haw River and Deep River drainage areas are located in the Carolina Slate Belt, which is characterized by low groundwater yield. Due to this geology, streams in this region have very low summer flows. According to the most recent U.S. Geological Survey (USGS) flow calculation methods, a minimum drainage area of 3 square miles is required to sustain a positive flow during a 7 day, 10 year low flow event (7Q10), and a minimum drainage area of 1 square mile is required to sustain positive flow during a 30 day, 2 year low flow event (30Q2). All but the largest tributaries in this area have 7Q10 flows under 0.1 cfs and limited assimilative capacity.

The Haw and the Deep Rivers flow together at Moncure to form the headwaters of the Cape Fear River in the Triassic Basin, and streams in the immediate area of this confluence are characterized by extremely low groundwater yields during drought periods. According to the most recent U.S. Geological Survey (USGS) methods, a minimum drainage area of 45 square miles is required to sustain a positive flow during 7Q10 flow event, and a minimum drainage area of 13 square miles is required to sustain positive flow during 30Q2 flow events for these areas. Tributaries to the Cape Fear in this area, at the confluence of the Haw and the Deep, include the Lick Creek watershed, as well as the White Oak and Buckhorn Creek watersheds (which are flooded to form Harris Lake). Shaddox Creek and Gulf Creek are also in the Triassic Basin.

From Buckhorn Dam to the community of Slocomb, the Cape Fear River and most of its tributaries lie in an area of mixed soils where flow estimates must be determined by USGS on a case by case basis. The downstream portions of the Upper Little River are in this region of mixed soils. The upstream portions of the Upper Little River watershed are in a region of sandy soils in which USGS estimates that a minimum drainage area of 2.0 square miles is required to sustain positive flow for 7Q10 and 30Q2. To the north and east of the Cape Fear mainstem as it winds to the coast, most tributaries are located in this region of sandy soils.

The Rockfish Creek and Lower Little River watersheds are located in the Sand Hills region. Streams in the Sand Hills are characterized by high yields during all flow stages. In this region, it is possible for very small drainage areas (i.e. 1.0 square mile or less) to sustain positive flow during 7Q10 and 30Q2 events. Below Rockfish Creek, tributaries on the south side of the Cape Fear Mainstem lie in clay soils. These streams in the lower areas of the basin will often hold stagnant standing water, but will have little or no fresh water inflow. USGS estimates that stream sites with drainage areas of less than 35 square miles will have no fresh water input during a 7Q10 flow event and sites with drainage areas of less than 2.0 square mile will have no fresh water input during a 30Q2 flow event.

Tributaries to the Northeast Cape Fear River are dispersed in areas of sandy soils, as described above for the Upper Little River, and in areas of clay soils, also described above. The Black River/South River watershed lies completely in the sandy soils region.

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

- 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 DO standard violations even when the waste water 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 to zero flow streams. Existing facilities 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 Cape Fear Basin they can cause localized problems in their low flow receiving streams.

6.3.2. Discharges to Swamp Waters

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

Given the difficulty of determining assimilative capacity in these waters, DWQ has identified the need to develop a better tool to evaluate a swamp system's ability to assimilate waste flow. A work group has been formed within the Water Quality Section to develop a methodology for determining which swamp systems can be modeled, to develop a desktop model for these systems, and to develop standard procedures for evaluating the assimilative capacity of those systems which cannot be modeled. Additionally, since many swamp systems naturally have low dissolved oxygen concentrations, the criteria by which impact is determined will be reevaluated. For example, changing the hydrologic regime of a swamp system by adding a large volume of wastewater may affect the surrounding ecosystem more than actual wastewater treatment. DWQ will also be investigating the potential for innovative outfall designs which allow a slower release of effluent to the system.

Until these studies are completed, new discharges will not be permitted at limits greater than 15 mg/l BOD_5 and 4 mg/l NH_3-N (NH_3-N may be lower if dilution is lower). On occasion, more stringent limits may be given if data or conditions suggest that adverse impacts will occur. Existing facilities will receive current permit limits unless they expand or site specific information is available which indicates more stringent limits are needed. Upon expansion, they will receive existing loading (mass basis). The following subbasin summaries describe other management strategies that may pertain to a given stream.

6.3.3. Mainstem Models

The Cape Fear River begins at the headwaters of the Haw and Deep Rivers. These rivers meet below the Jordan Dam on the Haw River to form the Cape Fear River. Flow in the Cape Fear River is regulated by the operation of Jordan Dam by the U.S. Army Corps of Engineers for flood control and maintenance of instream flows below the dam. Release from Jordan Dam is targeted so that the total flow downstream at Lillington (total flow from Deep River and Haw River/Jordan Dam outflow) is at least 550 cfs. USGS flow records for Lock & Dam 3 since construction of Jordan Dam in 1981, indicates an average daily flow of 2766 cfs and a minimum 7-day average flow of 806 cfs. The 7Q10 is seven day average low flow with a statistical recurrence interval of ten years, and is frequently approached in the Cape Fear due to regulation. USGS estimates of 7Q10 yields within the Cape Fear Basin downstream of the 550 cfs target at Lillington provide a 7Q10 flow estimate at Lock & Dam 3 of 791 cfs. It should be noted, however, that the natural 7Q10 (without the effect of Jordan Dam) is several hundred cfs less than the lowest observed flow in the last ten years.

Field calibrated models have been developed for much of the mainstem areas and are listed in the table below. The modeled areas are identified in Figure 6.3.

Table 6.4. Mainstem Models

Year	Waterbody	Modeled area
1995	Cape Fear River	Buckhorn Dam to Lock & Dam 3
1995	Cape Fear River	Lock & Dam 3 to Lock & Dam 1
1989	Cape Fear River	Federal Paper to Wilmington

These models will be used to determine wasteload allocations for the appropriate model reaches. In free-flowing areas which have not been modeled using the QUAL2E, the empirical desktop model, Level B, will be used to develop wasteload allocations per DWQ's modeling procedure. In tidal waters, management strategies will be developed on a case-by-case basis using all available flow and water quality information to assess discharge impacts.

6.3.3.1 Cape Fear River from Buckhorn Dam to Lock & Dam 3

A field calibrated model of the Cape Fear River beginning below Buckhorn Dam and extending to Lock & Dam 3 is under development. This modeled reach flows through subbasins 07, 13, 14, and 15 and includes nine of the facilities listed in Table 6.5. The current management strategy of BOD_5 = 12 mg/l and NH_3= 2 mg/l for new and expanding discharges below Buckhorn Dam appears to be protecting water quality: there have been no DO violations at the ambient monitoring stations within this modeled reach during the last five years. However, instream self-monitoring by the discharge facilities indicates DO violations occur under summer conditions. This instream facility self-monitoring is conducted on a weekly or 3 times per week basis while DWQ ambient monitoring is done monthly. Thus, self-monitoring may offer a more complete picture of the river conditions. A comparison between monthly ambient DO data collected by DWQ and self-monitoring DO data collected by dischargers on the mainstem of the river can be seen in Figures 4.17 and 4.18 in Chapter 4. In addition to low DOs, loading from this section of the Cape Fear is affecting water quality further downstream. Therefore, reductions in BOD loading will be examined through the modeling effort. In addition to these discharges, Angier has received a permit for discharge of 0.5 MGD with limits of BOD_5=12 and NH_3-N =2 and Monsanto is planning an expansion to 1.3 MGD.

Table 6.5. Discharges to Cape Fear River and tributaries from Buckhorn Dam to Lock & Dam 3

Facility	Subbasin	NPDES#	FLOW (MGD)	BOD5 (mg/l)	CBOD (lbs/day)	NH3-N (mg/l)	NBOD (lbs/day)
Fuquay-Varina WWTP	-07	NC0028118	1.2	16.0	256.2	5	225.2
Lillington WWTP	-07	NC0021636	0.6	12.0	162.1	2	45.0
Buies Creek WWTP	-07	NC0030091	0.5	30.0	550.4	20*	375.3
Swift Textiles	-13	NC0001406	2.5	40.8	8245	NL	NL
Erwin WWTP	-13	NC0064521	1.2	30.0	990.8	20*	900.7
Dunn WWTP	-13	NC0043176	3.0	30.0	1726.4	20*	2251.8
Fort Bragg WWTP	-14	NC0003964	8.0	16.0	2135	11	3302.6
Spring Lake WWTP	-14	NC0030970	1.5	28.0	770.6	8	450.4
Cross Creek WWTP	-15	NC0023957	22.0	8.0	3669.6	2	1651.3
Rockfish Creek WWTP	-15	NC0050105	12.0	6.0	3122.5	1	450.4
Raeford WWTP	-15	NC0026514	3.0	30.0	5179.1	20*	2251.8
Monsanto	-15	NC0003719	0.86	48.8	2905	3.2	103.5
total			**56.4**		**29457**		**11783**

** no limit; 20 mg/l is used for allocation purposes*

Using an estimated flow of 550 cfs at Buckhorn Dam, with long term BOD results from September 1994, BOD loading was estimated at the dam. BOD loads for this reach of the river appear to be dominated by the point sources. Point source CBOD loads are 1.5 times higher than the load calculated at Buckhorn. The total of the point sources and upstream load are only slightly greater than the load downstream at Lock & Dam 3. The mass balance of oxygen-consuming substances indicates little CBOD decay is occurring instream. It should be noted that through point and nonpoint source additions, the CBOD load has more than doubled from Buckhorn Dam to Lock & Dam 3.

Point source NBOD loads are 2.6 times higher than the load calculated at Buckhorn. The total of the point sources and upstream load are 80% lower than the load downstream at Lock & Dam 3. NBOD at Lock & Dam 3 is less than half the upstream NBOD load due to nitrogen decay. Based on the review of BOD loads, it appears that a significant fraction of oxygen loss is due to the oxidation of NH_3-N.

	CBOD (lbs/day)	NBOD (lbs/day)
Buckhorn Dam (1994)	19358	4536
Lock & Dam 3 (1994)	47243	2079

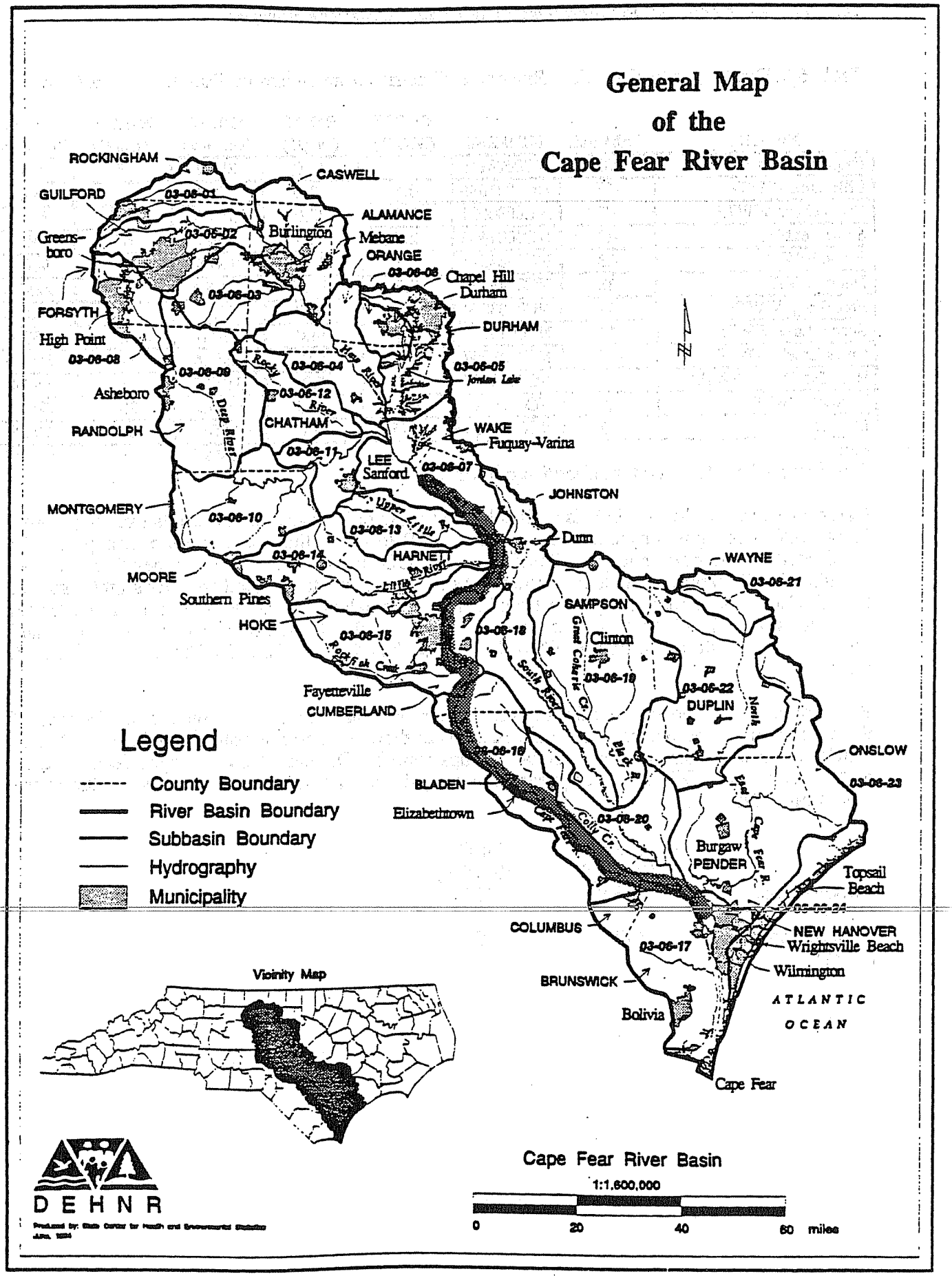

Figure 6.3 Field-Calibrated Models on the Mainstem of the Cape Fear River Buckhorn Dam to Wilmington

Preliminary modeling results indicate that the DO standard is not protected under current permitted loading. Modeling confirms the indication by instream data that the assimilative capacity of the river has been reached. At this time new and expanding discharges to the Cape Fear mainstem should prepare an alternatives analysis, including connection to a regional wastewater facility. If there are no other alternatives to discharge, treatment equivalent to that outlined in the table below will be recommended. A detailed description of the model development and management strategy will be available in a separate report upon completion.

	new	expanding
domestics < 1 MGD	BOD_5=12 & NH_3-N =2	BOD_5=12 & NH_3-N =2
domestics > 1 MGD	BOD_5=5 & NH_3-N =2	BOD_5=5 & NH_3-N =2
industrial	BOD_5=5 & NH_3-N =2	Best Available Technology or BOD_5=5 & NH_3-N =2

Technology-based limits will be determined on a case-by-case basis by DWQ, following a review of information submitted by the permittee.

6.3.3.2 Cape Fear River from Lock & Dam 3 to Lock & Dam 1

A QUAL2E model for the segment of the Cape Fear River between Locks & Dams 3 and 1 is currently under development. This area is contained within the subbasin 03-06-16 and includes 5 discharges of oxygen-consuming wastes (Table 6.6). Though there have been no DO violations at the ambient monitoring stations within this modeled reach during the last five years, instream monitoring by the facilities indicates DO violations occur under summer conditions. Due to the frequency of sampling, self-monitoring may offer a more complete picture of the river conditions. In addition to low DOs, loading from this section of the Cape Fear is affecting water quality further downstream. Therefore, reductions in BOD loading will be examined through the modeling effort.

Table 6.6 Discharges to the Cape Fear River between Lock & Dam 3 and Lock & Dam 1

FACILITY	NPDES#	FLOW (MGD)	BOD5 (mg/l)	CBOD (lbs/day)	NH3-N (mg/l)	NBOD (lbs/day)
Dupont-Fayetteville	NC0003573	2.0	10.5	1245.3	1.4	108
Carolina Foods	NC0078344	3.0	5.0	700.6	5	562.9
West Point Pepperell	NC0003522	2.5	10.9	1271.2	NL	NL
Elizabethtown WWTP	NC0026671	0.7	30.0	262.7	20*	525.4
East Arcadia School	NC0032913	0.006	30	2.25	20*	4.5
total				**3482**		**1201**

** no limit; 20 mg/l is used for allocation purposes*

In addition to these discharges, Elizabethtown has received a permit for discharge of 1.15 MGD with limits of BOD_5=12 and NH_3-N =2. Carolina Foods is planning an expansion to 4.5 MGD.

Long term BOD data from the 1992 time of travel survey was used with low flow estimates at Lock & Dam 3 (791 cfs) and above Lock & Dam 1 (843 cfs) to estimate BOD loads to the river reach. Point source CBOD loads are 10 times lower than the load calculated at Lock & Dam 3. The total of the point sources and upstream load are only slightly greater than the load downstream at Lock & Dam 1. The mass balance of oxygen consuming substances indicates little CBOD decay is occurring instream. It should be noted that through point and nonpoint source additions the CBOD load has only slightly increased between Lock & Dam 3 to Lock & Dam 1.

Point source NBOD loads are less than half the load calculated at Lock & Dam 3 The total of the point sources and upstream load is slightly lower than the load downstream at Lock & Dam 1. NBOD at Lock & Dam 1 is 1.5 times the upstream NBOD load due to nitrogen additions. Loads to the system appear to be outpacing nitrogen decay.

	CBOD (lbs/day)	NBOD (lbs/day)
Lock & Dam 3 (1992)	26,220	1,343
Lock & Dam 1 (1992)	30,125	2,045

This comparison of loads indicates that even without adding nonpoint sources of BOD, there is little CBOD or NBOD decay occurring within this reach of the river. One should note that the above data were collected before Carolina Foods began discharging. Carolina Foods has since doubled the ammonia load from wastewater.

Preliminary modeling results indicate that the DO standard is not protected under current permitted loading. Modeling confirms the indication by instream data that the assimilative capacity of the river has been reached. At this time new and expanding discharges should prepare an alternatives analysis including connection to a regional wastewater facility. If there are no other alternatives to discharge, treatment equivalent to that outlined in the table below will be recommended. A detailed description of the model development and management strategy will be available in a separate report upon completion.

	new	expanding
domestics < 1 MGD	BOD_5=12 & NH_3-N =2	BOD_5=12 & NH_3-N =2
domestics > 1 MGD	BOD_5=5 & NH_3-N =2	BOD_5=5 & NH_3-N =2
industrial	BOD_5=5 & NH_3-N =2	Best Available Technology or BOD_5=5 & NH_3-N =2

Technology based limits will be determined on a case-by-case basis by DWQ, following a review of information submitted by the permittee.

6.3.3.3 Cape Fear River from Lock & Dam 1 to Wilmington

The lower Cape Fear River below Lock and Dam 1 has occurrences of dissolved oxygen levels in the 3-4 mg/l range in the summer months. Minimum ambient dissolved oxygen concentrations for the last five years below Riegelwood decrease steadily from 5 mg/l near Acme to 3.6 mg/l near Phoenix to 3 mg/l at Navassa and then to 2.6 mg/l at Channel Marker #55. There are 12 permitted discharges in this reach of the Cape Fear River. The BOD loads for these discharges are summarized below in Table 6.7.

Table. 6.7 Discharger summary (permitted limits)

FACILITY	NPDES#	FLOW (MGD)	BOD5 (mg/l)	CBOD (lbs/day)	NH3-N (mg/l)	NBOD (lbs/day)
Federal Paper	NC0003298	50.0	12.0	29000	NL	NA
Wright Chemical (001)	NC0003395	0.0	5.0	10.4	2	1.5
Wright Chemical (002)	NC0003395	0.1	5.0	70.4	2	10.1
DuPont - Wilmington	NC0000663	NL		2775		1012.5
Takeda Chemical	NC0059234	1.0	57.3	2197.4	20	750.6
Fortron Industries	NC0082295	0.2	5.0	127.7	2	18.4
Cape Industries (001)	NC0001112	1.4	NL	NL	NL	NA
Cape Industries (002)	NC0001112	0.9	28.0	2743.9	NL	NA
Wilmington Northside	NC0023965	8.0	30.0	13211	20*	6004.8
Wilmington Southside	NC0023973	12.0	30.0	7506	20*	9007.2
New Hanover Landfill	NC0049743	0.1	30.0	156.4	NL	NA
Arcadian Corp.	NC0003727	0.3	NL	NL	24.9	261.9
Leland Industrial Pk.	NC0065676	0.3	30.0	781.9	NL	NA
New Hanover WWTP	NC0081763	4.0	5.0	2085	2	300.2
TOTAL LOAD		**78.3**		**60665**		**17367**

*no limit, 20 mg/l assumed in allocating wastes

The largest of these discharges are Federal Paperboard, Wilmington Northside, and Wilmington Southside. At permitted limits these discharges comprise 82% of the wastewater CBOD and 87% of the wastewater NBOD load to this reach of the river.

	% CBOD	% NBOD
Federal Paperboard	48	no limit
Wilmington North	22	35
Wilmington South	12	52
total	**82**	**87**

A QUAL2E model from Federal Paper's discharge to Wilmington was developed by Hydroscience, Inc. However, the model should be applied with caution since it is a one-dimensional, steady state model which has been applied to a multi-dimensional, tidal area.

Previous modeling analyses of the Cape Fear conducted in 1984 by the Division indicated the tidal range of the Cape Fear is 1 ft at Lock 1 and 3.6 ft at Wilmington. Tidal transport becomes increasingly important as the Cape Fear approaches the ocean. There is a salt wedge below Black River which carries low DO water under the freshwater from upstream sources. In addition to this source of low DOs, low DOs from Black River influences the mainstem. However, the steady state model GA.EST reinforced results of an earlier model, RECEIV-II, which showed the effect of Federal Paper's discharge on the Cape Fear DO levels. The model results indicate that DO improvements are expected if Federal removes additional BOD and adds oxygen, and if improvements are made in upstream water quality, i.e., the permit should reduce Federal to 3500 lbs/day of BOD_5 using a flow of 740 cfs at Lock 1.

The most recent modeling by Hydroscience indicated that dissolved oxygen falls below 5 mg/l without Federal Paper's discharge. The discharge of 4,000 lbs/day of BOD_5 creates an additional 0.8 mg/l dissolved oxygen deficit which can be mitigated somewhat by oxygen addition. The DO deficit can be reduced to 0.6 mg/l with the addition of 10,000 lbs/day of oxygen.

The most recent permit requires Federal to discharge less than 5000 lbs/day of BOD_5 between June and October and allows up to 10,000 lbs/day during the remaining months. Limits were based on Best Available Treatment for paper plants. However, Federal is currently operating under a variance which permits the months of April and May to be considered "winter" months during which higher quantities of BOD_5 may be discharged. Federal is also operating under an Special Order by Consent which allows relaxed limits for BOD_5 until 12/31/95. Federal operates a sidestream aeration system which feeds 10,000 lbs/day of oxygen to the Cape Fear River just below the Federal Paper outfall. The system operates whenever the instream DO concentration downstream near DuPont measures below 5 mg/l, and remains in operation until the downstream DO increases above 5 mg/l. Since 1985, the system has operated an average of 89 days (23 - 138 days) per season (June - October). During drought seasons, the system may operate every day, while during wet years, the oxygenation is needed only a few days per month.

As a result of documented water quality problems in this reach of the river, all new and expanding discharges will be required to conduct an engineering alternatives and economic analysis including the feasibility of connecting to municipal sewer service. If there are no feasible alternatives, a detailed evaluation of the potential impact of the discharge will be required and NPDES limits equivalent to those outlined in the table below will be recommended for discharges to the Cape Fear River.

	new	expanding
domestics < 1 MGD	BOD_5=12 & NH_3-N =2	BOD_5=12 & NH_3-N =2
domestics > 1 MGD	BOD_5=5 & NH_3-N =2	BOD_5=5 & NH_3-N =2
industrial	BOD_5=5 & NH_3-N =2	Best Available Technology or BOD_5=5 & NH_3-N =2

Technology based limits will be determined on a case-by-case basis by DWQ, following a review of information submitted by the permittee.

6.3.3.4 Effects of Lock and Dams Nos. Two and Three on Instream Dissolved Oxygen

In preparation for the Cape Fear Basinwide Management Plan, DWQ developed a series of field calibrated QUAL2E water quality models to examine the effects of cumulative loading of oxygen demanding wastes on the Cape Fear River mainstem from Buckhorn Dam to Army Corps' Lock and Dam #1. The modeling analysis indicated that the river mainstem was significantly affected by cumulative loading of oxygen demanding wastes from point source discharges. The dissolved oxygen profile resulting from the model shows that, when all sources discharge at maximum permitted loads with the river at low flow conditions, DO levels immediately below the dams will be in an acceptable range of 6-7 mg/l, but as it progresses downstream and the velocities of the river slow approaching each lock and dam structure, the DO will gradually decline and sag below 5.0 mg/l for a considerable stretch prior to each dam. As the cumulative loading increases moving downstream the sag behind each lock & dam becomes slightly more severe, with the sag behind Lock & Dam #1 being the most pronounced with a DO minimum of 4.3 mg/l. A copy of the DO profile from Lock and Dam #3 to Lock an Dam #1 is attached.

Instream DO levels in the river are determined by the balance between the rate at which oxygen consuming wastes are broken down instream (referred to as the decay rate) and the rate at which reaeration of the river occurs at its surface. The reaeration rate, the rate at which oxygen is mixed into the river, is a function of river velocity, width and depth. As the river approaches a dam, the velocity slows and less oxygen is mixed into the water, which allows the decay of oxygen consuming wastes to lower DO levels significantly. The effects of the lock and dam structures on water quality are localized but they are caused by the large cumulative load of oxygen consuming wastes discharged upstream. Removing a lock and dam may alleviate the local effects, but would likely shift them downstream, where the pollutant load would potentially exert itself at a greater magnitude, causing even lower DO levels at the next dam.

The U.S. Army Corps of Engineers has just recently spent about $1,000,000 refurbishing the lock and dam facilities for all three structures, and in recent meetings with DWQ, has expressed a reluctance to consider their removal due to ongoing navigational needs in the river. Even if the removal of Lock and Dams #3 and #2 could ultimately be affected, the removal would likely push the impact of the large pollutant load downstream to Lock and Dam #1, which cannot be removed because it protects the City of Wilmington's water supply intake from salt water intrusion from the estuarine portion of the Cape Fear.

6.3.4. Additional Field Calibrated Models

Field calibrated QUAL2E models have been developed or are under development for the streams listed below (Table 6.8). The models are summarized in the respective subbasin discussions. The modeled areas are identified in Figure 6.4.

Table 6.8 Field Calibrated Models

Year	Waterbody	Modeled area	subbasin
1995	Buffalo Creek/ Reedy Fork	North Buffalo Creek & South Buffalo Creek to Reedy Fork at Ossipee	03-06-02
1995	Haw River	Reedy Fork to Saxapahaw	03-06-02
1991	Rocky River	Loves Creek to Rocky River	03-06-07
1991	Morgan Creek	OWASA to Jordan Reservoir	03-06-06
1989	New Hope Creek	Durham - Farrington Rd WWTP to Jordan Reservoir	03-06-05

6.3.5 Recommended Control Strategies for Oxygen-Consuming Wastes in the Haw River/Jordan Lake Watershed (Subbasins 01 through 06)

Subbasin 01 - Haw River Headwaters This subbasin, the headwaters of the Haw River, generally offers little assimilative capacity for oxygen-consuming wastes due to low stream flows and high sediment oxygen demand. The Haw River and its tributaries upstream of SR 2711 near the Rockingham-Guilford County line are typically slow-flowing and swampy. Although there is only one major discharge to the Haw River in this subbasin, DO values at the State standard of 5 mg/l have been recorded. The desktop model will be applied as applicable. To protect the stream standard and allow for the allocation of the limited assimilative capacity in the subbasin, limits no less stringent than 15 mg/l of BOD5 and 4 mg/l of NH_3-N are recommended for new and expanding discharges to the Haw River and its tributaries upstream of SR 2711.

Currently only one major facility, Glen Raven Mills, discharges directly to the Haw River in this subbasin. However, Reidsville may relocate its discharge from Little Troublesome Creek to the Haw River to benefit from increased dilution and better assimilation of the wastewater. At the existing discharge location, the instream waste concentration downstream of the Reidsville WWTP is 98%. Reidsville currently discharges 5 MGD at limits of 6 mg/l BOD5 and 2 mg/l NH_3-N. With the relocation of the Reidsville WWTP, improvements to water quality are expected in Little Troublesome Creek which has been over allocated for oxygen-consuming wastes. Reidsville has received limits for expansion to 7.5 MGD at the current location of 5 mg/l BOD5 and 2 mg/l NH_3-N. If Reidsville pursues relocation to the Haw River, the same limits will apply.

Subbasin 02 (North and South Buffalo Creeks and Haw River in Alamance County) This subbasin contains a number of major facilities, industrial and municipal, and several areas where water quality is impaired as a result of over allocation, facility non-compliance, excessive non-point runoff, and other factors. Modeling analyses suggest that point sources are causing BOD/DO and toxicity problems, and contributing largely to nutrient related problems.

Recommended allocations reflect the level of treatment necessary to reduce the magnitude and frequency of water quality standard violations.

Buffalo Creek/Reedy Fork

North and South Buffalo Creeks, from their headwaters to their confluence at Buffalo Creek/Reedy Fork are low flow streams, dominated by the City of Greensboro's WWTPs and Cone Mills' effluents. Both streams also receive both urban and agricultural runoff. These creeks as well as Buffalo Creek and Reedy Fork are on the state's impaired waters list.

Ambient and self-monitoring water quality data, along with the results of QUAL2E modeling, indicate that Buffalo Creek is a marginal system with respect to assimilative capacity which has been over allocated for oxygen-consuming wastes. DWQ and facility self-monitoring data show severely low DO concentrations (less than 2 mg/l) in North and South Buffalo Creek below the WWTPs during summer conditions. Though the Greensboro treatment plants were in compliance with their permits, numerous violations of the DO standard were observed below Cone Mills and Greensboro's North Buffalo WWTP during the summers of 1993 and 1994. Cone Mills did not report BOD5 levels for much of the summer of 1993. During that period, instream DO levels below Cone Mills' discharge were severely degraded. This is reflected in the self-monitoring data of both Cone Mills and Greensboro's North Buffalo WWTP. These creeks also have poor biological quality. A QUAL2E model has been developed from Cone Mills on North Buffalo Creek and from the T.Z. Osborne WWTP on South Buffalo Creek to Reedy Fork at Ossipee in order to reallocate NPDES permit limits for the protection of water quality (Figure 6.4).

Table 6.9 Existing summer limits for major discharges

FACILITY	NPDES No.	Permitted flow (MGD)	Average flow (MGD)	BOD5 (mg/l)	NH3-N (mg/l)	DO (mg/l)
Cone Mills	NC0000876	1.25	1.145	10	2	6
North Buffalo WWTP	NC0024325	16	14.75	10	4	6
T.Z. Osborne WWTP	NC0047384	20	16.7	11	3	5

With the existing discharges at their average loads, the model predicts a DO sag to 4.0 mg/l on South Buffalo Creek just downstream of the T.Z. Osborne WWTP and sags to 4.9 mg/l on North Buffalo Creek below Cone Mills and to 4.7 mg/l below the North Buffalo WWTP. Buffalo Creek just downstream of North and South Buffalo Creeks has a DO concentration of 4.6 mg/l. Though the T.Z. Osborne and North Buffalo Wastewater Treatment Plants (WWTPs) operate within their permit limits, observed DOs below the WWTPs for April through October 1993 and 1994 violate the state standard for DO. The observed instream DOs confirm the model predictions.

If the three existing major discharges reach their permitted loads, the model predicts that instream DO concentrations will sag to 0.8 mg/l on South Buffalo Creek and to 3.4 mg/l on North Buffalo Creek. Buffalo Creek below the confluence will sag to 2.3 mg/l. The model indicates that it will be difficult under any management strategy for South Buffalo Creek to meet the 5.0 mg/l stream standard for dissolved oxygen under critical conditions because of existing physical conditions (e.g., low streamflow and slow velocities) and the large amounts of wasteflow relative to streamflow. The model was run assuming Cone Mills and the Greensboro WWTPs will implement "Best Available Technology" (BAT) to achieve tertiary treatment (i.e., BOD_5 = 5 mg/l, NH_3-N = 1 mg/l, and DO = 6-7 mg/l). With these effluent limits, the model predicts the DO

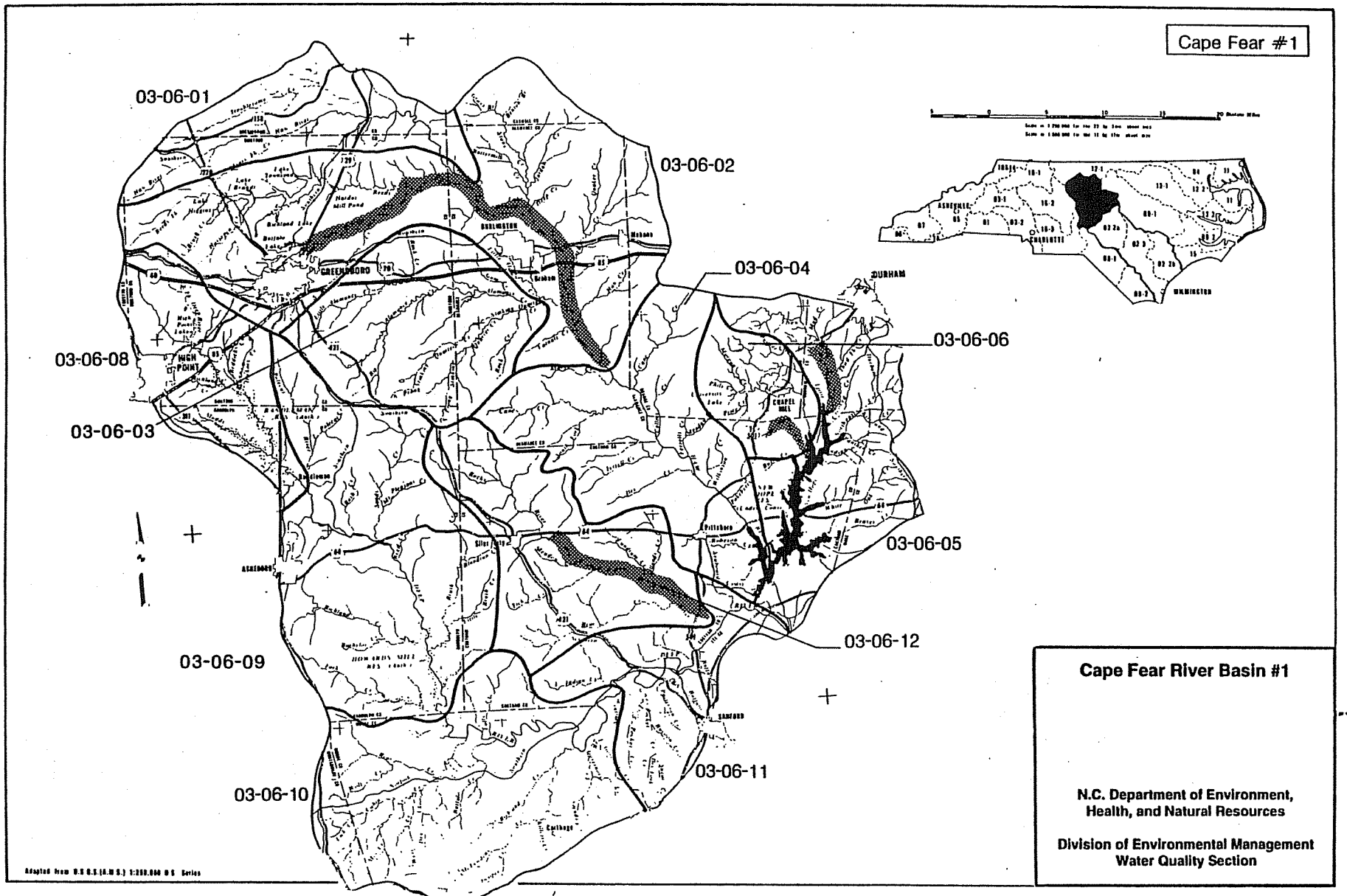

Figure 6.4 Calibrated Models for Streams in the Haw and Deep River Watersheds

concentrations will sag to 3.5 mg/l below T.Z. Osborne WWTP and to 5.1 mg/l below the North Buffalo WWTP. Below the confluence DO is still predicted to violate the DO standard. A detailed description of the model development can be found in a separate report (NC DEM, 1995).

In light of the extremely limited assimilative capacity for oxygen-consuming wastes in Buffalo Creek, no new wastewater outfalls should be constructed within the modeled area. The existing municipal facilities, should serve as regional treatment facilities to handle future wastewater needs. All remaining permitted facilities should conduct an engineering alternatives and economic analysis including the feasibility of connecting to municipal sewer service. If there are no feasible alternatives, limits of BOD_5=5 mg/l, NH_3-N=2 mg/l, and DO=6 mg/l will be recommended and a schedule for implementation developed. It is anticipated that, through basinwide planning, all discharges within the Buffalo Creek Basin will eventually be required to implement state-of-the-art treatment technology. At this time, the technology limits are BOD_5=5 mg/l, NH_3-N=2mg/l, and DO=6 mg/l. Future wastewater expansions may require environmental assessments.

New and expanding discharges to tributaries within the modeled area should have no adverse impact on the mainstem water quality. The desktop model should be run and wastewater fully assimilated prior to confluence with the mainstem area.

Haw River

This section of the Haw River, from the confluence of Reedy Fork Creek and the Haw River to Saxapahaw dam, is dominated by wastewater effluent during low summer flows. This is confirmed by high instream conductivity recorded at the ambient station near the town of Haw River. In addition to major facilities in the Reedy Fork Creek drainage area, East Burlington WWTP (12 MGD) and Graham WWTP (3.5 MGD) discharge to the Haw River. South Burlington WWTP (12 MGD) discharges to Alamance Creek just before it joins the Haw River. Considering all major discharges upstream of Saxapahaw, this results in a total waste flow of 74.75 MGD, or a 59% instream waste concentration at 7Q10 flow conditions. While the average daily dissolved oxygen standard of 5 mg/l is currently protected in this section of the Haw River, the predominance of wastewater effluent under summer conditions and projected growth in the area prompted the development of a field-calibrated QUAL2E model. The model starts near Altamahaw, at the confluence of Reedy Fork Creek and the Haw River, and ends just below the Saxapahaw Dam. The model is currently being developed, though there are insufficient data for full field calibration at this time. As future expansions of existing regional wastewater treatment plants place additional demands on the Haw River, this model will be fully developed to evaluate the assimilative capacity of oxygen consuming wastes.

Moadams Creek/Back Creek

The Mebane WWTP discharges 1.2 MGD of municipal wastewater to Moadams Creek, a zero 7Q10 tributary of Back Creek at limits of 11 mg/l BOD_5 and 4 mg/l NH_3-N. The instream waste concentration of Back Creek prior to the confluence with the Haw River is approximately 80%. During the July 1993 time of travel study for Haw River, the instream DO level at the mouth of Back Creek was 4.3 mg/l. Mebane's self-monitoring data show DO levels as low as 0.7 mg/l in Moadams Creek below the Mebane WWTP discharge. DO levels in Back Creek at SR 1936 were as low as 3 mg/l during 1993 while further downstream at NC 54, the lowest observed DO in 1993 was 4.4 mg/l. A benthic survey is recommended to evaluate the impact of the Mebane WWTP discharge and determine the stream's recovery. On average, the facility operates well within its limits, however there have been violations of the daily maximum permit requirements. Upon expansion to 2.5 MGD, Mebane will be required to meet limits of 5 mg/l BOD_5 and 2 mg/l NH_3-N in accordance with 15A NCAC 2B.0206.

In light of the extremely limited assimilative capacity for oxygen-consuming wastes in Back Creek and its tributaries, no new wastewater outfalls should be constructed. The existing municipal facility, should serve as the regional treatment facility to handle future wastewater needs. New and expanding facilities should be required to conduct an engineering alternatives and economic analysis including the feasibility of connecting to municipal sewer service. If there are no feasible alternatives, limits of BOD_5=5 mg/l, NH_3-N=2 mg/l, and DO=6 mg/l will be recommended and a schedule for implementation developed.

Haw Creek

During the June 1994 TOT study for the Haw River, the instream DO level at the mouth of Haw Creek was 4.8 mg/l. The source of low DO is unknown, though a number of single family residences discharge to Haw Creek. An investigation of sources including nonpoint sources is recommended. In 1993, Haw Creek received a biological rating of good-fair.

Subbasin 03 (Alamance Creek) This subbasin is comprised of Alamance Creek watershed which originates south of Greensboro and feeds into the Haw River immediately below Burlington. Major tributaries include Big and Little Alamance Creeks and Stinking Quarter Creek. The only major discharge in the creek's basin is the Burlington - South WWTP which is permitted to discharge up to 12.0 MGD to Big Alamance Creek immediately prior to the confluence with the Haw River.

The upper portion of the watershed has several small discharges including schools and mobile home parks along with a few single residence discharges. There are 9 small treatment plants and 2 residential discharges with a total combined wasteflow of 150,400 gpd. The cumulative instream waste concentration prior to the Burlington - South's outfall is 7.2%. The localized impacts of these discharges are significant because most of the outfalls are located in zero flow streams. Ambient DO has been observed at 4 mg/l in Alamance Creek and at 5 mg/l in Little Alamance Creek. Alamance Creek received a water quality rating of good-fair in 1993 while Little Alamance Creek received a good rating.

Water quality in this watershed would benefit from more extensive regional wastewater treatment. These facilities should explore and implement alternatives to surface water discharge and/or tie into larger treatment facilities within a reasonable period of time after such service becomes available. Most of the discharges are relatively near Greensboro's T.Z. Osborne WWTP or Burlington - South WWTP, which should function as the regional wastewater treatment facilities for this area.

Subbasin 04 (Lower Haw River and Tributaries) This subbasin includes the Haw River and its tributaries from Saxapahaw Dam to Jordan Reservoir. With the exception of the Haw River mainstem, most streams are low flow. Standard policies and regulations for zero flow discharges will apply.

Haw River

The QUAL2E model under development for the Haw River to Saxapahaw, will be extended to Jordan Reservoir for the next basin plan. No DO violations have been observed in this reach during the last five years.

Robeson Creek

The Pittsboro WWTP discharges 0.75 MGD to Robeson Creek, a zero 7Q10 tributary of Jordan Reservoir with fair water quality (1990 BMAN sampling). Pittsboro's self-monitoring data show DO levels as low as 3.7 mg/l in Robeson Creek below the Pittsboro WWTP discharge and

however, concentrations are lower upstream. Though the ambient DOs appear to have improved since 1988, ambient DO downstream of Pittsboro has been observed at 3 mg/l during the last 5 years. Comparison of ambient data to facility instream monitoring is difficult since the ambient station is located in an arm of Jordan Reservoir and may not be representative of stream conditions. The Town of Pittsboro recently completed an upgrade to 5 mg/l BOD_5 and 1 mg/l NH_3-N. However, there have been violations of the BOD_5 limit, particularly the daily maximum limit. A reconnaissance study should be undertaken to determine the source of impacts upstream of Pittsboro's discharge and to evaluate any improvements resulting from Pittsboro's upgrade. A follow up benthic survey is recommended for the next basin assessment.

Subbasin 05 (Jordan Reservoir Watershed except Haw River and Morgan Creek) New Hope Creek, Northeast Creek, and other smaller tributaries to Jordan Reservoir comprise this subbasin. This is the entire Jordan Reservoir drainage with the exception of the Haw River and Morgan Creek. There are two major municipal WWTPs in this subbasin, Durham-Farrington Road and Durham-Triangle, each of which has recently expanded and/or upgraded to tertiary limits for both oxygen-consuming wastes and nutrients. Extensive data from Jordan Reservoir reveal water quality problems caused by the sensitive nature of lake headwaters to receiving wastewater. Water quality problems include DO and eutrophication problems, and during the summer months much of the input to upper Jordan Reservoir from this subbasin is effluent.

A field calibrated model was done for New Hope Creek in 1989. The QUAL2E model extends 5 miles from the Durham-Farrington Road WWTP to Jordan Reservoir. The WWTP comprises 99% of the streamflow under summer low flow conditions. The model predicted the existing permit limits do not protect water quality. In addition, upon expansion from 10 MGD to 20 MGD advanced tertiary treatment to 5 mg/l BOD_5 and 1 mg/l NH_3-N was recommended to protect the DO standard (NC DEM, 1989). A detailed description of the model development can be found in a separate report. Currently the facility is under an SOC allowing relaxed limits for BOD_5, NH_3, and DO. Ambient instream DOs have been observed at 4.4 mg/l. Durham's self-monitoring data shows DO levels as low as 2.5 mg/l in New Hope Creek below the Farrington Road WWTP discharge.

A proliferation of single family residence and other small discharges has occurred in the upper portion of the New Hope Creek watershed. Upstream of the Durham/Farrington Road WWTP there are at least 15 single family residences discharging, as well as one subdivision, a rest home and two mobile home parks. In addition, there is a potential for additional unpermitted discharges of this nature in the watershed. The localized impacts of these discharges are increased because most of the outfalls are located in zero flow streams. The cumulative instream waste concentration (IWC) of these discharges is 67% prior to the Farrington Road WWTP discharge. DO levels below these discharges are consistently low with DOs less than 1 mg/l having been observed during drought conditions.

Water quality in this watershed would benefit from more extensive regional wastewater treatment. The larger treatment facilities in this area, such as Durham/Farrington Road or Orange Water and Sewer Authority should make efforts to provide service to the upper areas of the watershed as soon as possible, and small discharges should be encouraged to connect to regional facilities as soon as service becomes available. Due to continued violations of the water quality standard, no new discharges will be permitted to New Hope Creek.

Durham County's Triangle WWTP discharges 6 MGD to the Northeast Creek arm of Jordan Reservoir and meets advanced tertiary treatment limits of 5 mg/l BOD_5 and 1 mg/l NH_3-N. Instream DOs at the ambient station have been observed at 4 mg/l while Durham's self-monitoring data show DO levels as low as 0.3 mg/l in Northeast Creek below the Triangle WWTP discharge. Water quality remains impaired as 99% of the streamflow is wastewater under summer low flow

conditions. This creek receives no freshwater inflow and should receive no new discharges per 15A NCAC 2B.0206.

Subbasin 06 (Morgan Creek tributary to Jordan Reservoir) Subbasin 06 is a very small basin that is primarily the drainage area surrounding Chapel Hill. The major stream is Morgan Creek, which flows into Jordan Reservoir. Water quality in this watershed would benefit from more extensive regional wastewater treatment. The larger treatment facilities in this area, such as Durham/Farrington Road or Orange Water and Sewer Authority should make efforts to provide service to the upper areas of the watershed as soon as possible, and small discharges should be encouraged to connect to regional facilities as soon as service becomes available. New and expanding discharges should conduct an alternatives analysis including non-discharge alternatives and the feasibility of connecting to municipal sewer service.

A field calibrated model was done for Morgan Creek in 1991. The QUAL2E model extends 5 miles from the Orange Water and Sewer Authority (OWASA) Mason Farm WWTP to Jordan Reservoir. A detailed description of the model development can be found in a separate report (NC DEM, 1991). The WWTP comprises 95% of the streamflow under summer low flow conditions. The model predicted the existing permit limits do not protect water quality. However, the WWTP has been operated well below the permitted limits. Upon completion of the permitted expansion from 8 MGD to 10 MGD OWASA will be required to achieve advanced tertiary treatment levels of 4 mg/l $CBOD_5$ and 2 mg/l NH_3-N. This level of treatment was recommended to improve the instream DO level (NC DEM, 1991). The model predicts DOs may still fall below 5 mg/l under summer low flow conditions. Ambient DO levels less than 5.0 mg/l (4.8 mg/l) have been observed below the WWTP. OWASA's self-monitoring data shows DO levels as low as 4.6 mg/l in Morgan Creek below the discharge. DOs are expected to improve with the increased wasteflow, stream velocity and treatment plant removal efficiency when OWASA completes its expansion. Due to continued violations of the water quality standard, Morgan Creek should receive no new discharges.

6.3.6 Recommended BOD and NH_3 Strategies for the Deep River Watershed (Subbasins 08 through 12)

Overview

The Deep River is one of two headwater tributaries of the Cape Fear River. It begins west of Greensboro and flows southeast through Guilford, Randolph, and Moore counties to High Falls, where it turns and flows northeast along the Chatham and Lee county line until it meets the Haw River near Moncure (Figure 6.5). In the upper reaches the Deep River is shallow and rocky as it flows through the rolling hills of the Piedmont, while the lower, easternmost reaches are flatter, with greater depths and slower velocities. Seventeen dams create impoundments which slow flow and trap pollutants. Because the Deep River lies in the Carolina Slate Belt, 7Q10 flows are very low and all but the largest tributaries are zero-flow streams. DO violations have been observed at a number of ambient sites, with most violations occurring downstream of Carbonton Dam in the lower reaches of the Deep River.

The East Fork Deep River and the West Fork Deep River form the High Point Reservoir between High Point and Greensboro. This area receives runoff from urban, industrial, agricultural, and forested areas: there are few point source discharges. The river is also impounded downstream from High Point Lake at Oakdale, as well as by two small dams downstream of Richland Creek. Field data show a violation of the dissolved oxygen standard below High Point Lake dam, but the cause of this violation is currently unknown. The violation may be the result of low DO releases from High Point Lake, though further study is needed to identify the cause.

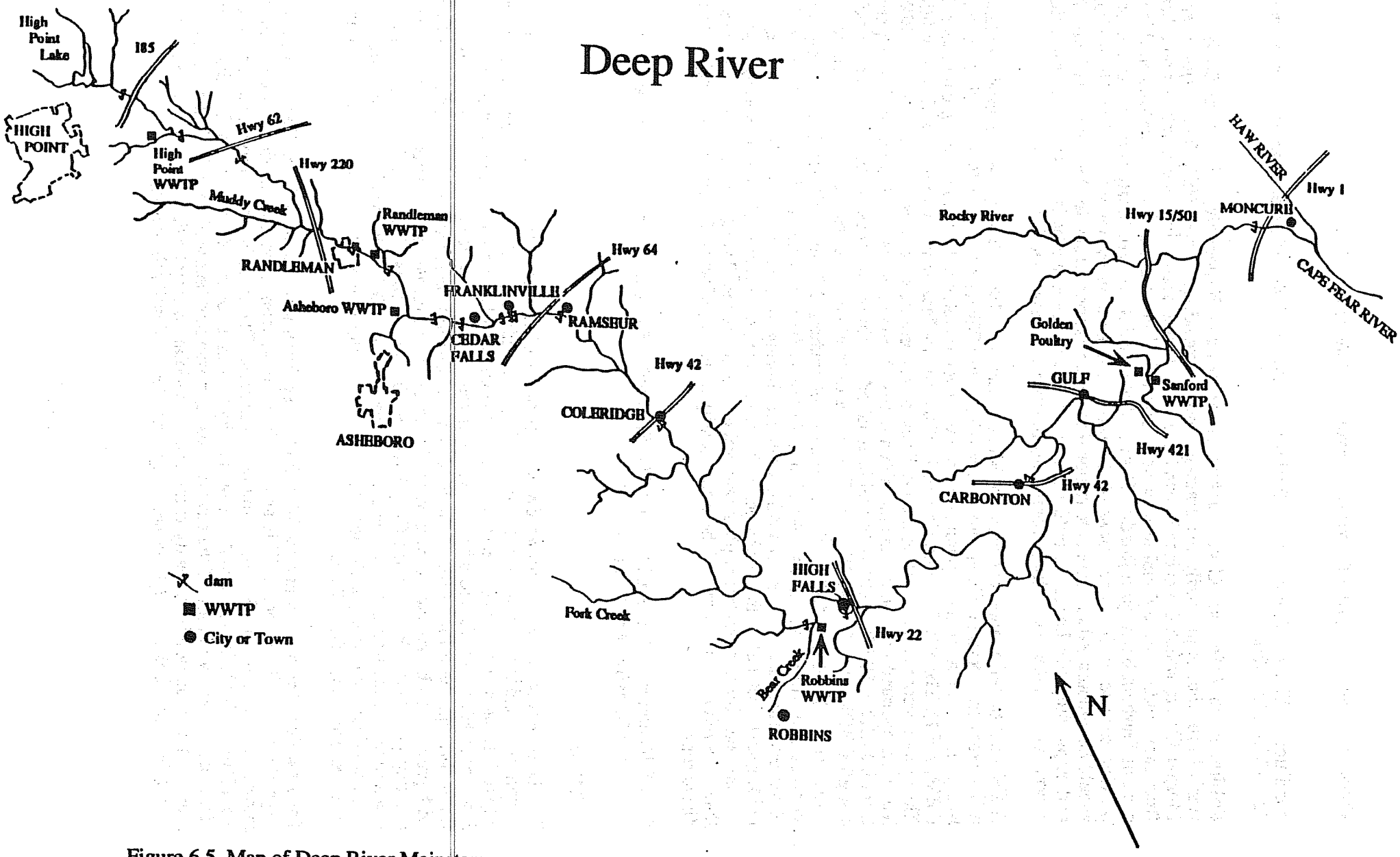

Figure 6.5 Map of Deep River Mainstem

The largest wastewater treatment facility within the Deep River basin, High Point - Eastside, discharges 16 MGD of treated wastewater to Richland Creek, a low flow tributary of the Deep River. During 7Q10 conditions this discharge makes up 90% of the flow in Richland Creek and 73% of the flow in the Deep River at Freeman Mill. Violations of the DO standard below Richland Creek were reported in facility instream self-monitoring data at SR 1129 and at the ambient site below Coltranes Mill, with an observed DO minimum of 1.2 mg/l in 1993. Facility data from Randleman WWTP show the DO recovers in downstream reaches near Randleman.

River flow in the reach downstream from High Point, from Randleman to Coleridge, is controlled by eight impoundments. The second largest facility in the basin, Asheboro WWTP, discharges 6.0 MGD to Hasketts Creek, with a permitted expansion to 9 MGD. Hasketts Creek joins the Deep River just upstream of Cox Lake, a large hydroelectric impoundment. Asheboro self-monitoring data from Cox Lake at SR 2261 show violations of the state minimum DO standard and of the DO saturation standard of 110%. The elevated DO saturation (as high as 174%) is indicative of algae blooms and overenrichment. This will be discussed in Section 6.4, Management Strategies for Nutrients.

The Deep River is classified as HQW between Robbins and Carbonton Dam. The Town of Robbins discharges within this HQW section just above a hydroelectric dam. Robbins requested a speculative analysis for an expansion of its treatment facility. The analysis was prepared in accordance with the HQW regulations.

Carbonton Lake, downstream of High Falls, is another large impacted hydroelectric impoundment on the Deep River. Violations of the DO and the chlorophyll *a* standards have been recorded by DWQ personnel behind Carbonton dam. DWQ studies of this impoundment show the DO sags are the result of excessive algae growth. Further discussion of algae-related DO problems is in Section 6.4 Management Strategies for Nutrients.

Below Carbonton Dam there are numerous DO violations and a secondary sag downstream at Sanford (3.8 mg/l in 1992). Sanford WWTP and Golden Poultry are the only major discharges in this subbasin. To better identify causes of DO violations within and below the Carbonton impoundment, a DWQ study was conducted in the summer of 1993. The study concentrated on the section of the Deep River from Ramseur to HWY 15/501. This reach of the Deep River exhibits high productivity with significant periphyte growth occurring throughout the free-flowing sections. Study results showed that long-term BOD levels were moderate but diurnal fluctuations in DO concentrations existed both upstream and downstream of the impoundment. This fluctuation is the result of excessive algae growth and indicates the recorded DO violations were caused by algae growth and die-off.

Recommended Management Strategies (Subbasins 08 through 11)

DWQ ambient monitoring and facility self-monitoring data indicate that dissolved oxygen levels fall below minimum criteria or are lowered to levels where further loss may be harmful to aquatic life. The cause of low dissolved oxygen levels below High Point Lake should be investigated. Consideration of options, including a minimum release requirement for High Point Lake, should be evaluated.

Due to the predominance of wastewater in this system during low flow conditions it is recommended that all new and expanding major facilities in the Deep River basin between High Point Reservoir and Carbonton dam be issued advanced tertiary limits (BOD_5 = 5 mg/l and NH_3-N = 2 mg/l). For new and expanding discharges between High Point Lake and Carbonton dam with flows less than 1 MGD, regionalization of wastewater treatment is encouraged. If discharge to a regional WWTP is not feasible, an alternatives analysis should be performed to evaluate all

practicable alternatives to surface water discharge. Where discharge is the most feasible option, permit limits no less stringent than BOD_5 = 15 mg/l and NH_3-N = 4 mg/l are recommended. Additionally, because DO violations in the Deep River are strongly linked to algae growth, nutrient limits will be recommended in this section. This is discussed in Section 6.4 Management Strategies for Nutrients.

In the section of the Deep River from Carbonton dam to the Haw River, the assimilative capacity is exhausted and new discharges should not be permitted. Expansion requests by Sanford WWTP due to further regionalization will be thoroughly evaluated to insure no additional water quality degradation will result.

Richland Creek

Richland Creek (subbasin -08) is a small urban stream with a 7Q10 of 1.1 cfs. The City of High Point's Eastside WWTP discharges 16 MGD to Richland Creek just above the confluence with the Deep River. At permitted flows, the instream waste concentration in Richland Creek is 96%. The High Point Eastside discharge permit currently contains limits of BOD_5 = 8 mg/l and NH_3-N = 3 mg/l. A modeling analysis conducted in 1987 indicates the need for advanced tertiary limits of BOD_5 = 5 mg/l and NH_3-N = 2 mg/l. Due to the high IWC, the reported instream occurrences of dissolved oxygen below the 5.0 mg/l daily average standard, and water quality problems in downstream impoundments, it is recommended that High Point Eastside WWTP be issued limits of BOD_5 = 5 mg/l and NH_3-N = 2 mg/l. DWQ will work with the facility to determine an appropriate schedule for these changes.

Hasketts Creek

Hasketts Creek (subbasin -09) below the Asheboro WWTP has a zero 7Q10 and receives 6 MGD of municipal wastewater with advanced tertiary limits of BOD_5 = 5 mg/l and NH_3-N = 2 mg/l. The City is currently in the process of expanding the facility to 9 MGD with the same limits. Relocation to the Deep River was considered but assimilative capacity is limited in the Deep River as well as in Hasketts Creek. Thus, it is more economical for the City to remain on Hasketts Creek since there are currently no DO violations in Hasketts Creek below the WWTP. Water quality is rated poor below the WWTP due to effluent dominance. Conductivity is ten times higher downstream and temperature is significantly greater downstream.

Cotton Creek

The Town of Star WWTP (subbasin -10) is permitted to discharge 0.6 MGD of complex wastewater (90% industrial) to Cotton Creek, a zero 7Q10 and zero 30Q2 stream with limited assimilative capacity for oxygen consuming wastes. Currently, the facility has summer (winter) limits of 17 (26) mg/l BOD_5 and 4 (8) mg/l NH_3-N. Since the facility discharges to a zero flow stream, it is required to meet advanced tertiary limits of BOD_5 = 5 mg/l and NH_3-N = 1 mg/l in August 1995 per its current NPDES permit.

The current permit limits do not protect water quality. DOs have been low downstream of the discharge throughout the summer of 1994 including observed DOs less than 2 mg/l. The facility has been out of compliance with limits for BOD_5, NH_3, fecal coliform and toxicity in the recent past. A reconnaissance study will be conducted after the facility comes into compliance with its 1995 permit limits to determine the effect of the discharge on the stream.

Subbasin 12 (Rocky River) This subbasin includes Rocky River to its confluence with the lower Deep River. The Rocky River watershed has a proliferation of single family residence and other small discharges. There are at least 16 single family residences discharging, and a potential for additional unpermitted discharges of this nature in the watershed. The localized impacts of these discharges are significant because most of the outfalls are located in zero flow streams. Water quality in this watershed would benefit from more extensive regional wastewater treatment. The larger treatment facilities in this area, such as Pittsboro WWTP or Siler City WWTP should make efforts to provide service to the lower areas of the watershed, and small discharges should be encouraged to connect to regional facilities as soon as service becomes available. If the Pittsboro WWTP were to extend a sewer interceptor south down Highway 15/501 several of the small discharges could potentially be eliminated.

Loves Creek/Rocky River

Siler City discharges to Loves Creek, a tributary of the Rocky River downstream of the Siler City Reservoir. Water quality is impaired in Loves Creek, the Rocky River below the dam and below the confluence with Loves Creek. Low DOs (less than 5 mg/l) and algal blooms have been observed. A biological assessment of Loves Creek resulted in a Poor rating with effects of the discharge evident in Rocky River 3 miles below the confluence with Loves Creek.

A QUAL2E model was developed for the Rocky River beginning at Siler City's discharge on Love's Creek and continuing 21 miles below the discharge point based on Black and Veatch's TOT study in 1988. DWQ calibrated the model and prepared a WLA Modeling Analysis in 1990 which required advanced tertiary limits at Siler City to improve the instream DO in the Rocky River (NC DEM, 1991). The model predicted that with advanced tertiary treatment the DO standard of 5 mg/l would be violated downstream of the WWTP. The 1990 model predicted a DO sag to 4.6 mg/l 3 miles below the discharge; a DO sag to 4.1 mg/l is predicted using the long term BOD results from 1993.

In addition, an instream flow study was undertaken by Water Resources in order to determine an appropriate minimum release from the Siler City Reservoir. A minimum release from the reservoir was recently required that should mitigate impacts from the Siler City WWTP, improve aquatic habitat, and reduce stagnant conditions in the Rocky River.

Siler City has expanded its WWTP to 4 MGD and upgraded the facility to meet advanced tertiary treatment levels recommended by the modeling analysis. Implementation of the minimum release from the Siler City Reservoir should mitigate the effects of the discharge. Water quality is expected to improve substantially due to the minimum release and improved treatment. Siler City's self-monitoring data show DO levels as low as 3 mg/l in Rocky River below the Siler City WWTP discharge. Follow up studies should be performed once the minimum release is operational to determine if stream improvement has occurred.

6.3.7 Recommended BOD and NH_3 Strategies for the Upper Cape Fear Watershed (Subbasin 07, 13, 14 and 15)

Subbasin 07

Cape Fear River

This subbasin is the uppermost basin of the Cape Fear River. Within this subbasin, the Haw and Deep Rivers join to form the Cape Fear. There are a number of industrial and domestic discharges to the Haw River between Jordan Reservoir and the mouth of the Deep River, three of which have significant amounts of oxygen demanding waste. An empirical model of these discharges has been

developed to gauge potential interaction between them and predict their collective impact on instream dissolved oxygen. The model was run from Allied-Signal's discharge point to Buckhorn Dam, 7.5 miles downstream in the headwaters of the Cape Fear River. The discharges included in the model are summarized in the following table:

Table 6.10 Discharges to Haw River below Jordan Reservoir

FACILITY	PROCESS (source of wastewater)	Wasteflow (MGD)	BOD_5 (mg/l)	DO (mg/l)
Allied-Signal, Inc.	Polyester fiber production	0.244	15.8	NL
Williamette Industries, Inc.	100% domestic waste stream	0.008	30	5.0
Neste Resins Corporation	Synthetic resin production	0.100	34.9	NL

None of these facilities have NH_3 limits nor discharge significant amounts of NH_3, so nitrogenous BOD (NBOD) was not a significant factor in the model. The model predicted that CBOD from the discharges had the most significant affect on instream DO levels. Due to uncertainty concerning the decay rate of the effluent from Neste Resins, the model was run under various scenarios of CBOD. All model runs predicted a DO sag below 5.0 mg/l behind Buckhorn Dam.

The model predicts that if all three facilities discharge at maximum permitted levels while Jordan Dam is at the minimum release level (40 cfs) there will be a violation of the 5.0 mg/l instream dissolved oxygen standard, which indicates a potential overallocation of assimilative capacity in this area of the Haw and Cape Fear Rivers. Discharger impact may be mitigated by increased flow releases from Jordan Dam. Instream data are limited, however, at Moncure, the ambient DO has been observed at 5.6 mg/l. Further downstream at HWY 42 (1.5 miles above Buckhorn Dam), the DOs indicate supersaturation typical of algal blooms.

Upon expansion, more stringent BOD limits may be applied to protect the instream DO standard. It should be noted that assimilative capacity is somewhat limited in this area because the river has a low slope (1.0 ft/mi.) and slow velocities which cause reaeration rates to be low, so oxygen demanding wastes decay very slowly. In addition, the BOD from the industries breaks down slowly so there is residual BOD behind the dam. A long term BOD sample was taken from the mouth of the Haw River in order to assess the impact of these discharges and quantify loading to the Cape Fear at Buckhorn Dam. Results indicate that the CBOD at the mouth of the Haw River (6.1 mg/l) is well above typical background levels of CBOD (2 mg/l).

Kenneth Creek

Fuquay-Varina discharges 1.2 MGD of municipal wastewater to Kenneth Creek, a tributary of Neils Creek. At the point of Fuquay-Varina's discharge the creek has a drainage area of 4.0 square miles and has a zero flow 7Q10, but has positive flow for 30Q2. Benthic macroinvertebrate sampling gave the creek a rating of Poor, and attributed the degradation of the stream directly to impacts of the Fuquay-Varina discharge. Fish community sampling also yielded a Poor rating for Kenneth Creek. Water quality ratings in Neils Creek recover to Good-Fair prior to confluence with the Cape Fear. Fuquay-Varina has documented DO concentrations as low as 3.8 mg/l below the discharge during the summer of 1994. It is recommended that new and expanding discharges meet advanced tertiary limits of 5 mg/l BOD_5 and 2 mg/l NH_3-N.

Utley Creek

Holly Springs discharges to Utley Creek, a low flow tributary of Harris Lake. Holly Springs' self-monitoring data show DO levels as low as 4.8 mg/l in Utley Creek below the Holly Springs WWTP discharge. A survey of water quality below the discharge is recommended since the

instream waste concentration is 87.5%. If Holly Springs pursues expansion at this location, a field calibrated model may be developed in order to determine appropriate permit limits.

Subbasin 13 This subbasin includes the Upper Little River watershed which drains to the Cape Fear River. There is no interaction between discharges to this low flow stream. There are no known water quality problems in this watershed.

Subbasin 14 This subbasin includes the Lower Little River watershed. The river is HQW above Fort Bragg's discharge. An empirical model was run to examine the potential for interaction between the discharges for Dilton Mobile Home Park, Fort Bragg WWTP and the Town of Spring Lake WWTP. The model was run to simulate the cumulative impact of the discharges if all facilities discharged at maximum permitted levels during 7Q10 conditions. The model was developed with the discharge parameters listed in the following table:

Table 6.11 Discharges to Little River

FACILITY	Flow (MGD)	BOD_5 (mg/l)	NH_3N (mg/l)	DO (mg/l)
Dilton Mobile Home Park	0.015	30	NL	NL
US Army - Fort Bragg WWTP	8.0	16/30	11/NL	5/NL
Town of Spring Lake WWTP	1.5	28/30	8/NL	5/NL

The model was run from the outfall point of Dilton MHP to a point on the Little River about 2.5 mi. below the confluence with Jumping Run Creek and accounts for the presence of a large drinking water treatment plant, serving Fort Bragg, located in this area of the river. The treatment plant's intake is located upstream of Dilton MHP and the Fort Bragg wastewater discharge, and it is permitted to withdraw up to 8.0 MGD. The maximum withdrawal can constitute as much as 30% of the river's flow during a 7Q10 event, so the water plant can have a direct impact on the assimilative capacity and the wasteload allocations in the stream.

The model predicts a significant over allocation of the Little River in the Spring Lake area, and the model attributes it almost entirely to the Fort Bragg WWTP. However, ambient data and biological sampling data indicate that water quality has improved in this area of the Little River, most likely due to the fact that the US Army completed an upgrade of the Fort Bragg WWTP in summer of 1991. Even though BOD_5 and NH_3-N limits have been 16/30 mg/l (sum/win) and 11/NL mg/l, the plant has been treating to tertiary levels since the WWTP upgrade. No instream violations of the DO standard have been observed.

In light of their current treatment performance, Fort Bragg WWTP's BOD5 limit will not be changed at this time. Upon renewal, the facility will receive ammonia limits according to current DWQ ammonia toxicity policy. Per the modeling, it is recommended that new and expanding discharges to the Little River receive summer limits no less stringent than 10 mg/l BOD_5 and 4 mg/l NH_3-N to protect the 5.0 mg/l instream dissolved oxygen standard.

Subbasin 15 This subbasin includes the Cape Fear River from Erwin to Lock & Dam 3 as well as Rockfish Creek. Modeling for this section of the river is described in Section 6.3.3.1.

6.3.8 Recommended BOD and NH_3 Strategies for the Lower Cape Fear Watershed (From Lock and Dam No. 1 to the mouth) and Coastal Waters (Subbasins 16, 17 and 24)

Subbasin 16 This subbasin includes the Cape Fear River from Lock and Dam 3 to Lock and Dam 1 including Elizabethtown. Modeling for this section of the river is described in Section 6.3.3.2.

Subbasin 17 This Subbasin can be broken into three distinct areas:

1. Cape Fear between Lock and Dam 1 and Wilmington: A QUAL2E model was developed for this section of the river and is described in Section 6.3.3.3.
2. Northeast Cape Fear from Castle Hayne to Wilmington: Low DOs (4-5 mg/l) have been observed at the ambient station at HWY 421 .
3. Cape Fear from Wilmington to the Ocean: Low ambient DOs (2-3 mg/l) have been recorded at the ambient stations at Channel Markers 55 & 50.

WLA analyses in estuarine areas are more complex than those to river systems due to the tidal and wind effects on the hydrology and the three-dimensional circulation patterns. Due to the time and resource constraints, a comprehensive estuary model was not developed for inclusion in this plan. However, monitoring regimes are being developed and results are planned to be available by the next permit cycle to evaluate the current pollutant loads and water quality and to determine the status of Primary Nursery Areas (PNAs). A coalition of industries, municipalities, and educators has evolved to develop a monitoring program. UNC - Wilmington is overseeing the group and performing the monitoring. As a result of documented low dissolved oxygen levels and pending completion of further studies, it is recommended that new and expanding discharges in the estuary area receive NPDES limits reflecting advanced wastewater treatment, i.e., BOD_5 = 5 mg/l and NH_3-N = 2 mg/l. This area is heavily used for wastewater assimilation and is susceptible to strong development pressure.

A section of this subbasin was reviewed for reclassification to HQW in 1989 based on the presence of PNA waters. The EMC recommended additional surveys of water quality and aquatic life be undertaken prior to making a final decision. The UNC -Wilmington, Dept. of Marine Sciences was delegated to undertake the sampling. The area under consideration includes the Northeast Cape Fear from the mouth of Ness Creek to the Cape Fear, the Brunswick River, and the Cape Fear River from the Black River to a line across the river upstream of Lilliput Creek. Data from these surveys will be reviewed prior to the next basin plan to determine what changes in the study plan are needed.

The Corps of Engineers and the NC Division of Water Resources is investigating the feasibility of deepening the Wilmington harbor to allow access to larger ships. Studies are focusing on the effects of the dredging on the ground water system. The impacts on salt water intrusion upstream have not yet been quantified.

New Hanover County

New Hanover County has recently purchased the wastewater treatment facilities for several subdivisions located on the north side of the county and plans to regionalize wastewater treatment. Regionalization will be achieved in the short run through connection to one of Wilmington's regional wastewater treatment plants. The long-term solution is construction of the 4.0 MGD new Hanover County WWTP to serve northern New Hanover County. The proposed facility has been permitted to discharge to the Cape Fear River below the confluence with the Northeast Cape Fear with requirements for advanced tertiary treatment, i.e., summer (winter) limits of BOD_5 = 5 (10) mg/l and NH_3-N = 2 (4) mg/l.

Subbasin 24 This subbasin is a small coastal watershed which includes the Intracoastal waterway, beach communities, and Topsail Island. There are many SA waters and ORW waters. Most water quality problems can be traced to development and marinas. Discharges are discouraged to all waters. DO levels drop below 5 mg/l during summer months due to high temperatures and limited tidal flushing. Biological Assessment has sampled in this subbasin as part of its efforts to improve estuarine survey techniques and rating methods.

6.3.9 Recommended BOD and NH_3 Strategies for the Black River Watershed (Subbasins 18, 19 and 20)

Subbasins 18, 19 and 20 The South River (subbasin 18) from Big Swamp to the Black River and the Black River (subbasins 19 and 20) from it's source to the Cape Fear River have been designated ORW. All of the protective measures included in the ORW management strategy will apply to these waterbodies. No new discharges or expansion of existing ones are allowed in ORW stream segments as per 15A NCAC 2B .0216 (c) (1).

The following point source management strategies are recommended 1 mile upstream of the ORW stream segments. These management strategies are in accordance with 15 NCAC 2B .0203 and 15 NCAC .0216 (e) (9).

(A) All new and expanded NPDES wastewater discharges will be required to meet summer (winter) effluent limitations of BOD5 = 5(10) mg/l, NH_3-N = 2(4) mg/l.

(B) Fail-safe treatment designs will be employed including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent fail-safe treatment designs.

A number of municipalities: Clinton, Garland, Magnolia, Roseboro, and Warsaw discharge to swamp waters in subbasin -19. Naturally occurring low DOs are typical for these systems. For example, DOs less than 3 mg/l have been observed above and below the Magnolia WWTP. White Lake also discharges to swamp waters (Colly Creek) in subbasin -20. A major concern in these subbasins is the application of the desktop empirical model to swamp waters. The model should be used with caution as it was developed for free-flowing streams and assumes complete mixing across the waterbody. See Section 6.3.2 for a description of management for swamp waters. In addition, a number of these facilities are currently operating under SOCs which allow the discharge of effluent of lesser quality than the permit limits require. The facilities are scheduled to be in compliance in 1995 or 1996.

6.3.10 Recommended BOD and NH_3 Strategies for the Northeast Cape Fear Watershed (Subbasins 21, 22 and 23)

Subbasin 21 This subbasin contains the headwaters of the Northeast Cape Fear River within a very small drainage area. The major concern as a result of its impact on the biological community and instream DO is the Mount Olive Pickle Plant which discharges 0.4 MGD of industrial wastewater to Barlow Branch, a zero 7Q10 and zero 30Q2 tributary of the Northeast Cape Fear River. The facility has received limits of BOD_5 = 6 mg/l and NH_3-N = 2 mg/l. However, these limits do not protect water quality due to the high strength of the wastewater, i.e., CBOD is 6 mg/l BOD_5* 5.6 (ratio of CBOD/BOD_5) = 33.6 mg/l compared to domestic strength of 6 mg/l BOD_5* 1.5 (ratio of CBOD/BOD_5) = 9 mg/l. In addition, Mount Olive Pickle is under an SOC until 12/31/96 which allows the discharge of BOD_5, NH_3, and TSS above the permitted limits. Anoxic conditions periodically occur downstream of the pickle plant while the DO concentration averages approximately 4 mg/l. Impacts are seen for over 4 miles of the Northeast Cape Fear River an improvement over past sampling efforts. Additional information on the impacts of the discharge can be found in Section 6.5 addressing toxicant conditions.

Subbasin 22 This subbasin drains most of the NE Cape Fear. The river and its tributaries are swamp waters and blackwater which possess naturally low DOs (<4 mg/l). The NE Cape Fear is classified HQW from Muddy Creek to Rock Fish Creek. DOs drop to 4-5 mg/l at HWY 41 near

Chinquapin. Tributaries have limited assimilative capacity for major discharges and tertiary treatment has been required in most cases based on localized water quality problems.

Panther Branch

A major concern due to its impact on the biological community and instream DO is the Cates Pickle Plant which discharges 0.5 MGD of industrial wastewater to an unnamed tributary of Panther Branch, a zero 7Q10 and zero 30Q2 stream which flows to Goshen Swamp in the Northeast Cape Fear River drainage basin. The facility has received limits of BOD_5 = 5 mg/l and NH_3-N = 2 mg/l per zero flow regulations.

Subbasin 23 This subbasin includes the Lower NE Cape Fear River which is classified swamp waters. The Biological Assessment group has been collecting data here as part of its swamp study to refine methods of rating swamp waters. Most waters are rated fair and good-fair. DOs at the ambient station at HWY 117 drop to 3-5 mg/l during summer months due to the influence of the discharges, the salt wedge, swamp waters, and high temperatures. The former Ammons - Northchase WWTP (now Bridgeport), has been purchased by New Hanover County with plans to connect it to a regional treatment plant.

Osgood Canal/Burgaw Creek

The Town of Burgaw wastewater treatment plant is permitted to discharge up to 0.5 MGD to Osgood Canal 1/2 mile above its confluence with Burgaw Creek, which flows through a slow moving swamp area to the Northeast Cape Fear River. At the point of Burgaw's discharge, Osgood Canal is estimated by US Geological Survey to have zero flow during 7Q10 flow conditions and minimal positive flow (0.4 $ft.^3/sec.$) during 30Q2 flow conditions. Biological sampling of benthic macroinvertebrate and fish communities done in 1987 and 1985, respectively, has shown Burgaw Creek to be substantially impaired by the discharge. During summers from 1991 to 1993, the Burgaw WWTP had 7 effluent violations of the monthly BOD_5 limit and 8 violations of the NH_3-N limit. The facility is currently under a Special Order by Consent which allows relaxed limits for BOD_5 and NH_3-N, and requires compliance with final NPDES effluent limitations by June 30, 1996. The Town of Burgaw has submitted a 201 Plan and Environmental Assessment which evaluated the alternatives of expanding the treatment plant at the current discharge location, relocating the discharge to the Northeast Cape Fear River at NC Highway 53, and land application of the discharge. The plan selects upgrading and expanding the WWTP to 1.0 MGD at the current discharge location. Speculative limits provided to Burgaw for planning purposes were advanced tertiary treatment limits of BOD_5 = 5.0 mg/l (summer) and 10.0 mg/l (winter) and NH_3-N = 2.0 mg/l (summer) and 4.0 mg/l (winter) with a minimum effluent dissolved oxygen limit of 6.0 mg/l for the expansion to 0.75 MGD.

6.4 MANAGEMENT STRATEGIES FOR NUTRIENTS

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

6.4.1 Assimilative Capacity

The Cape Fear River basin has limited areas where eutrophication problems exist. The Jordan Reservoir watershed (subbasins 01 through 06) has limited assimilative capacity for nutrients and has been designated NSW. Due to its physical and geographical characteristics, the lake is

especially susceptible to degradation from excessive nutrient loadings. Eutrophic conditions are well documented throughout the lake during summer conditions (See data summaries, Chapter 4). The Deep River has been identified as impacted based on excessive nutrient loading and subject to eutrophication in stagnant areas. At this time the Cape Fear mainstem has not been overallocated for nutrients though instream levels of nutrients are high.

6.4.2 Management of the Jordan Reservoir Watershed: Subbasins 01-06

NCDWQ first recommended nutrient management in the Jordan Reservoir watershed in 1983. NCDWQ recognized the need for watershed-wide nutrient management in the watershed and developed a Nutrient Sensitive Water (NSW) strategy. Effluent TP limits of 2.0 mg/l were applied to all new or expanding discharges in subbasins 01 through 06. Existing facilities with design flows of 50,000 gallons per day and greater were given until January 1990 to come into compliance with the TP limit (2 mg/l). Currently a majority of the facilities have done so.

In addition to the NSW strategy, more stringent TP limits, as well as possible establishment of TN limits, have been necessary in localized areas including a number of tributaries to Jordan Reservoir. While the NSW designation was designed to protect the watershed as a whole on an annual basis, some localized areas are much more impacted by a constant discharge. Through modeling analyses and detailed monitoring, it is evident that eutrophication problems (i.e., algae blooms, nuisance conditions, etc.) are common in areas where a discharge dominates a low flow stream, especially above lakes or other impoundments. Currently, the Division procedure is to assign more stringent nutrient limits where it can be shown that during summer low flow periods the discharge is directly impairing the water quality of the receiving water. Nutrient strategies for the major tributaries of Jordan Reservoir are discussed below.

Haw River

The many small dams located on the Haw River present the potential for algae growth by slowing water velocity. Nutrient concentrations, both nitrogen and phosphorus, are very high throughout subbasin 02, due to the presence of a number of major wastewater discharges in addition to nonpoint sources. Nutrient loading is particularly high on Reedy Fork Creek which is dominated by wastewater from Greensboro and Cone Mills. Although no algae blooms have been reported on Reedy Fork Creek, EPA Algal Growth Potential Test data show Reedy Fork Creek at Ossipee and the Haw River at Glencoe and at Saxapahaw are highly nutrient enriched and have strong potential for algal growth in the absence of limiting factors. Currently growth may be limited by the color, foam, and short residence time behind the dams. EPA testing ruled out metals toxicity as a limiting factor for algal growth. The ratio of nitrogen to phosphorus at these stations indicates nitrogen limitation.

In addition, analysis of nutrient data taken by DWQ personnel during a time-of-travel study on June 7-9, 1994 shows elevated nutrient concentrations in both the Haw River and its tributaries, including Reedy Fork Creek and Alamance Creek. A mass balance identifies Reedy Fork Creek as a major source of nutrients to the Haw River, with loading rates 2.5 times higher than any other source. These data and ambient monitoring data indicate the NSW strategy is not sufficiently controlling nutrient loading to the Haw River. Plots of nutrient concentration versus flow taken at DWQ ambient monitoring stations at Haw River and Bynum show high nutrient concentrations at both high and low flows, implicating both point and nonpoint sources. Development of a nutrient fate and transport model is recommended to better identify both point and nonpoint sources and re-evaluate the NSW management strategy. Modeling is also needed to identify the relative contributions of point and nonpoint sources. Due to the significance of wastewater in the Haw River (Instream waste concentration of over 66% at Bynum), more stringent nutrient limits may be needed to reduce the potential of algal blooms in Jordan Reservoir.

New Hope Creek

A water quality study of New Hope Creek in 1988 indicated that little or no assimilation of nutrients was occurring in the channel above Jordan Reservoir. Bioavailable and chemical nutrient data indicated that virtually all of the effluent input remains available for biological uptake (NC DEM, 1989). As a result of observed nutrient concentrations, chlorophyll *a* levels and algal growth potential, phosphorus removal to 0.5 mg/l during summer months was required upon expansion of the Durham-Farrington Road WWTP. In addition, biological nitrogen removal was recommended to reduce eutrophication in the New Hope arm of Jordan Reservoir. A detailed description of the nutrient analysis can be found in a separate report (NC DEM, 1989).

Northeast Creek

Effluent and instream nutrient studies were conducted on Northeast Creek in 1990. As a result of observed nutrient concentrations, chlorophyll *a* levels and algal growth potential, phosphorus removal to 0.5 mg/l during the summer months was required of the Durham-Triangle WWTP.

Morgan Creek

A water quality study of Morgan Creek in 1989 indicated that OWASA's effluent dominates Morgan Creek during the critical low flow summer period. A reduction in OWASA's nutrient concentrations was needed to reduce the potential for eutrophication below the OWASA facility (NC DEM, 1991). As a result of observed nutrient concentrations, chlorophyll *a* levels and algal growth potential, phosphorus removal to 0.6 mg/l during summer months was required upon expansion of the Mason Farm WWTP to 10 MGD. The eutrophication issue will be reevaluated for the next expansion phase. A detailed description of the nutrient analysis can be found in a separate report (NC DEM, 1991).

6.4.3 Management of the Deep River watershed (Subbasins 08 to 11)

Overview

The upper reaches of the Deep River contain the drainage areas of High Point Lake and Oak Hollow Lake. Algae blooms have been reported in these reservoirs, but they are currently supporting their designated uses. DWQ ambient nutrient data, taken at the USGS flow gage on the East Fork Deep River, show high nutrient concentrations at both high and low flows and indicate the influence of both point and nonpoint sources. A few small point source discharges may contribute to the nutrient loading, but there are no major discharges above these lakes. Both agricultural and urban nonpoint source pollution controls should be implemented to protect these two reservoirs from further eutrophication.

Below Richland Creek, nutrient concentrations within the entire Deep River, especially phosphorus, are excessively high. Total phosphorus and total nitrogen concentrations are measured at three ambient stations with USGS gages. At Coltranes Mill, downstream from High Point's Eastside WWTP, high concentrations of nutrients occur at low flows when nonpoint source input is minimal, indicating water quality in this reach is strongly influenced by point sources. At permitted flow (16 MGD), effluent from the Eastside WWTP constitutes over 70% of the Deep River flow. Other discharges above Coltranes Mill have a total permitted discharge of only 0.085 MGD. At the Ramseur ambient station both point and nonpoint sources contribute to high nutrients, while at the Moncure station, in the lowest reaches of the Deep River, most of the nutrient load is delivered at high flows. Field observations suggest this is caused by both nonpoint source pollution and the resuspension and washout of stored sediments from impoundments. Development of a nutrient fate and transport model of the Deep River is limited by the multitude of impoundments and the resulting complex, unsteady river discharge.

A DWQ study was conducted on the Deep River in September 1994 to determine the significance of upstream point sources on nutrient loads to the Carbonton impoundment (NC DEM, 1995). The study showed High Point's Eastside WWTP is a major contributor of nutrients to the upper Deep River. High concentrations of nutrients (maximum TP = 1.8 mg/l, maximum TN = 11.9 mg/l) were measured in the Deep River downstream from Richland Creek during low flow conditions. The concentrations drop rapidly until Ramseur, as the river is slowed by several dams and nutrients are retained in the impoundments. During higher flows, there is a large nutrient flux to downstream reaches. This is believed to be the result of both nonpoint sources and the flushing of nutrients stored behind the dams.

Nonpoint sources within the Deep River basin include urban, agricultural, and forestry operations. The headwaters of the Deep River receive runoff from Greensboro and High Point, and Hasketts Creek is impacted upstream of the WWTP by stormwater from Asheboro. Although there are these urban impacts, agriculture and forestry are the significant land uses in the basin. Agriculture consists mostly of poultry and cattle operations (Cooperative Extension Service, pers. comm.). Livestock manure and poultry litter are typically applied to pastures as organic sources of nutrients. While land application of waste is generally both economically and environmentally sound, this practice can result in the overapplication of phosphorus. Improper application rates and timing can leave excess nutrients that are not used by the plants. During rainstorms, these excess nutrients may be washed into nearby streams and lakes. Soil erosion from forestry and agricultural operations is also a concern, not only because of sedimentation of lakes, but because phosphorus is readily attached to soil particles. As sediment accumulates in impoundments, attached phosphorus can be released to the water.

Water quality problems from high nutrient concentrations are exacerbated by the many hydroelectric and mill dams on the Deep River. Additionally, several bridge crossings collect significant amounts of debris, further impounding the river. These impoundments slow water velocity and encourage algae growth during low flow events. Instream self-monitoring data from Asheboro WWTP show violations of the dissolved oxygen saturation standard (110%) in Cox Lake during summer months from 1991-1994. The elevated levels of DO saturation (as high as 174%) are indicative of algae blooms and overenrichment. Algae blooms have also been reported in the impoundments at Carbonton and Coleridge and significant periphyte growth has been noted by DWQ personnel throughout the lower Deep River below Franklinville.

Low dissolved oxygen concentrations in Cox Lake and the lower reaches of the Deep River are attributed to excessive algae and periphyte growth and die-off. Although nutrient concentrations in the upper reaches of the Deep River near High Point and Randleman are frequently sufficient to support algae blooms, water velocities are too high and retention times in the smaller impoundments are too low for significant algae growth. In the eastern, downstream reaches, the river bed slope is lower and water velocities are slow enough for algae growth during low flow conditions.

Management Strategies

Three factors, stream velocity, point source nutrient loading, and nonpoint source loadings, are predicted to play a significant role in the control of eutrophication and DO standards violations in the Deep River. A three-tiered management strategy is recommended.

1.) Maintenance of Stream Velocity

Restoring the natural riverine flow conditions will reduce algae blooms and improve river reaeration. As discussed before, algae require quiescent conditions for growth. Where possible, removing unnecessary impoundments, acquiring and removing hydroelectric dams, and

eliminating debris snags will maintain water velocity at low flows and will immediately reduce algae blooms. As a condition of Federal Energy Regulatory Commission (FERC) permitting, dams along the Deep River are required to release the same flow that enters the impoundments instead of holding water for peak hydropower releases. In the past, many of the dams were operated in a peaking mode instead of run-of-the-river. Although flow peaking has been reduced, inadvertent flow fluctuations still exist due to failures and inadequacies of outdated equipment in many older hydroelectric facilities on the Deep River. These flow fluctuations further limit the system's assimilative capacity by reducing flow velocities behind the dams and total flow downstream. The Division of Water Resources (DWR) is currently working with hydropower operators to reduce these problems. Water level recorders have been installed at some hydropower facilities on the Deep River and operational evaluations by DWR are recommended during future low flow periods.

2.) Point Source Nutrient Control

Excessive algae growth can be prevented by limiting phosphorus. This is particularly true in the Deep River system where phosphorus, removed in the impoundments under low flow conditions, is resuspended and flushed downstream at higher flows. As discussed above, point sources, especially in the upper reaches, contribute a significant fraction of the phosphorus load to the Deep River. Comparisons of the average daily total phosphorus load from wastewater treatment plants above the Carbonton impoundment indicate the High Point Eastside WWTP contributes more phosphorus to the Deep River than all other discharges combined. Due to the size of the High Point discharge and the extremely high phosphorus concentrations measured in the Deep River downstream from Richland Creek (as high as 3 mg/l), it is recommended that High Point Eastside take immediate steps to reduce phosphorus loading. A total phosphorus (TP) discharge limit of 1.0 mg/l is recommended. DWQ will work with the facility to determine an appropriate schedule for these changes. It is also recommended that all other new and expanding major discharges (flow >= 1 MGD) receive a TP limit of 1 mg/l, while discharges with a discharge less than 1.0 MGD and greater than or equal to 0.5 MGD receive effluent TP limits of 2 mg/l. This should reduce permitted point source phosphorus loading above Carbonton Lake by 73%. This should result in an overall reduction of at least 30% in average instream summer TP concentrations at the ambient station at Ramseur.

Additionally, DWQ's studies have shown excessive levels of nitrogen loading in the upper Deep River system. Instream data from the Deep River mainstem 1.5 miles downstream of the High Point - Eastside WWTP discharge have shown combined nitrate-nitrate levels as high as 19.0 mg/l. Ambient data from the Deep River at Coltrane's Mill, 5 miles below the Eastside WWTTP discharge, has shown total nitrogen (TN) levels as high as 16.0 mg/l. As with phosphorus, instream TN levels are dramatically higher during low flows, indicating that point sources are the dominant nitrogen loading contributions in this area. The High Point - Eastside WWTP constitutes over 99% of all wastewater discharged from point above Coltrane's Mill. Therefore, in order to reduce the incidence of nuisance algae blooms downstream in the Deep River, it is recommended that, upon expansion, the Eastside WWTP be required to meet an effluent TN limit of 6.0 mg/l during summer month (April-October).

3.) Nonpoint Source Nutrient Control

While reducing point source loading to the Deep River will significantly reduce nutrient concentrations, nonpoint source controls are also necessary to minimize the occurrence of algae blooms under low flow conditions. Urban nonpoint source pollution will be reduced in the headwaters of the Deep River as the Greensboro stormwater plan is implemented. Richland Creek and Hasketts Creek upstream from the municipal WWTPs should continue to be monitored and these two urban tributaries should be reassessed in the next basin plan.

Nutrient loading from land application of animal wastes should be reduced as a result of the 15A NCAC 2H.0217 rules. Effective December 31, 1997, existing animal operations with liquid waste collection systems above a threshold size must provide certification of an animal waste management plan to DWQ. Other systems are required to apply animal wastes at agronomic rates, to keep records of waste disposal for a year, and to maintain 100 foot setbacks from perennial waters for waste storage areas. DWQ is currently working with the Cooperative Extension Service to increase education on the proper handling, storage, and application of wastes, as well as the implementation of nutrient management plans, erosion control measures, and other agricultural BMPs. Additionally, due to the numerous algae and dissolved oxygen problems resulting from excessive nutrient concentrations, the Deep River basin, from High Point Lake to Carbonton dam, should receive high priority within the Cape Fear basin for 319 and cost share funding.

A statewide nonpoint source work group was recently formed to combine the efforts of agencies involved in NPS control. Basin teams will be formed by representatives from each agency to develop nonpoint source management strategies for each river basin. It is anticipated that these teams will provide information from their respective programs that apply to protection of water quality in the basin. Further they will help develop and implement strategies to restore targeted impaired streams as identified in Tables 6.1 and 6.2 of this chapter. A team will be formed for the Cape Fear basin during the next five years. In light of the size and variation of water quality concerns in the basin, sub-teams may also be established for such areas as closed shellfish waters in the coastal portion of the basin and nutrient-related problems in upper reaches of the basin. For example, DWQ anticipates providing information on the Deep River water quality problems to this work group to encourage focused multi-agency attention and efforts in this area.

Lastly, DWQ will work to further quantify nutrient loading to the Deep River and to monitor long-term changes in phosphorus and nitrogen concentrations and fluxes. This could include the relocation of the ambient water quality monitoring station at High Falls to the new USGS gage at Glendon to improve the quantification of mainstem nutrient fluxes.

Proposed Randleman Reservoir

During the summer of 1983, an intensive water quality survey was conducted on the Deep River headwaters. One study intent was an assessment of potential water quality impacts of the proposed 3,000 acre water supply reservoir, the Randleman Reservoir, which would inundate much of the 25 miles of the Deep River study area in Guilford and Randolph counties. It was found that the elevated phosphorus and nitrogen levels in the Deep River could have a significant effect on the proposed Randleman Lake's trophic status (NC DEM, 1985). The report recommended diverting the major discharges around the lake in order to greatly reduce nutrient loading. Modeling indicated that point sources would be the dominant source of nutrients with over 90% of phosphorus inflow from High Point and Jamestown.

A second modeling study of the proposed lake was undertaken in 1990 as part of the Environmental Impact Statement. An Army Corps of Engineers BATHTUB model was developed which relies on loading estimates of point and nonpoint sources of nutrients to calculate total phosphorus and chlorophyll *a* concentrations within the lake as a growing season average. Under all model scenarios with the High Point - Eastside discharge, nuisance algal blooms are predicted to occur. Blooms may be exacerbated be the long retention time of the lake. Under average flow conditions, retention is predicted to be 229 days.

The existing land use for the watershed is 52% forested and 21% developed. The future scenario assumes forest and pasture land will be developed. Under this scenario, the watershed is 14% forested and 78% developed. With the increase in impervious service (from 11% to 32%), runoff and nutrient load to the lake increase. The future scenario also assumes the WWTP will expand to 20 MGD and remove phosphorus to 0.5 mg/l. Under this scenario there is a shift in nutrient

loading from point source dominated to nonpoint source dominated. The overall TP load to the lake decreases by 42% and TN loading increases by 41.5%. Under this scenario, the model predicts mean chlorophyll *a* in the lake segment below the WWTP will range from 75 - 86 ug/l with nuisance algal blooms predicted to occur 80-86% of the time. The lakewide average chlorophyll *a* is predicted to be 22 ug/l with an algal nuisance frequency of 11%. If the High Point discharge is eliminated from the lake, the percentage of nuisance algal blooms in the upper Deep River arm is predicted to be reduced to between 50 and 71% (PTRWA, 1990).

The Final EIS also compares the lake-wide average predicted chlorophyll *a* of Randleman Reservoir to lakes sampled for DWQ's 1988 Lakes Report. Water quality in Randleman Reservoir will be within the range of values measured in other NC lakes that are all eutrophic. From the model results, it is highly likely that Randleman Reservoir will be eutrophic as well.

In 1991, after reviewing supporting information, the EMC approved the Randleman Reservoir thereby permitting the Piedmont Triad Regional Water Authority to purchase land for the project through eminent domain. A petition contesting the EMC decision was filed in March 1992 by landowners whose land would be taken by the Piedmont Triad Regional Water Authority and a public interest group with concerns about the proposed reservoir as a safe drinking water source. The reservoir project has been investigated and evaluated, and the EMC decision was overturned by a Superior Court judge in 1994 in favor of the landowners. The judge recognized in his decision that not only are the low inflows, eutrophication potential, and the direct discharge to the lake by the High Point WWTP all concerns, but that alteration of natural flow patterns in the river could have significant impact for miles downstream. The EMC has appealed the ruling against the reservoir to the NC Court of Appeals.

6.4.4 Rocky River Watershed: Subbasin 12

A nutrient budget was done for the Rocky River Subbasin due to persistent algal blooms on the Rocky River downstream of the Siler City WWTP. The analysis recommended that Siler City implement phosphorus removal (0.5 mg/l) upon expansion in order to reduce the potential for algal blooms (NC DEM, 1991). The nutrient budget indicated that under summer low flow conditions nutrient loading was due to point sources.

6.5 TOXIC SUBSTANCES

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

6.5.1 Assimilative Capacity

The assimilative capacity, the amount of wastewater the stream can assimilate under designated flow conditions (7Q10 for aquatic life based standards, average flow for carcinogens), available for toxics in the Cape Fear Basin varies from stream to stream. In larger streams where there is more dilution flow, there is more assimilative capacity for toxic discharges. In areas with little dilution, facilities will receive chemical specific nutrient limits which are close to the standard. Toxics from nonpoint sources typically enter a waterbody during storm events. The waters need to be protected from immediate acute effects and residual chronic effects.

6.5.2 Control Strategies by Subbasin

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

permit. Whole effluent toxicity limits are also assigned to all major discharges and any discharger of complex wastewater.

Nonpoint source strategies to be implemented through the municipal and industrial NPDES stormwater program should also be helpful in reducing toxic substance loading to surface waters. Industries are being required to control runoff from their sites and to cover stockpiles of toxic materials that could pose a threat to water quality. Greensboro, Fayetteville, and Cumberland County will also be implementing stormwater programs that will include identifying and removing illicit discharges to storm drain systems. Additional strategies for streams not meeting instream standards or action levels are discussed by subbasin below:

Subbasin 01

The City of Reidsville WWTP currently discharges 5.0 MGD to Little Troublesome Creek for an instream waste concentration of 98%. More than 60% of the treatment plant inflow is from industrial sources. Prior to June 1994, the facility had never passed a toxicity test at the permit limit, Quarterly Chronic *Ceriodaphnia* Pass/Fail at 90%, despite over 4 years of monthly testing. Most tests in that period indicated that the effluent would exhibit toxicity to aquatic organisms at effluent concentrations of 35% or more. The facility is currently under an SOC which requires full compliance with the current test limit by December 1995 and requires a Toxicity Identification Evaluation (TIE) and a Toxicity Reduction Evaluation (TRE) be completed. To date all requirements of the SOC have been met. Reidsville has been considering relocation of its outfall to the Haw River at NC HWY 150 as an alternative to full toxicity reduction. By obtaining more dilution, the facility will receive a less stringent toxicity test requirement. The IWC at the Haw River site will be 51% at 5 MGD (61% at 7.5 MGD). However, with implementation of the Phase II TRE recommendations, toxicity test results have improved significantly and the facility may soon achieve compliance with its current NPDES toxicity limit. Since June 1994, the facility has reported chronic toxicity at effluent concentrations greater than 90% for 7 of 10 tests.

Subbasin 02

Buffalo Creek

Cone Mills discharges 1.1 MGD of textile waste to North Buffalo Creek, a low flow stream. The facility has an inconsistent record of compliance with its quarterly toxicity tests. In addition, Greensboro discharges 16 MGD of municipal wastewater to North Buffalo Creek downstream of Cone Mills. The City is required to meet limits close to the standards for effluent metals due to lack of instream dilution (IWC=96%). Poor water quality has been documented downstream of both the Cone Mills and Greensboro North Buffalo WWTPs. Discussions are underway between the City of Greensboro and Cone Mills to enable the removal of the Cone Mills discharge through connection to the Greensboro T.Z. Osborne WWTP. Regionalization of wastewater treatment and disposal is recommended. Water quality in North Buffalo Creek is expected to improve with the removal of the Cone Mills discharge.

Greensboro's T.Z. Osborne WWTP discharges 20 MGD of municipal wastewater to South Buffalo Creek. The City is required to meet limits close to the standards for effluent metals due to lack of instream dilution (IWC=94%). Poor water quality has been documented downstream of the T.Z. Osborne WWTP. An expansion to at least 30 MGD is planned. Improvements to effluent quality are recommended at both of Greensboro's WWTPs since these waters are the headwaters of the Haw River and significantly impact the Haw River water quality.

Haw River

The Haw River receives toxic loads from the Burlington WWTPs, Burlington Industries, Graham WWTP, Dixie Yarns, Mebane WWTP, and Reedy Fork Creek. There is a high instream waste concentration below these facilities and interaction between discharges. Metals limits will be reallocated upon permit renewal to account for interaction between discharges to the Haw River near Burlington.

Richland Creek/Deep River

Though water quality in the upper Deep River has improved from poor to fair between 1983 and 1993, an intensive water quality survey conducted by DWQ in 1992 indicates water quality violations remain. Most improvement appears to be correlated with removal of the Jamestown WWTP. The 1992 study found metals concentrations exceeding the action levels for copper, zinc, and iron in the upper Deep River site downstream of the High Point Eastside WWTP. Copper and zinc were found in association with the High Point Eastside WWTP. The facility is currently in compliance with its NPDES Whole Effluent Toxicity Test Limitation. Because the test organism used in these tests are very sensitive to these metals, it is unlikely that the metals are in a chemical form that is biologically available and therefore it is unlikely that they are causing degradation to the Deep River. Iron is found associated with clay soils within Piedmont North Carolina and also is considered biologically unavailable. In addition, pesticides and organics were found in river samples downstream of the WWTP. Numerous unidentified peaks in pollutant scans suggested the presence of many organic chemicals both in the treatment plant effluent and instream. High Point is required to conduct quarterly whole effluent chronic toxicity tests at 90% effluent strength. In 1993 and 1994 the city failed one test in five. The WWTP is required to conduct an annual pollutant analysis scan (APAM). The results of the past APAMs will be reviewed and chemical specific limits or additional monitoring may be required in order to protect water quality.

Subbasin 07

The Lillington WWTP and Swift Textiles WWTP have been non-compliant with toxicity requirements. Lillington has been fined and is negotiating an SOC for additional time to investigate and determine sources of toxicity in order to achieve compliance. Swift Textiles has undergone intensive study of dye and chemical use to identify sources of toxicity, and has made WWTP improvements without complete resolution of its toxicity problem.

Subbasin 08

A cluster of large bulk petroleum storage and distribution facilities is located at the headwaters of the East Fork of the Deep River. Eleven "tank farms" are currently permitted to discharge

Table 6.12. Oil tank farms within the East Fork Deep River watershed

FACILITY	LOCATION
Amerada Hess	UT East Fork Deep River
Ashland Petroleum Company	UT East Fork Deep River
Colonial Pipeline	UT East Fork Deep River
Conoco, Inc.	UT East Fork Deep River
Exxon Company, USA	UT East Fork Deep River
GNC Energy Corporation	UT East Fork Deep River
Louis Dreyfus Energy Corporation	UT East Fork Deep River
Plantation Pipeline Company	UT East Fork Deep River
Shell Oil Terminal	UT East Fork Deep River
Star Enterprise	UT East Fork Deep River
Triad Terminal Company	UT East Fork Deep River

wastewater from their treatment systems which collect various forms of runoff. These tank farms are located in the watershed for High Point Lake, a public water supply (the East Fork Deep River and Long Branch are classified WS-IV). As a result, a TMDL for phenols (total phenolic compounds) has been established for the lake headwaters. Due to the low to zero flow at the points of discharge, and proximity of a water supply, the amount of phenols allowable at the water supply intake under low flow conditions was divided equally among the discharges. Since the discharges occur at low and mid flows as well as high flow (i.e. after rain events), and since most facilities do not have a design flow, this limit was calculated as an allowable instream concentration (1 ug/l). The allowable concentration was then converted to a mass load, based on the stream flow, and allocated evenly among the discharging facilities.

In 1994, the Aquatic Toxicology Unit completed a study of bulk petroleum storage facilities in North Carolina. The study involved sampling effluent from several such facilities and performing toxicity tests and extensive chemical analyses on the samples. The purpose of the study was to evaluate the different levels and/or types of treatment and management practices employed at the facilities and their ability to meet NPDES permit limits. Two of the storage facilities in the cluster of tank farms at the East Fork Deep River headwaters were evaluated in the study. The study results showed that, when proper treatment and management practices were observed, the facilities were consistently able to produce WET test results that indicated no measurable toxic effects on aquatic organisms. The study also showed that the facilities with oil/water separators and some capacity for stormwater storage prior to discharge were able to consistently meet chemical specific discharge limits for discharges to non-water supply waters. However, the study showed that the facilities discharging to water supply waters had a higher potential to experience occasional violations of the more stringent chemical specific standards for such waters. Several tank farms employ more extensive treatment methods, such as air strippers and carbon absorption, to meet the more stringent water supply standards.

The Division of Water Quality is considering the development of a general NPDES permit for bulk petroleum storage facilities. If tank farm facilities maintain proper treatment systems and on-site management practices, the risk posed to surface water quality by their minimal discharges is negligible. It is also recommended that local emergency management agencies develop extensive contingency plans to protect water supplies in the event of spills, substantial leaks, or any other incidental petroleum product releases.

Subbasin 10

The Star WWTP discharges to Cotton Creek, a zero flow creek with limited assimilative capacity for toxics. Water quality has consistently been rated poor below the WWTP primarily due to the presence of textile salts. The Fayetteville Regional Office and the Town of Star are currently developing a Special Order to resolve the toxicity testing failures. The Town is coordinating efforts with the textile industries to reduce salt loading to the WWTP through reformulation of the textile dyes.

Subbasin 15

Rockfish Creek

Biological sampling was performed on Rockfish Creek in 1990 as part of an investigation to determine the potential for High Quality Waters designation. Below the Raeford WWTP the creek received a Good-Fair rating which rendered it ineligible for HQW classification. At that time the Raeford WWTP was experiencing consistently acidic effluent pH levels (below the lower limit of 6.0 SU), high residual chlorine levels, and occasional toxicity test failures. The facility has since improved performance in all of these areas and most recent sampling, in 1993, resulted in

improvement to an Excellent rating for the stream. In May 1994, Rockfish Creek was Rockfish Creek was re-investigated for reclassification to High Quality Waters, but again the waterbody did not meet the requirements for reclassification.

Subbasin 17

Currently a number of discharges to the Cape Fear have received chronic toxicity tests based on an IWC derived from estimates of advective flow which assumes complete mixing, while facilities upstream of them received acute tests on the basis of tidal flushing and mixing. Investigations will be pursued to determine the boundary at which the flow in the river becomes dominated by tidal influences, and the advective flow from upstream becomes "insignificant", or vice versa. Meanwhile the whole effluent toxicity for Arcadian and Wilmington Northside should be changed to acute (24 hr., NSM @ 90%) tests. This change would reflect the tidal nature of the stream at their discharge locations.

For new and expanding discharges in subbasin 17 with acutely toxic discharges to tidal areas, DWQ has begun looking at plume model results to determine initial dilution at the end-of-pipe. This dilution is used to determine toxics limits and dilution for chronic toxicity tests. The facility may improve their near-field dilution by constructing a diffuser. The purpose of the diffuser is to reduce the size of the mixing zone around the effluent pipe.

Subbasins 21 & 22

Mount Olive Pickle Plant discharges 0.4 MGD of treated process wastewater to Barlow Branch, a zero flow tributary of the Northeast Cape Fear River. Due to the high levels of chlorides used in brine solutions to store, process and package pickle products, the facility discharges high chloride concentrations into the receiving stream. Studies conducted by DWQ have shown that the discharge is adversely impacting the stream's biological community, mainly by reducing the diversity of species to a level lower than would be expected in an unaffected stream similar to Barlow Branch.

The facility has completed documentation required to support an application for a variance from the water quality standard for chlorides, and the variance request has been approved by the EMC's NPDES Committee to proceed to public hearing. As part of the variance process, the facility will continue to evaluate and pursue new methods of source reduction and removal technology which can lower the effluent levels of chloride without placing the facility in an economically untenable position.

<u>Panther Branch</u>

Cates Pickles discharges 0.5 MGD of process wastewater with high chloride concentrations to an unnamed tributary of Panther Branch, a zero flow stream that flows to Goshen Swamp. In cooperation with Mt. Olive Pickles, Cates is pursuing a variance to allow a high saline discharge. The water quality concerns and responsibilities of maintaining the variance mentioned above for Mt. Olive Pickles also apply to the Cates discharge.

6.6 MANAGEMENT STRATEGIES FOR CONTROLLING SEDIMENTATION

6.6.1 Overview of Sedimentation Problems in the Cape Fear Basin

Sedimentation is a serious concern in the Cape Fear Basin as indicated in section 3.2.4 of Chapter 3. There are 613 miles of streams thought to be impaired by erosion and sedimentation. Eleven of the 24 subbasins in the basin had 20 or more miles of streams thought to be impaired by sediment

(see Table 4.15 in Chapter 4). Each of these subbasins and their respective miles of sediment-impaired streams is listed below by major watershed areas.

Haw River Watershed: subbasins 01 (26 miles), 02 (31 miles), 03 (23 miles) and 05 (38 miles)
Deep River Watershed: Subbasin 11 (58 miles)
Upper Cape Fear River Watershed: subbasins 07 (44 miles) and 15 (50 miles)
Lower Cape Fear River and Coastal Waters: subbasins 16 (54 miles) and 17 (52 miles)
Black River Watershed: subbasin 18 (31 miles) and 19 (27 miles)
Northeast Cape Fear: subbasin 22 (68 miles) and 23 (35 miles)

Sedimentation is essentially a widespread nonpoint source-related water quality problem which results from land-disturbing activities. The most significant of these activities include agriculture and land development (e.g., highways, shopping centers, and residential subdivisions). For each of these major types of land-disturbing activities, there are programs being implemented by various government agencies at the state, federal and/or local level to minimize soil loss and protect water quality. These programs are listed in Table 6.13 and are briefly described in Chapter 5.

Table 6.13 State and Federal Sediment Control-related Programs (with Chapter 5 Section References in Parentheses)

- o Agricultural Nonpoint Source (NPS) Control Programs (Section 5.3.1)
  - 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)
- o Construction, Urban and Developed Lands (Sections 5.3.2 and 5.3.3)
  - Sediment Pollution Control Act (Section 5.3.3)
  - Federal Urban Stormwater Discharge Program
  - Water Supply Protection Program
  - ORW and HQW Stream Classifications
- o Forestry NPS Programs (Section 5.3.6)
  - Forest Practice Guidelines Related to Water Quality
  - National Forest Management Act (NFMA)
  - Forest Stewardship Program
- o Mining Act (Section 5.3.7)
- o Wetlands Regulatory NPS Programs (Section 5.3.8)

  The sediment trapping and soil stabilization properties of wetlands are particularly important to nonpoint source pollution control. Several important state and federal wetland protection programs are listed below.
  - Section 10 of the Rivers and Harbors Act of 1899
  - Section 404 of the Clean Water Act
  - Section 401 Water Quality Certification (from CWA)
  - North Carolina Dredge and Fill Act (1969)

6.6.2 Overview of Strategies/Programs to Control Sedimentation

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.

DWQ's role in sediment control is to work cooperatively with those agencies that administer the erosion and sediment control programs in order to maximize the effectiveness of the programs and protect water quality. Where programs are not effective, as evidenced by violation of instream water quality standards (section 3.2.4), and where DWQ can identify a source, then appropriate enforcement action can be taken. Generally, this would entail requiring the land owner or responsible party to install acceptable best management practices (BMPs). BMPs vary with the type of activity, but they are generally aimed at minimizing the area of land-disturbing activity and the amount of time the land remains unstabilized; setting up barriers, filters or sediment traps (such as temporary ponds or silt fences) to reduce the amount of sediment reaching surface waters; and recommending land management approaches that minimize soil loss, especially for agriculture. Some control measures, principally for construction or land development activities of 1 acre or more, are required by law under the state's Sedimentation and Erosion Control Act administered by the NC Division of Land Resources (Section 6.6.4). For activities not subject to the act such as agriculture, erosion and sediment controls are carried out on a voluntary basis through programs administered by several different agencies. The NC Agricultural Cost Share Program administered by the NC Division of Soil and Water Conservation provides incentives to farmers to install best management practices (BMPs) by offering to pay up to 75% of the average cost of approved BMPs (Section 6.6.3). A federal Farm Bill program administered by the Soil Conservation Service provides an incentive not to farm on highly erodible land (HEL) by taking away federal subsidies to a farmer that fails to comply with the provision.

Despite the combined efforts of all of the above programs for construction, forestry, mining and agriculture, there were still hundreds of miles of streams in the Cape Fear Basin thought to be impaired by sediment, thus pointing to the need for continued overall improvements in erosion and sediment control. Part of the problem is that no sediment control measures are 100% effective so some sedimentation is expected where land-disturbing activities occur. But there are still additional improvements that can be made as listed below. Education and promotion of stewardship are keys to improvement along with judicious strengthening of regulations and enforcement. The following sections outline some existing and proposed recommendations for addressing sedimentation.

6.6.3 Sedimentation Control Through the NC Agricultural Cost Share Program

The NC Agricultural Cost Share Program funding totals for 1985 through 1994 are presented in Tables 6.14 and 6.15. Table 6.14 presents expenditures by subbasin within the Cape Fear basin. The cost share figures include a wide array of BMPs including conservation tillage, terraces, diversions, critical area plan, sod-based rotation, crop conservation grass, crop conservation trees,

Table 6.14 NC Agricultural Cost Share Program Statistics for Erosion Control in the Cape Fear River Basin (Cumulative totals 1985 -1994)

ACRES SUBBASIN	TONS OF AFFECTED	TOTAL SOIL SAVED	CONTRACT AMT
03-06-01	5,988	50,445	$628,013
02	11,662	60,103	$1,268,735
03	5,852	34,469	$525,709
04	12,855	75,852	$1,015,135
05	1,714	11,341	$113,957
06	1,009	6,715	$54,719
07	3,361	33,368	$275,502
08	1,101	26,770	$90,811
09	4,735	66,260	$289,792
10	4,586	12,433	$285,588
11	2,167	26,230	$153,024
12	4,401	52,672	$419,036
13	3,823	38,244	$299,604
14	3,312	12,719	$198,749
15	4,064	6,196	$157,371
16	3,807	1,920	$158,637
17	5,447	19,183	$237,539
18	6,318	11,223	$276,365
19	6,501	10,180	$450,708
20	4,540	15,974	$107,229
21	21,465	37,186	$820,207
23	14,587	21,449	$483,312
24	69	730	$48,323
TOTALS	135,547	630,079	$8,697,572

filter strip, field border, grass waterway, water control structure and livestock exclusion. Total expenditures for the entire basin for each approved practice are presented in Table 6.15.

Cape Fear River Basin BMP Summary 85-94 (to S. Hoover 2/2/95) Sh

Table 6.15 Cape Fear River Basin BMP Summary 1985 - 1994.

EROSION/NUTRIENT CONTROL GRAND TOTAL

ITEM	UNITS	MSR	COST
Conserve Tillage	16,520.04	A	178,270.50
Terraces	396,253.00	F	139,991.84
Diversions	164,425.50	F	173,631.12
Crtcl Area Plan	539.97	A	303,527.31
Sod-Based Rotatn	16,677.55	A	751,895.43
Stripcropping	9,170.83	A	585,625.35
Crop Cnv Grass	12,493.17	A	1,485,794.13
Crop Cnv Trees	1,310.50	A	142,475.00
Crop Cnv Wldlife	.50	A	57.00
0.00 A	0.00		Lvstock Excl
15.00 N	16,667.00		Nutr Red Mgt

SEDIMENT/NUTRIENT CONTROL GRAND TOTAL

ITEM	UNITS	MSR	COST
Filter Strip	22.52	A	13,754.00
Field Border	679.50	A	553,773.67
Grass Wtrway	812.37	A	1,198,208.03
H2O Ctrl Str	115	N	115,381.00
Heavy Use	14	N	45,656.00
Spring Dvlpmt	8	N	6,015.00
Stock Trail	27	N	68,019.00
Stream Cross	20	N	40,737.00
Trough Tank	34	N	33,872.00
116,574.00 F	62,360.00		
0.00 A	0.00		
Wells	3	N	3,450.00
Pesticide Load	1	N	15,000.00
Portable Wtr Fac	0	N	0.00

ITEM	UNITS	MSR	COST
Windmills	0	N	0.00
Pesticide Mgmt	0	A	0.00
Sediment Basin	0	N	40,000.00

ANIMAL WASTE MANAGEMENT GRAND TOTAL

WASTE MANAGEMENT

ANIMALS	NUMBER
Cows	13,353
Fish	0
Hogs	171,029
Horses	0
Poultry	6,790,226
Sheep	0

SYSTEMS	
Lagoon	103
Cost	998,775.00
Ponds	64
Cost	398,416.00
Dry Stack	6
Cost	75,249.00
Pads	0
Cost	0.00
LittrStor	1
Cost	6,075.00
Composter	95
Cost	444,185.00
Loafing Lot	1
Cost	231.00
Abandon CAO	1

LAND APPLICATION

ANIMALS	NUMBER
Cows	15,826
Fish	0
Hogs	337,161
Horses	13,515
Poultry	9,943,571
Sheep	0

Acres	40,310.01
Gallons	301,971,219
Tons	329,458.01
Cost	1,108,712.20
Solid Set	15
Cost	144,160.00
Wetlands	0
Cost	0.00
Hydrants	19
Cost	169,604.00
Mob. Irrig.	0
Cost	0.00

GRAND TOTAL SUMMARY DATA

Acres Affected	135,547.80
Tons Saved	630,079.00
ASCS Payment	(619,541.00)
Total Contract Amount	8,697,572.58

6.6.4 Sediment Control for Construction Activities

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.

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.

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 6.16 presents actions that will help to address sediment problems associated with construction activities.

Resource materials:

- 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)

6.6.5 Sediment Control for Private Access Roads

Improperly designed, constructed, and maintained private access roads are a significant source of sediment in the Piedmont and mountains. Often, landowners do not realize the importance of building driveways for lasting service. Some landowners depend entirely on their contractor to design the road. Others try to design it themselves without consulting a reputable source. The consequences of not paying attention to an access road as it is designed and constructed can be serious. In addition to losing the road and potentially losing land and property, the washed-out road can damage water quality. Table 6.17 offers suggestions for addressing these issues.

Most of the responsibility for an access road rests on the landowner. However, local governments, citizens, and state/federal agencies can also make their contribution to solving this problem.

Resources:

- *Guidelines for Drainage Studies,* NCDOT Hydraulic Design Unit (1995). To obtain, call NCDOT at (919) 250-4128.
- *Final Report: Timbered Branch Demonstration/BMP Effectiveness Monitoring Project* by Richard Burns, USDA Forest Service (1994). To obtain, call USDA at (704) 257-4214.

Table 6.16 Recommended Actions to Address Construction-Related Sediment Problems

Homeowners	Fit the development to existing site conditions. Development that follows natural contours and avoids flood plains and highly erodible soils, 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 permanent vegetation is established and maintained on construction site ASAP. Continue to control sediment after construction is complete.
Developers/ Contractors	Fit the development to existing site conditions. Development that follows natural contours and avoids flood plains and highly erodible soil 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 onsite. Protect low points below disturbed areas. Build barriers to reduce sediment loss. When possible, 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. Will prevent sediment loss from certain tracts of land.
Local Govts. With Delegated Sediment/ Erosion Control Programs	Educate citizens as to the importance of erosion and sediment control. Maintain publicly-owned open space. Will prevent sediment loss 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.
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.

Table 6.17 Recommended Actions to Address Problems Associated with Private Access Roads

Homeowners	Know the state and local laws, ordinances and regulations about access road construction. Be prepared to pay the cost of constructing a good road that will last. The cost of constructing a road will vary greatly from site to site. The cost may increase due to steep or rocky land, low stability soils, or drainage needs. In the long run, it does not pay to skimp. Avoid steep grades. Sustained grades should not exceed 10% for gravel or crushed stone roads. Make sure the road has adequate drainage. Adequate drainage is necessary to control erosion. The following water sources must be considered: rainfall on the roadbed and cut/fill slopes, overland storm flows from the watershed above the road, and springs or streams intercepted by the road. Use drainage methods that protect water quality. These methods include capture areas to treat runoff and routing runoff parallel to streams. Inspect the road periodically. Check for ruts and dips in the road, the condition of the drainage outlets, and the general condition of the cut and fill slopes. Repair any problems immediately. Any problems with ruts, drainage outlets, bare areas, etc. should be repaired before a small problem turns into a large problem.
Contractors	Watch for signs of subsurface drainage problems before, during, and after construction. Some things to look for include: soils that are gray in color, areas with springs or seeps, low areas, and areas dominated by water-tolerant plants such as alders, black walnut, poplar, cattails, reeds, etc. Road and ground cover should be applied as soon as possible after construction.
Citizens	Report any serious problems with access roads. Some problems to look for include big ruts in the roadway, wash-outs, and clogged drainage outlets. You can report problems to your local government officials. If they are not able to help, contact the regional office of the NC Division of Land Resources.
Local Governments	Require properly designed and constructed roads as part of the building permit process. Institute ordinances requiring proper maintenance of private access roads.
State and Local Agencies	Provide citizens with information about how to properly construct private access roads. Investigate innovative new ways of constructing private access roads while protecting water quality.

6.7 MANAGEMENT STRATEGIES FOR STORMWATER CONTROL

6.7.1 Overview of Stormwater Impacts in the Cape Fear River Basin

A number of studies, including the Nationwide Urban Runoff Program (NURP) sponsored by the US Environmental Protection Agency, have shown that urban stormwater runoff, and the pollutants it carries, can be a significant contributor to water quality impairment. Water quality impairment from growth and development is a major concern in the Cape Fear River Basin. There are 200 miles of streams in the Cape Fear River Basin that are thought to be impaired by urban stormwater. Several streams identified as being at least partially impaired from urban runoff based on DWQ's most recent biological monitoring include the following:

Subbasin 01: Little Troublesome Creek (Reidsville)
Subbasin 02: South Buffalo Creek, Horsepen Creek, UT Horsepen Creek, Mile Run Creek (Greensboro)
Subbasin 05: Northeast Creek, Burdens Cr (Durham)
Subbasin 06: Morgan Creek, Bolin Creek, Little Creek, Meeting of Waters Creek (Chapel Hill)
Subbasin 08: UT East Fork Deep River, E Fk Deep River, Richland Creek (High Point) Hasketts Creek (Asheboro)
Subbasin 11: Big Buffalo Creek, Little Buffalo Creek (Sanford)
Subbasin 15: Cross Creek (Fayetteville)
Subbasin 17: Greenfield Lake (Wilmington)

6.7.2 Overview of Stormwater Control Programs

DWQ administers a number of programs aimed at controlling urban stormwater runoff. These include: 1) programs for the control of development activities in the 20 coastal counties, near High Quality Waters (HQW) and Outstanding Resource Waters (ORW) (Section 6.7.3), and activities within designated Water Supply (WS) watersheds and 2) NPDES stormwater permit requirements for industrial activities (Section 6.7.4)and municipalities greater than 100,000 in population (Section 6.7.5 and Section 5.3.2).

6.7.3 Stormwater Controls in HQW, ORW and Water Supply Watersheds

The Cape Fear River Basin includes a number of streams and lakes that are assigned HQW, ORW and WS water classifications (see Section 2.7 in Chapter 2 for locations). Coastal counties in the basin subject to stormwater requirements include Brunswick, New Hanover, Pender and part of Onslow. As described in other parts of this plan, these waters carry with them specific management strategies to protect their uses, including measures to control stormwater runoff from urban development (Section 2.7 and Appendix I). The HQW, ORW and coastal county stormwater requirements in this basin are implemented by DWQ through its Regional Offices (Winston-Salem, Raleigh, Fayetteville and Wilmington). Any development activities subject to the HQW or ORW requirements must submit plans and receive stormwater approvals from these regional offices. The water supply protection requirements are implemented by all local governments that have jurisdiction in a water supply watershed. There are a number of local governments in the Cape Fear basin that have developed water supply watershed protective ordinances for watersheds in the basin. Development activities covered by water supply protection requirements must be reviewed and approved by the appropriate local government.

6.7.4 Recommendations for Controlling Industrial Stormwater

Throughout the Cape Fear 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 industrial activities such as manufacture of ready mixed concrete; asphalt paving mixtures and blocks; furniture and fixtures; stone, clay, glass and concrete products; timber products; apparel and printing; mining activities; and vehicle maintenance activities.

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.

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.

6.7.5 Management Strategies For Urban Stormwater Control

Water quality impairment from urbanization is a major concern in the Cape Fear River Basin. Virtually every urban stream sampled by DWQ biologists is found to be impaired, and as land is

developed, more streams are impaired. The impacts result from a combination of sedimentation from construction, increased streamflow from more impervious surface areas, and decreased quality of runoff water that contains lawn care products, automobile-related pollutants, fecal coliform bacteria from animals and more.

In the Cape Fear River basin, three municipalities are required to develop urban stormwater programs under the NPDES stormwater requirements because their population exceeds 100,000. These include Greensboro, Durham and Fayetteville/Cumberland County. These programs would cover much of the watershed areas of those seven streams listed above in subbasins 02, 05 and 15. Also, at least two other local governments in the basin have undertaken voluntary stormwater programs including High Point and Chapel Hill.

However, most municipalities in the basin not subject to state or federal urban stormwater requirements but have streams that are being adversely impacted by urban stormwater. The entire community plays a role in controlling the quality and quantity of urban stormwater. And 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).

Listed below are resource materials available to help communities address the control of urban stormwater runoff on water quality. Table 6.18 provides a list of recommendations for local governments, citizens, businesses, developers, and state agencies in addressing urban runoff. Also, tables 6.19 and 6.20 present recommendations for minimizing the adverse impacts on water quality from yard care activities and home care products.

Resources for Control of Urban Stormwater:

- *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.

Table 6.18 Recommendations for Urban Stormwater Control

Local governments	Create public education programs. These programs advise citizens on how to care for their homes, businesses, and neighborhoods while minimizing stormwater pollution. Topics to cover can include environmentally sensitive methods of caring for lawns and vehicles (see Table 6.8). 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. Also, planning can be used to protect surface waters by directing growth away from sensitive areas/waters such as floodplains, steep slopes, wetlands, 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. Many agencies like DWQ offer work-shops 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 inlets, pipes, and outlets that make up their storm drain system, they will be well equipped to identify sources of 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 6.19 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 6.20). 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 drainage ways and buffers along streams.

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 6.19 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 6.20 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)

6.8 MANAGEMENT STRATEGIES FOR CONTROLLING COLOR

The discharge of color is to be regulated such that only such amounts as will not render the waters injurious to public health, secondary recreation, or to aquatic life and the wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses. However, the practical application of this regulation must take into account the various ways in which color is perceived in the environment. Color in natural waters is rarely the result of one specific chemical, rather a mixture of many dissolved and/or suspended constituents contribute to color. Also, the stream bed and sediments may contribute to color. Because color is perceived differently by different people and in different lighting conditions, no general definition of color impairment can be specified by a simple set of criteria.

DWQ is presently working to develop a color monitoring protocol that will allow specific analyses of color in waters of the State. Because textile industries are a significant source of color to waters of the North Carolina including the Cape Fear River Basin, DWQ plans to meet with the North Carolina Textile Manufacturing Association to develop appropriate methodologies for color analysis. This will be followed with a monitoring program with the goal of developing treatment strategies for facilities that are a significant source of colored effluent. Two subbasins that make up the South Fork Catawba River watershed have been targeted in a pilot study to address color. A number of facilities including those in the Cape Fear Basin listed below have been identified for participation in future color monitoring (Table 6.21).

Table 6.21 Facilities identified for color monitoring program.

facility	stream	subbasin
Reidsville	Little Troublesome Creek	03-06-01
Cone Mills	North Buffalo Creek	03-06-02
Burlington East	Haw River	03-06-02
High Point East	Richland Creek	03-06-08
Star WWTP	Cotton Creek	03-06-10
Stevecoknit	Little Rockfish Creek	03-06-22
Guilford East	NE Cape Fear River	03-06-22

6.9 MANAGEMENT STRATEGIES FOR CONTROLLING FECAL COLIFORM

Fecal coliforms are bacteria typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of disease-causing bacteria and viruses. They enter surface waters from a number of sources including failing onsite wastewater systems, broken sewer lines, improperly treated discharges of domestic wastewater, pump station overflows, and runoff carrying livestock and wildlife wastes.

Based on evaluation of fecal coliform data from 69 ambient water quality monitoring sites throughout the basin (monitoring stations sampled by DWQ once a month), 10 sites were found to have bacteria counts where the geometric mean of all samples (minimum of 10 samples) over the last five years exceeded the state standard of 200 / 100 ml. These sites include:

Subbasin 01:	Little Troublesome Creek at SR 2600 near Reidsville (Rockingham County)
Subbasin 02:	Reedy Fork at Ossipee (Alamance County)
"	Haw River at Haw River (Alamance County)
"	Town Branch at SR 2109 near Graham (Alamance County)
"	North Buffalo Creek near Greensboro (Guilford County)
Subbasin 05:	New Hope Creek near Blands (Durham County)
"	Northeast Creek near Nelson (Durham County)

Subbasin 08:	East Fork Deep River at SR 1541 near High Point (Guilford County)
"	Muddy Creek at SR 1936 near New Market (Randolph County)
Subbasin 09:	Deep River at SR 2128 at Worthville (Randolph County)

Also, for the last two years, the Town of Star WWTP in subbasin 10, has been exceeding its fecal coliform limit by extraordinary counts; bacteria counts have consistently been in the thousands and up to 760,000/100 ml in the effluent. These counts are directly affecting the instream fecal coliform levels. Measures have been taken to reduce fecal levels in the effluent. The Town of Star has received fines for the above permit violations and treatment has improved recently.

In addition, approximately 4,800 acres of shellfish (SA) waters in the estuarine portion of the basin have been closed to harvesting by the NC Division of Environmental Health's Shellfish Sanitation Branch due to elevated levels of bacteria. The fecal coliform bacteria standard for shellfish waters is 14/100 ml. Nonpoint sources are reported to be the pollution source for 78% of the impaired estuarine waters with point sources accounting for the remaining 22%. Probable sources of the fecal coliform contamination include urban runoff, failing septic tanks, agriculture, marinas and improperly operating wastewater treatment plants.

Several general recommendations for addressing fecal coliform contamination in both fresh and estuarine waters include:

- Proper maintenance of onsite waste disposal systems (such as septic tanks).
- Maintenance and repair of sanitary sewer lines by WWTP authorities.
- Elimination of direct unpermitted discharges of domestic sewage wastes (also known as "straight pipes") from homes and businesses to streams or stormwater systems.
- Proper management of livestock to keep wastes from reaching surface waters.
- Encouragement of local health departments to routinely monitor waters known to be used for body contact recreation (e.g., swimming and tubing). DWQ has classified 272 miles of streams for primary water contact.

In coastal waters, a major hurdle in controlling fecal coliform contamination and reopening closed shellfish waters has been in identifying the specific sources of bacterial pollution and then ensuring implementation of effective control measures. Because of the high costs of treatment (e.g. replacement of septic systems with centralized wastewater treatment systems or installation of BMPs in urban or agricultural areas), there has been a reluctance to require control measures without being able to document specific sources. However, documentation of sources requires expensive and time-consuming monitoring, and there is little money and insufficient staff time and resources available to pinpoint sources "beyond a reasonable doubt". And third, even when a source has been identified, control of bacteria to meet shellfish water standards may be extremely difficult as in the case of runoff from densely developed areas.

Clearly, if the continued closure of shellfish waters is to be prevented, and the reopening of closed shellfish waters is to be accomplished, there needs to be a concerted effort by state, local and federal government agencies, cooperation of landowners and support by the state legislature to make it happen. Such an effort will require funding, staff time, public education, and probably new regulations aimed clearly at controlling fecal coliform bacteria in the area of shellfish waters. The basinwide planning process is not empowered with the authority to require these actions, however, it does offer the opportunity to draw attention to this issue and to set into motion actions that may lead to positive results.

DWQ has targeted several fecal-coliform impaired coastal water bodies in the Cape Fear Basin in which localized watershed-based planning will be needed to begin to effectively address the problems: Bradley Creek, Howe Creek, Pages Creek, Futch Creek, Virginia Creek, and Mill Creek.

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CHAPTER 7

FUTURE INITIATIVES

7.1 OVERVIEW OF CAPE FEAR BASINWIDE GOALS AND OBJECTIVES

Near-term objectives, or those achievable at least in part during the next five years, include implementing the strategies, or TMDLs (total maximum daily loads) outlined in Chapter 6 to reduce point and nonpoint source loadings of BOD, nutrients and other pollutants. These steps are necessary to progress towards restoring impaired waters, protecting high resource value and biologically sensitive waters and maintaining the quality of other waters currently supporting their uses.

The long-term goal of basinwide management is to protect the water quality standards and uses of the basin's surface waters while accommodating reasonable economic growth.

Attainment of these goals and objectives will require determined, widespread public support; the combined cooperation of state, local and federal agencies, agriculture, forestry, industry and development interests; and considerable financial expenditure on the parts of all involved. However, with the needed support and cooperation, NCDWQ believes that these goals are attainable through the basinwide water quality management approach.

7.2 FUTURE ACTIVITIES IN THE CAPE FEAR RIVER BASIN

7.2.1 Specific Areas in Need of Management Strategies

There are a number of areas within the Cape Fear River Basin in need of future management strategy development. The Division of Water Quality has identified areas it would like to target for study during the next basin planning cycle. These areas may be modified based on comments received from the public on the basin plan. In addition, this list contains a number of items that would require much staff time to adequately evaluate, and therefore some of these issues will probably not be addressed in the next basin plan. The Division would anticipate holding meetings approximately three years prior to the due date of the second Cape Fear Basin Plan to inform the public of any changes in priorities in the basin and to obtain feedback on them. The following areas are tentatively prioritized:

Cape Fear River Below Lock and Dam 1 and Northeast Cape Fear River Below Castle Hayne The Cape River below Lock and Dam #1 has documented measurements of dissolved oxygen of 4 mg/l or less. Many sources may be contributing to these low values. Additional monitoring data should be collected to evaluate the magnitude of water quality impacts from the point source dischargers, the swamp systems in the area, particularly from the Northeast Cape Fear River and the Black River, and the impact from higher salinity waters. A group of dischargers in the area along with the University of North Carolina at Wilmington (UNC-W) have met with state representatives to discuss setting up a monitoring plan in lieu of individual monitoring requirements in NPDES permits. The Division is currently working cooperatively with UNC-W and dischargers in order to develop a Cape Fear River Program. Under this program, which would be conducted under the guidance of the Center for Marine Research at the University of North Carolina at Wilmington, additional sampling stations would be established up and down the river in order to help scientists better understand and provide improved protection to the river's water quality. More

sophisticated modeling than the current QUAL2E may be performed if the data collected through this program indicate it is warranted.

Jordan Lake NSW Strategy Jordan Lake is support-threatened overall, and the lake has been classified as eutrophic. In addition, many tributaries to the lake are impaired (e.g. rated as not supporting or partially supporting their uses). Algal blooms frequently occur in many of the lake arms. Greater emphasis will be placed in the future on nonpoint source programs to control nutrients.

Deep River Nutrients The Deep River has severe nutrient problems, and the Deep River and many of its tributaries have been listed as impaired. The Basin Plan recommends total phosphorus limits for major dischargers in the Deep River watershed. In addition, communication with the agricultural agencies has begun in order to encourage farmers in this watershed to develop and implement nutrient management plans. DWQ will also coordinate with the Division of Water Resources to work towards having dams operated in a run of river mode rather than a peaking mode and that minimum releases from the many reservoirs in the basin are met. This management strategy should be followed up with further monitoring in the basin to determine if improvements are occurring. Finally, the Division should consider developing an NSW strategy for the Deep River watershed that will more explicitly address the point and nonpoint sources of nutrients. DWQ will also suggest to the nonpoint source team set up in this basin that the Deep River be prioritized in their studies (see Section 7.2.3).

Cape Fear River A QUAL2E model has been developed for the Cape Fear mainstem from Buckhorn Reservoir to Lock and Dam 1. There is some uncertainty associated with the model. For example, water quality data collected on the river indicate that instream BOD concentrations remain fairly constant which indicates that little decay is occurring or there are other sources of BOD. In addition, data concerning photosynthesis and retention time behind the dams would be useful in fine-tuning the model.

Haw River Water quality data have been collected on the Haw River to Saxapahaw in light of the number of major dischargers in this watershed (total permitted flow of 74.75 MGD). Further information on oxygen-consuming wastes may be collected on the river to Jordan Lake. These data will then be compiled into a QUAL2E model to evaluate the interaction of the Greensboro WWTPs located in the Buffalo Creek Basin, South Burlington, East Burlington and Graham. The model can then be used to fine tune management strategies for new and expanding dischargers in the area.

Toxicity Limits in Lower Cape Fear Currently a number of discharges to the Cape Fear have received chronic toxicity tests based on an instream waste concentration derived from estimates of advective flow which assumes complete mixing while facilities upstream have received acute tests based on tidal flushing and mixing. Major discrepancies between facilities will be addressed when NPDES permits are renewed. However, DWQ should determine a boundary at which the flow in the river becomes dominated by tidal influences in order to ensure that future recommendations for toxicity limits are objectively based.

Haw Creek Low DO values have been observed on Haw Creek. An investigation of sources including nonpoint sources should be made.

Utley Creek Holly Springs discharges to Utley Creek, a low flow tributary to Harris Lake. Holly Springs' self monitoring data show DO levels as low as 4.8 mg/l below

the discharge. DWQ's empirical desktop model may not adequately predict dissolved oxygen concentrations in this stream, and DWQ should consider developing a QUAL2E model if Holly Springs pursues an expansion in this tributary.

7.2.2 Other NPDES Program Initiatives

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

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

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

7.2.3 Nonpoint Source Control Strategies and Priorities/Nutrient Reduction Efforts

Improving our knowledge of and controlling nonpoint source pollution will be a high priority over the next five years. Nonpoint source pollution, as noted in Section 4.5 in Chapter 4, accounts for the majority of impaired waters in the Cape Fear River Basin. Sediment and nutrients are the most widespread cause of nonpoint source impairment in freshwater streams and lakes.

To address nonpoint sources of pollution, DWQ has begun setting up nonpoint source teams in each of the state's 17 major river basins. These teams will have representatives from agriculture, urban stormwater, construction, mining, on-site wastewater disposal, forestry, solid waste, wetlands, groundwater, the League of Municipalities and wildlife organizations. These teams will provide descriptions of NPS activities within a basin, conduct assessments of NPS controls in targeted watersheds, identify future monitoring sites, develop five-year action plans for NPS pollutants, and develop Section 319 project proposals for targeted watersheds.

Agricultural, urban stormwater, and construction BMPs are particularly needed in the Deep River and its tributaries to address the water quality issues in that particular watershed. This Deep River watershed has been prioritized for further work during the next basin planning cycle, and the NPS team for the Cape Fear River Basin may be asked to consider this watershed for high priority status in developing its strategies.

Reducing nonpoint source nutrient loading to the Jordan Lake Basin will also be a high priority over the next five years. Progress has been seen in reducing point source loadings of total phosphorus to the basin; however, little is known at present on the location and effectiveness of agricultural BMPs that have been implemented in the Jordan Lake watershed in recent years.

Depending on resource availability, NCDWQ would like to evaluate the present NSW nutrient reduction strategy prior to updating the Cape Fear River Basin Plan in 2000 with the objective of developing revised point and nonpoint source nutrient reduction goals. This objective will include

identification of nutrient reduction technologies and associated costs of implementation for both point and nonpoint source pollution. This effort will require continuing close coordination with researchers, baseline water quality monitoring data and obtaining solid information on the location, type, number and effectiveness of agriculture BMPs. NCDWQ is currently working with the USDA Natural Resources Conservation Service to develop hydrologic maps for maintaining agriculture BMP data that will be compatible with the subbasin map units used by NCDWQ. This should prove extremely helpful in gathering the data needed on agricultural BMPs.

7.2.4 Future Monitoring Priorities

Monitoring of the chemical and biological status of receiving waters will provide critical feedback on the success of the basin management strategy. As discussed in Chapter 4, monitoring data will be collected from (1) ambient water chemistry, (2) sediment chemistry, (3) biological communities, (4) contaminant concentrations in fish and other biota, (5) ambient toxicity, and (6) facility self-monitoring data. The specific parameters measured will relate directly to the long-term water quality goals and objectives defined within the basinwide management strategy.

7.3 FUTURE PROGRAMMATIC INITIATIVES

7.3.1 Further Evaluation of Swamp Systems

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

DWQ's desktop dissolved oxygen model is also not an adequate tool to use in a swamp system. It appears that the decay rates assumed in the model are not indicative of swamp systems, and that the predicted reaeration rates under critical flows are low. DWQ would like to develop a model that can be used in channelized swamps that have some degree of slope to allow for one dimensional flow. Work has begun on reviewing swamp models. In addition, DWQ will begin determining which swamp systems may be modelable. Most likely, early analyses will be limited to black water river systems. The Northeast Cape Fear River may be a good river to study in the Cape Fear River basin.

7.3.2 Discharger Association Monitoring

The Division has been encouraging the formation of discharger associations in the lower, mid and upper Cape Fear River Basin for the purpose of obtaining higher quality monitoring data at a lower cost to dischargers. Discharger assocation members would be relieved of having to perform upstream and downstream monitoring on their own. Instead, they would pool the money otherwise spent on this monitoring, and would contract with a professional firm to conduct intensive data collections at times and locations agreed upon by DWQ and the association. One important benefit of the data would be to improve the predictive water quality models used by DWQ to determine waste limits for many dischargers in the basin. A discharger monitoring program has been established in the lower Cape Fear River Basin (below Lock and Dam #1) as part of the Cape Fear Program at UNC-Wilmington. The Cape Fear Program is a comprehensive research program that is examing both the water quality and ecological aspects of the lower Cape Fear River. Effort are underway to establish dischargers assocations in the mid and upper reaches of the basin.

7.3.3 Promotion of Non-Discharge Alternatives/Regionalization

NCDWQ requires all new and expanding dischargers to submit an alternatives analysis as part of its NPDES permit application. Non-discharge alternatives, including tying on to an existing WWTP or land-applying wastes are preferred from an environmental standpoint. If the Division determines that there is an economically reasonable alternative to a discharge, DWQ may recommend issuance of the NPDES permit.

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

NCDWQ is in the process of centralizing and improving its computer data management systems. Most of its Water Quality Program data including permitted dischargers, waste limits, compliance information, water quality data, stream classifications, and so on, will be put in a central data center which will then be made accessible to most staff at desktop computer stations. Much of this information is also being entered into the state's GIS computer system (Center for Geographic Information and Analysis or CGIA). As this and other information is made available to the GIS system, including land use data from satellite or air photo interpretation, and as the system becomes more user friendly, the potential to graphically display the results of water quality data analysis will be tremendous.

Research Triangle Institute is performing a pilot study in the Tar-Pamlico River Basin in which high priority waterbodies for nonpoint source control programs are mapped. These maps will be used by the various nonpoint source agencies for planning purposes. As resources become available, this tool will be developed for other basins.

7.3.5 Water Supply Planning/Interbasin Transfers

A water supply plan for the Jordan Reservoir and the Cape Fear River needs to developed. Water quantity in the basin needs to be managed in order to ensure an adequate and clean supply of water and healthy ecosystem while providing adequate waste assimilative capacity for dischargers. As noted in Chapter 2, public water supply users are predicting a doubling of their water supply needs by the year 2020. This is a critical and ongoing issue that needs to be addressed in future updates of the plan. It is anticipated that the Division of Water Resources will take the lead in developing a plan and that it will include input from water authorities, local governments and other basin stakeholders.

7.3.6 Integrate Wetlands, Groundwater and Atmospheric Deposition into Basinwide Planning in the Cape Fear Basin

Research is being conducted in other basins to assess the impacts of groundwater and atmospheric deposition on water quality. The prime pollutant of concern is nitrogen loading to lakes and estuaries. Livestock operations are a potential source for both atmospheric and groundwater nutrient loading.

On wetland, the general assembly passed a bill in 1996 calling for developing of basinwide wetland restoration plans beginning in 1997. As the program develops, its findings will be applied to future updates of the basin plan.

7.3.7 Increasing Public Participation and Stakeholder Involvement in the Basinwide Planning Process

Protection and enhancement of water quality is a shared need and a responsibility of all those who work, reside or recreate in the basin. Communication of ideas, conducting

research, sharing information, solving problems cost-effectively with minimal regulation, and balancing the needs of various stakeholder groups are all necessary for long-term success. Basinwide planning can assist in meeting these needs but the planning process and products will need to be improved. Below are several recommended improvements to be undertaken during the next basinwide planning cycle for the Cape Fear basin.

- More clearly define the role for citizen participation in basinwide planning
- Ensure active interaction between DWQ staff and other basin programs and organizations
- Increase state staff involved in public outreach so as to provide better opportunities for communication between stakeholders and the state.
- Produce more user-friendly basin plans and associated reports in order to enhance public interest and understanding in water quality protection.

APPENDIX 1

CONTENTS:

- Summary of North Carolina's Water Quality Classifications and Standards

- Anti-Degradation Policy and High Quality Waters (15A NCAC 2B .0201)

- Outstanding Resource Waters (15A NCAC 2B .0216)

SUMMARY OF NORTH CAROLINA'S WATER QUALITY CLASSIFICATIONS AND STANDARDS

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
Freshwater:				
Class C (standards apply to all freshwaters, unless preempted by more stringent standard for more protective classification)	Secondary recreation (including swimming on an unorganized or infrequent basis); fish and other aquatic life propagation and survival; agriculture and other uses, except for primary recreation, water supply or other food - related uses	See attached Table 1.; WATER QUALITY STANDARDS FOR FRESHWATER CLASSES; standards listed under "Standards For All Freshwaters" column (aquatic life and human health sections) apply to Class C waters, unless preempted by more protective standard.	Stormwater Disposal Rules apply in the 20 coastal counties as described in 15A NCAC 2H .1000	
Class B	Primary recreation (swimming on an organized or frequent basis) and all uses specified for Class C (and not water supply or other food-related uses)	Same as for Class C	Same as for Class C	Wastewater treatment reliability requirements (dual train design; backup power capability) may apply to protect swimming uses (15A NCAC 2H .0124)
WS-I Water Supply NOTE: Revised water supply classifications and standards effective as of 8/3/92	Water supplies in natural and undeveloped watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; no point sources except groundwater remediation when no alternative exists	Not applicable since watershed is undeveloped	No landfills, sludge/residual or petroleum contaminated soils application allowed in watershed
WS-II Water supply	Water supplies in predominantly undeveloped watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; only general permit wastewater discharges allowed in watershed and groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(d): 2-acre lots or 6% built-upon area in critical area; 1-acre lots or 12% built-upon area outside of critical area; up to 64% in the critical area and 30% built upon area outside of the critical area allowed with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area and no new discharging landfills outside of critical area; no new sludge/ residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required; spill containment structures required for new industries in the critical area using, storing or manufacturing hazardous materials
WS-III Water Supply	Water supplies in low to moderately developed watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; general permits allowed throughout watershed, domestic and non-process industrial outside of the critical area, groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(e): 1-acre lots or 12% built-upon area in critical area; ½-acre lots or 24% built-upon outside of critical area; up to 30% in critical area and 50% built-upon area outside critical area with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area and no new discharging landfills outside of the critical area; no new sludge/ residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required; spill containment structures required for new industries in the critical area using, storing or manufacturing hazardous materials

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

PRIMARY CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
WS-IV Water Supply	Water supplies in moderately to highly developed watersheds	See Table 1. under "More Stringent Standards to Support Additional Uses": WS Classes heading; general permits, domestic and industrial discharges allowed throughout water supply [2]; groundwater remediation discharges allowed when no alternative exists	Local land management program required as per 15A NCAC 2B .0211(f): ½-acre lots or 24% built-upon area in critical area and protected area [3,4]; up to 50% in critical area and 70% built-upon area outside critical area with engineered stormwater controls for the 1" storm[1]	Buffers required along perennial waters; no new landfills allowed in the critical area; no new sludge/residual or petroleum contaminated soils application allowed in the critical area; hazardous material and spill/failure containment plan required
WS-V Water Supply	River segment	No categorical restrictions on development or wastewater dischargers. Instream water quality standards for water supply waters are applicable.		

NOTE: Please refer to 15A NCAC 2B .0101, .0104, .0202, .0211 and .0301 for more specific requirements for surface water supply protection.

1 If the high density development option is utilized, then wet detention basins are required and local governments will assume ultimate responsibility for the operation and maintenance of these engineered stormwater control structures.

2 New industrial process wastewater discharges in the critical area are allowed but must meet additional treatment requirements.

3 Applies to projects requiring an Erosion/Sedimentation Control Plan.

4 1/3 acre or 36% built-upon area is allowed for projects without a curb and gutter street system in the protected area.

- Critical area is ½ mile and draining to water supplies from normal pool elevation of reservoirs, or ½ mile and draining to a river intake.
- Protected area is 5 miles and draining to water supplies from normal pool elevation of reservoirs, or 10 miles upstream of and draining to a river intake.
- Agricultural activities are subject to provisions of the Food Security Act of 1985 and the Food, Agriculture, Conservation and Trade Act of 1990. In WS-I watersheds and critical areas of WS-II, WS-III and WS-IV areas, agricultural activities must maintain a 10 foot vegetated buffer or equivalent control, and animal operations >100 animal units must use BMPs as determined by the Soil and Water Conservation Commission.
- Silviculture activities are subject to the provisions of the Forest Practices Guidelines Related to Water Quality (15A NCAC 1I .0101-.0209).
- The Department of Transportation must use BMPs as described in their document, "Best Management Practices for Protection of Surface Waters".

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

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

Supplemental Classifications are added to the primary classifications as appropriate (Examples include Class C-NSW, Class SA-ORW, Class B-Trout, etc.) and impose additional requirements.

SUPPLEMENTAL CLASSIFICATIONS	BEST USAGE	NUMERIC STANDARDS	STORMWATER CONTROLS	OTHER REQUIREMENTS
High Quality Waters (HQW) (categories: (1) waters rated as Excellent by DEM; (2) Primary Nursey Areas; (3) Native or Special Native Trout Waters; (4) Critical Habitat Areas; (5) WS-I and WS-II water supplies; (6) SA waters)	Waters with quality higher than the standards (EPA's Tier II waters; the minimum standards for Class C and SC define Tier I); see Standards and Stream Classifications Rules (15A NCAC 2B .0100) for detailed description (15A NCAC 2B .0101(e)(5))	For new or expanded discharges, advanced treatment requirements are: BOD_5=5 mg/l; NH_3-N= 2 mg/l; DO=6 mg/l	Projects requiring Erosion/ Sedimentation Control Plan and are within 1 mile and draining to HQW waters: 1-acre lots or 12% built-upon area, or higher density with engineered structural controls (wet detention ponds); WS-I, WS-II and 20 coastal counties exempt since stormwater control requirements already apply	Other treatment requirements may apply, dependent upon type of discharge and characteristics of receiving waters (see pp. 1 and 2 of Section .0200 Rules: 15A: NCAC 2B .0201(d) of Antidegradation Policy)
Outstanding Resource Waters (ORW)	Unique and special waters having exceptional water quality and being of exceptional state or national ecological or recreational significance; must meet other certain conditions and have 1 or more of 5 outstanding resource value criteria as described in Rule 2B .0216	Water quality must clearly maintain and protect uses, including outstanding resource values; management strategies must include at a minimum: no new or expanded discharges to freshwater ORWs; some discharges may be allowed in coastal areas	Same as for High Quality Waters for Freshwater ORWs; for Saltwater ORWs, development activities within a 575' buffer must comply with the low density option of Stormwater Disposal Rules (generally, 25% built-upon area around SA waters and 30% around other waters)	Other management strategy components as described in Rule .0216
Trout Waters (Tr)	Protected for natural trout propagation and survival of stocked trout;	More protective standards for cadmium, total residual chlorine, chlorophyll-a, dissolved oxygen, turbidity and toluene to protect these sensitive species (see Table 1. under "Trout" heading)		
Nutrient Sensitive Waters (NSW)	Waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation	No increase of nutrients over background levels		Nutrient management strategies developed on a case-by-case basis
Swamp Waters (Sw)	Waters with low velocities and other characteristics different from other waterbodies (generally, low pH, DO, high organic content)	pH as low as 4.3 and DO less than 5 mg/l allowed if due to natural conditions		

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TABLE 1. WATER QUALITY STANDARDS FOR FRESHWATER CLASSES

Parameters	Standards For All Freshwater:		More Stringent Standards To Support Additional Uses	
	Aquatic Life	Human Health	WS Classes	Trout
Arsenic (ug/l)	50			
Barium (mg/l)			1.0	
Benzene (ug/l)		71.4	1.19	
Beryllium (ng/l)		117	6.8	
Cadmium (ug/l)	2.0			0.4
Carbon tetrachloride (ug/l)		4.42	0.254	
Chloride (mg/l)	230 (AL)		250	
Chlorinated benzenes (ug/l)			488	
Chlorine, total residual (ug/l)	17 (AL)			17
Chlorophyll a, corrected (ug/l)	40 (N)			15 (N)
Chromium, total (ug/l)	50			
Coliform, total (MFTCC/100ml)			50 (N)(2)	
Coliform, fecal (MFTCC/100ml)		200 (N)		
Copper (ug/l)	7 (AL)			
Cyanide (ug/l)	5.0			
Dioxin (ng/l)		0.000014	0.000013	
Dissolved gases	(N)			
Dissolved oxygen (mg/l)	5.0 (Sw)(1)			6.0
Fluoride (mg/l)	1.8			
Hardness, total (mg/l)			100	
Hexachlorobutadiene (ug/l)		49.7	0.445	
Iron (mg/l)	1.0 (AL)			
Lead (ug/l)	25 (N)			
Manganese (ug/l)			200	
MBAS (ug/l) (Methylene-Blue-Active Substances)	500			
Mercury (ug/l)	0.012			
Nickel (ug/l)	88		25	
Nitrate nitrogen (mg/l)			10	
Pesticides				
Aldrin (ng/l)	2.0	0.136	0.127	
Chlordane (ng/l)	4.0	0.588	0.575	
DDT (ng/l)	1.0	0.591	0.588	
Demeton (ng/l)	100			
Dieldrin (ng/l)	2.0	0.144	0.135	
Endosulfan (ng/l)	50			
Endrin (ng/l)	2.0			
Guthion (ng/l)	10			
Heptachlor (ng/l)	4.0	0.214	0.208	
Lindane (ng/l)	10			
Methoxychlor (ng/l)	30			
Mirex (ng/l)	1.0			
Parathion (ng/l)	13			
Toxaphene (ng/l)	0.2			
2,4-D (ug/l)			100	
2,4,5-TP (Silvex) (ug/l)			10	
pH (units)	6.0-9.0 (Sw)			
Phenolic compounds (ug/l)		(N)	1.0 (N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079		
Polynuclear aromatic hydrocarbons (ng/l)		31.1	2.8	
Radioactive substances		(N)		
Selenium (ug/l)	5			
Silver (ug/l)	0.06 (AL)			
Solids, total dissolved (mg/l)			500	
Solids, suspended	(N)			
Sulfates (mg/l)			250	
Temperature	(N)			
Tetrachloroethane (1,1,2,2) (ug/l)		10.8	0.172	
Tetrachloroethylene (ug/l)			0.8	
Toluene (ug/l)	11			0.36
Toxic Substances	(N)			
Trialkyltin (ug/l)	0.008			
Trichloroethylene (ug/l)		92.4	3.08	
Turbidity (NTU)	50; 25 (N)			10 (N)
Vinyl chloride (ug/l)		525	2	
Zinc (ug/l)	50 (AL)			

Note: (N) See 2B .0211 (b), (c), (d), or (e) for narrative description of limits.

(AL) Values represent action levels as specified in .0211 (b)(4).

(Sw) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.

(1) An instantaneous reading may be as low as 4.0 ug/l but the daily average must be 5.0 ug/l or more.

(2) Applies only to unfiltered water supplies.

TABLE 2. WATER QUALITY STANDARD FOR SALTWATER CLASSES

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

Note: (N) See 2B .0212 (b), (c), or (d) for narrative description of limits.
(AL) Values represent action levels as specified in .0212(b)(4).
(1) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.

HIGH QUALITY WATERS

Excerpt from Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina 15 NCAC 2B .0200

.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 following procedures will be implemented in order to meet the requirements of this part:

(1) New or expanded wastewater discharges in High Quality Waters will comply with the following:

(A) Discharges from new single family residences will be prohibited. Those that must discharge will install a septic tank, dual or recirculating sand filters, disinfection and step aeration.

(B) All new NPDES wastewater discharges (except single family residences) will be required to provide the treatment described below:

(i) Oxygen Consuming Wastes: Effluent limitations will be 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 than 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.

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) will 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 will 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 will 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 will 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 will 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 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 of 90 percent as measured by the North Carolina "Pass/Fail Methodology for Determining Acute Toxicity in a Single Effluent Concentration". Ammonia toxicity will be evaluated according to EPA guidelines promulgated in the Ammonia Criteria Development Document (1986); EPA document number 440/5-85-001; NTIS number PB85-227114; July 29, 1985 (50 FR 30784).

(C) All expanded NPDES wastewater discharges in High Quality Waters will be required to provide the treatment described in part (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) will be required to control runoff from the one inch design storm as follows:

(A) Low Density Option: Developments which limit single family developments to one acre lots and other type developments to 12 percent built-upon area, have no stormwater collection system as defined in 15A NCAC 2H .1002(13), and have built-upon areas at least 30 feet from surface waters will be deemed to comply with this requirement, unless it is determined that additional runoff control measures are required to protect the water quality of High Quality Waters necessary to maintain existing and anticipated uses of those waters, in which case more stringent stormwater runoff control measures may be required on a case-by-case basis. Activities conforming to the requirements described in 15A NCAC 2H .1003(a) [except for Subparagraphs (2) and (3) which apply only to waters within the 20 coastal counties as defined in 15A NCAC 2H .1002(9)] will also be deemed to comply with this requirement, except as provided in the preceding sentence.

(B) High Density Option: Higher density developments will be allowed if stormwater control systems utilizing wet detention ponds as described in 15A NCAC 2H .1003(i), (k) and (l) are installed, operated and maintained which control the runoff from all built-upon areas generated from one inch of rainfall, unless it is determined that additional runoff control measures are required to protect the water quality of High Quality Waters necessary to maintain existing and anticipated uses of those waters, in which case more stringent stormwater runoff control measures may be required on a case-by-case basis. The size of the control system must take into account the runoff from any pervious surfaces draining to the system.

(C) All waters classified WS-I or WS-II and all waters located in the 20 coastal counties as defined in Rule 15A NCAC 2H .1002(9) are excluded from this requirement since they already have requirements for nonpoint source controls.

If an applicant objects to the requirements to protect high quality waters and believes degradation is necessary to accommodate important social and economic development, the applicant can contest these requirements according to the provisions of G.S. 143-215.1(e) and 150B-23.

(e) Outstanding Resource Waters (ORW) are a special subset of **High Quality Waters** with unique and special characteristics as described in Rule .0216 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.

0216 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 will 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 will 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 will be required to control stormwater runoff as follows:

(A) Low Density Option: Developments which limit single family developments to one acre lots and other type developments to 12 percent built-upon area, have no stormwater collection system as defined in 15A NCAC 2H .1002(13), and have built-upon areas at least 30 feet from surface water areas will be deemed to comply with this requirement, unless it is determined that additional runoff control measures are required to protect the water quality of Outstanding Resource Waters necessary to maintain existing and anticipated uses of those waters, in which case such additional stormwater runoff control measures may be required on a case-by-case basis.

(B) High Density Development: Higher density developments will be allowed if stormwater control systems utilizing wet detention ponds as described in 15A NCAC 2H .1003(i), (k) and (l) are installed, operated and maintained which control the runoff from all built-upon areas generated from one inch of rainfall, unless it is determined that additional runoff control measures are required to protect the water quality of Outstanding Resource Waters necessary to maintain existing and anticipated uses of those waters, in which case such additional stormwater runoff control measures may be required on a case-by-case basis. The size of the control system must take into account the runoff from any pervious surfaces draining to the system.

(2) Saltwater: Water quality conditions shall clearly maintain and protect the outstanding resource values of waters classified ORW. Management strategies to protect resource values will be developed on a site-specific basis during the proceedings to classify waters as ORW. At a minimum, new development will comply with the low density options as specified in the Stormwater Runoff Disposal rules [15A NCAC 2H .1003(a)(2)] within 575 feet of the mean high water line of the designated ORW area. New non-discharge permits will be required to meet reduced loading rates and increased buffer zones, to be determined on a case-by-case basis. No dredge or fill activities will 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 will be considered on a site specific basis during the proceedings to classify waters as ORW and will be specified in Paragraph (e) of this Rule. These actions may include anything within the powers of the commission. The commission will 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 will 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 will initiate public proceedings to classify waters as ORW or will 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 will have only new development which complies with the low density option in the stormwater rules as specified in 15A NCAC 2H .1003(a)(2) within 575 feet of the Roosevelt Natural Area (if the development site naturally drains to the Roosevelt Natural Area).

(2) Chattooga River ORW Area (Little Tennessee River Basin and Savannah River Drainage Area): the following undesignated waterbodies that are tributary to ORW designated segments shall comply with Paragraph (c) of this Rule in order to protect the designated waters as per Rule .0203 of this Section. However, expansions of existing discharges to these segments will 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 Rule .0216(c)(1), will be applied to protect the designated ORW areas:

(A) Stormwater controls described in Rule .0216(c)(1) will 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 will 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 will not exceed 50 percent of the total instream flow in the designated ORW under 7Q10 conditions;

(ii) a safety factor will be applied to any chemical allocation such that the effluent limitation for a specific chemical constituent will 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 will 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 will comply with the following:

(i) Oxygen Consuming Wastes: Effluent limitations will be as follows: BOD = 5 mg/1, and NH3-N = 2 mg/1;

(ii) Total Suspended Solids: Discharges of total suspended solids (TSS) will be limited to effluent concentrations of 10 mg/1 for trout waters and to 20 mg/1 for all other waters;

(iii) Emergency Requirements: Failsafe treatment designs will 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 over-enrichment is projected to be a concern, appropriate effluent limitations will 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 Rule .0216(c) of this Section in order to protect the designated waters as per Rule .0203 of this Section.

APPENDIX II

CONTENTS:

DEM Water Quality Monitoring Programs:

- **Benthic Macroinvertebrate Sampling**
- **Fisheries Studies**
- **Lakes Assessment**
- **Whole Effluent Toxicity Testing**

A-II.1 BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates, or benthos, are organisms, mostly aquatic insect larvae, that live in and on the bottom substrates of rivers and streams. The use of benthos data has proven to be a reliable monitoring tool as benthic macroinvertebrates are sensitive to subtle changes in water quality. Since many taxa in a community have life cycles of six months to one year, the effects of short term pollution (such as a spill) will generally not be overcome until the following generation appears. The benthic community also integrates the effects of a wide array of potential pollutant mixtures.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S). 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. Higher taxa richness values are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is poorly assessed by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal) within North Carolina.

Classification Criteria by Ecoregion*

A. EPT taxa richness values

	10-sample Qualitative Samples			4-sample EPT samples		
	Mountains	Piedmont	Coastal	Mountains	Piedmont	Coastal
Excellent	>41	>31	>27	>35	>27	>23
Good	32-41	24-31	21-27	28-35	21-27	18-23
Good-Fair	22-31	16-23	14-20	19-27	14-20	12-17
Fair	12-21	8-15	7-13	11-18	7-13	6-11
Poor	0-11	0-7	0-6	0-10	0-6	0-5

B. Biotic Index Values (Range = 0-10)

	Mountains	Piedmont/Coastal
Excellent	<4.18	<5.24
Good	4.17-5.09	5.25-5.95
Good-Fair	5.10-5.91	5.96-6.67
~~Fair~~	~~5.92-7.05~~	~~6.68-7.70~~
Poor	>7.05	>7.71

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

All the benthic macroinvertebrate collections in the Cape Fear River basin between 1983 and 1993 are presented in Chapter 4. They include site location, DEM classification schedule Index Number, collection date, taxa richness and biotic index values, and bioclassifications. Final bioclassifications assigned may take into account seasonal correction of both EPT taxa richness and Biotic Index value if the sample is collected outside of summer. Bioclassifications listed in this report may differ from older reports because evaluation criteria have changed since 1983. Originally, total taxa richness and EPT taxa richness criteria were used, then just EPT taxa richness, and now BI as well as EPT taxa richness criteria are used. Refinements of the criteria continue to occur as more data are gathered.

A-II.2 FISHERIES

To the public, the condition of the fishery is one of the most meaningful indicators of water quality. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by chemical and physical changes in the environment. Water quality conditions that significantly affect lower levels of the food web will affect the abundance, species composition, and condition of the fish population.

A-II.2.1 Fish Community Structure Methods

The North Carolina Index of Biotic Integrity (NCIBI) is a modification of Karr's IBI (1981) which was developed as a method for assessing a 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 NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

The assessment of biological integrity using IBI is provided by the cumulative assessment of 12 parameters, or metrics. The values provided by the metrics are converted into scores on a 1, 3, 5 scale. A score of 5 represents conditions expected for undisturbed streams in the area, while a score of 1 indicates that the conditions vary greatly from those expected in undisturbed streams of the region. The scores for each metric are summed to attain the overall IBI score.

Each metric is designed to contribute unique information to the overall assessment. A discussion of each metric is presented below; some metrics have been grouped together.

1. The total number of species and individuals supported by streams of a given size in a given region decrease with environmental degradation.
2. Darters are sensitive to environmental degradation particularly as a result of their specific reproductive and habitat requirements. Darter habitats are degraded as a result of channelization, siltation, and reduced oxygen levels. Collection of fewer than expected darter species can indicates that some habitat degradation is occurring.
3. Sunfish species are used because they are particularly responsive to degradation of pool habitats and to other aspects of habitat degradation like quality of instream cover.
4. Sucker species are intolerant of habitat and chemical degradation and, because they are long lived, provide a multiyear integrated perspective.
5. Intolerant species are those which are most effected by environmental perturbations and therefore should have disappeared, at least as viable populations, by the time a stream is degraded to a fair rating.
6. Tolerant species are those which are often present in a stream in moderate numbers, but as the stream degrades they tend to dominate.
7. The three trophic composition metrics, proportion of omnivores, insectivores, and piscivores, are used to measure the divergence from expected production and consumption patterns in the fish community that can result from environmental degradation. The main cause for a shift in the trophic composition of the fish community (a greater proportion of omnivores and few insectivores) is nutrient enrichment.

8. The proportion of fish with disease, tumors, fin damage, and skeletal anomalies increases as a stream is degraded. The length distribution metric measures the amount of reproduction which is occurring in the community by looking at the number of age groups, determined by length range, present for each species.

A field methodology for fish collections to be used for NC IBI is included in the standard operating procedures of the NC Division of Environmental Management (NCDEM, 1989). A representative section of stream, 600 feet in length, is selected, measured, and blocked at the upstream and downstream ends with small mesh nets. The stream is then sampled with one or two backpack electrofishing units depending upon stream width. After collection, the fish are examined for sores, lesions, fin damage, and skeletal anomalies and preserved in 10% formalin. Once preserved the fish are identified to species, length recorded, and batch weighed by species.

Streams with larger watersheds or drainage areas can be expected to support more fish species and a larger number of fish. Figures 1 and 2 represent the relative number of species and number of fish that can be expected in the North Carolina river basins. Table 2 presents a summary of fish community assessment data from 1980 to 1993 for each sampling location in the basin.

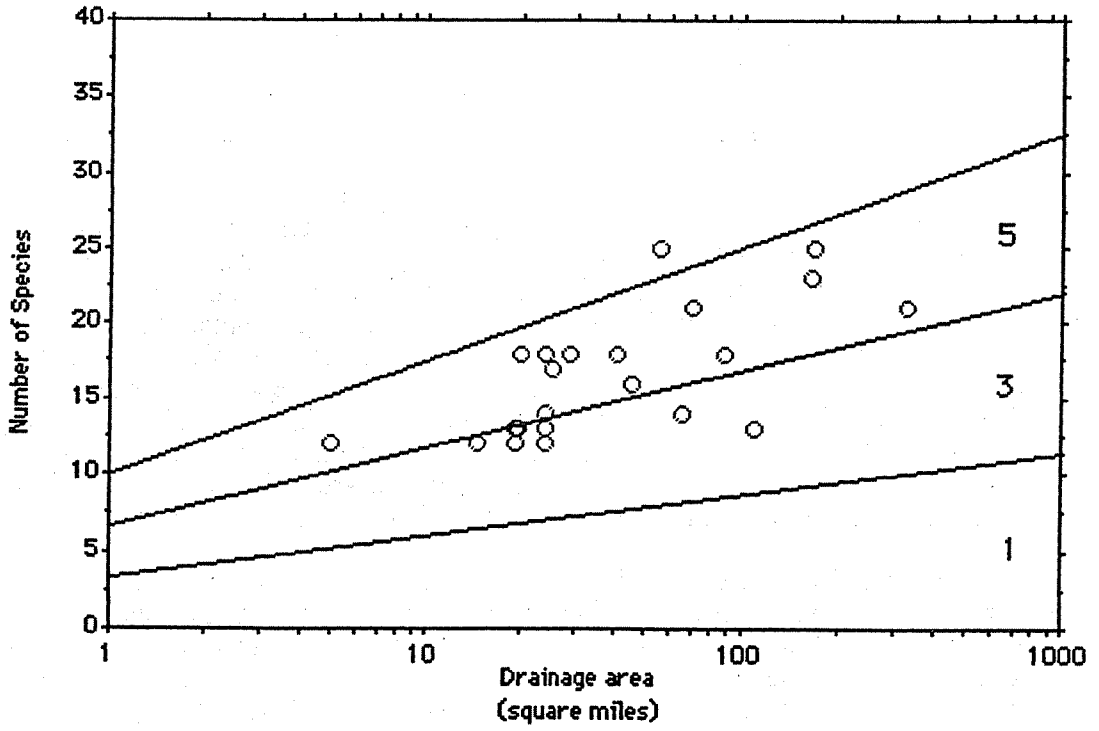

Figure 1. Expectations of the Number of Species based upon Drainage Area Size

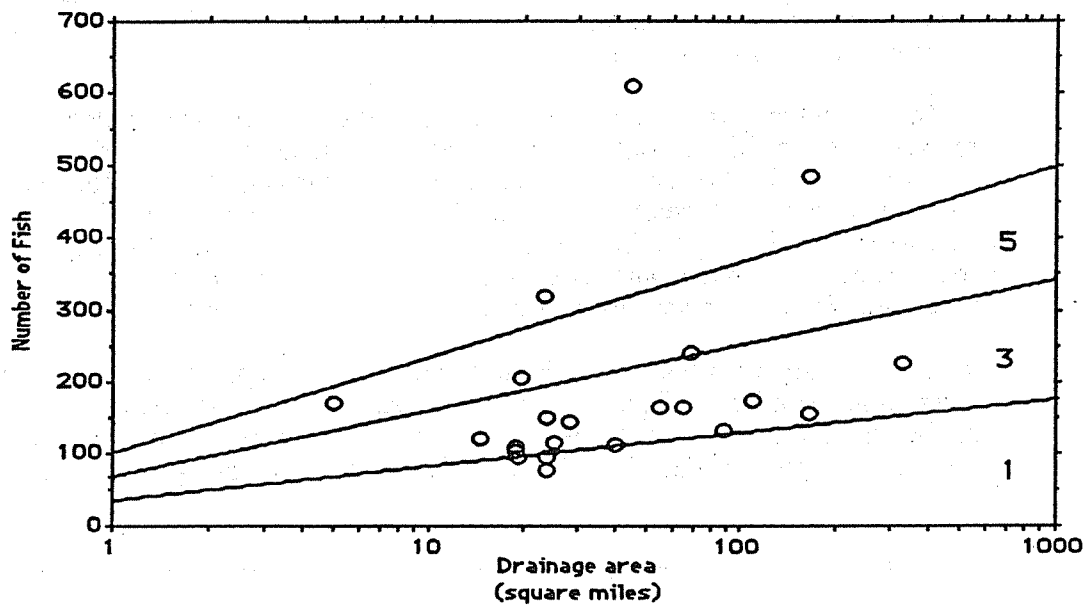

Figure 2. Expectations of the Number of Fish based upon Drainage Area Size

FISH TISSUE ANALYSES

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. Once 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. Thus results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water. Fish tissue analysis results are also used as indicators for human health concerns and fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem. 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.

In evaluating fish tissue analysis results, several different types of criteria are used. Currently human health concerns related to fish consumption are screened by comparing results with Federal Food and Drug Administration (FDA) action levels. 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 below. Individual parameters which appear to be of potential human health concern are evaluated by the N.C. Division of Epidemiology by request of the Water Quality Section.

Metals

	FDA		FDA
Cadmium	None	Chromium	None
Nickel	None	Lead	None
Copper	None	Arsenic	None
Mercury	1.0 mg/kg	Selenium	None

Synthetic Organics

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

The USEPA is currently developing screening values for target analytes which are formulated from a risk assessment procedure. The EPA screening value for a particular analyte is the concentration of that analyte in edible fish tissue that is associated with a maximum limit of acceptable health risk to the general population or subpopulation of concern.

A-II.3 LAKES ASSESSMENT PROGRAM

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

Tables presented in each subbasin summarize data used to determine the trophic status and use support status of each lake. These determinations are based on information from the most recent summertime sampling (date listed). The most recent North Carolina Trophic State Index (NCTSI) value is shown, followed by the descriptive trophic state classification (O=oligotrophic, M=mesotrophic, E=eutrophic, H=hypereutrophic, D=dystrophic).

Numerical indices are often used to evaluate the trophic status of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NRCD 1982). The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), Secchi depth (SD in inches), and chlorophyll-a (CHL in µg/l). Lakewide means for these parameters are integrated 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 are also skewed by the highly colored water typical of dystrophic lakes. These acidic, "black-water" lakes are scattered throughout the coastal plain, often located in swampy areas or overlying peat deposits.

A-II.4 WHOLE EFFLUENT TOXICITY TESTING

Table A-II.1 NPDES Facilities in the Cape Fear River Basin Required to Conduct Whole Effluent Toxicity Testing

Sub-Basin	Facility	NPDES #	Receiving Stream	County	Permitted Flow	% IWC
CPF01	Episcopal Diocese Camp	NC0046019/001	UT To Haw River	Rockingham	0.015	100.0
	Glen Raven Mills	NC0003913/001	Haw River	Alamance	0.09	1.6
	Pentecostal Holiness Ch.	NC0046809/001	UT Benaja Creek	Guilford	0.02	30.6
	Reidsville WWTP	NC0024881/001	Little Troublesome Crk	Rockingham	5.0	97.0
CPF02	Amoco Oil Co.	NC0003671/001	UT Horsepen Crk	Guilford	NA	100.0
	Brin-Mont Corporation	NC0084778/001	UT N. Buffalo Creek	Guilford	0.110	100
	Burlington East WWTP	NC0023868/001	Haw River	Alamance	12.0	35.63
	Burlington-South WWTP	NC0023876/001	Big Alamance Creek	Alamance	12.0	86
	Cone Mills Greensb.-001	NC0000876/001	N. Buffalo Creek	Guilford	1.25	79
	Graham WWTP	NC0021211/001	Haw River	Alamance	3.50	14
oro - N Buffalo						Greensb
325/001 Buffalo Creek						NC0024 N. Guilford 16.0 96.50
	Greensboro Osborne	NC0047384/001	S. Buffalo Crk	Guilford	20.0	93.08
	Lawrence Industries	NC0084328/001	UT Haw Creek	Alamance	0.120	100
	Mebane WWTP	NC0021474/001	Moadams Crk	Alamance	1.20	100
	Monarch Hosiery	NC0001210/001	Reedy Fork Crk	Alamance	0.05	0.16
	Petroleum Fuel Co.	NC0071463/001	UT Horsepen Creek	Guilford	NA	100.00
	Worth Chemical Corp.	NC0078000/001	UT S. Buffalo Creek	Guilford	0.216	21.8
CPF05	Durham Co.-Triangle	NC0026051/001	Northeast Crk	Durham	3.0	100.00
	Durham-Farrington Rd.	NC0047597/001	New Hope Creek	Durham	20.00	99.52
CPF06	OWASA/Mason Farm	NC0025241/001	Morgan Crk	Orange	8.0	92.54
	UNC-CH Power Plant	NC0025305/001	UT Morgan Crk	Orange	—	100.00
CPF07	Allied Chem. Corp./002	NC0001899/002	UT To Shaddox Creek	Chatham	N/A	100.0
	Allied Signal Fibers	NC0001899/001	Haw River	Chatham	0.244	0.94
	Broadway WWTP	NC0059242/001	Daniels Creek	Lee	0.16	83
	Buies Creek WWTP	NC0030091/001	Cape Fear River	Harnett	0.50	0.13
	CP&L-Cape Fr S.E./007	NC0003433/007	UT Cape Fear River	Chatham	180.7	100.0
	CP&L-Sh. Harris Env.Ct	NC0026735/001	Harris Lake	Wake	0.014	NA
	CP&L-Sh. Harris/006	NC0039586/006	Harris Reservoir	Chatham	17.05	NA
	Fuquay-Varina/ Kenn. Br	NC0028118/001	Kenneth Creek	Wake	1.20	100.00
	Lillington WWTP	NC0021636/001	Cape Fear River	Harnett	0.6	0.17
	Neste Resins Corp.	NC0000892/001	Haw River	Chatham	0.1000	0.39
CPF08	Amerada Hess (Greensb.)	NC0069256/001	UT E Fork Deep River	Guilford	NA	NA
	Colonial Pipeline/001	NC0031046/001	UT E Fork Deep River	Guilford	NA	100.0
	Colonial Pipeline/002	NC0031046/002	UT E. Fork Deep River	Guilford	NA	100.0
	Colonial Pipeline/003	NC0031046/003	UT E. Fork Deep River	Guilford	NA	100.0
	Colonial Pipeline/004	NC0031046/004	UT E. Fork Deep River	Guilford	NA	100.0
	Colonial Pipeline/005	NC0031046/005	UT E. Fork Deep River	Guilford	NA	100.0
	Colonial Pipeline/006	NC0031046/006	UT E. Fork Deep River	Guilford	NA	100.0
	Conoco, Inc. Greensb.	NC0074578/001	UT Long Branch	Guilford	.0067	100.00

	Exxon /Tank Farm-Gree.	NC0000795/001	UT East Fork Deep River	Guilford	NA	100.0
	GNC Energy Corp/ 001	NC0074241/001	UT E. Fork Deep River	Guilford	VAR	100.00
	Hidden Forrest Est. MHP	NC0065358/001	UT Deep River	Randolph	0.027	NA
	High Point Eastside	NC0024210/001	Richland Crk	Guilford	16.00	96.11
	LCP Plastics	NC0036366/001	UT W Fk Deep River	Guilford	NA	100.0
	Louis Dreyfus Energy	NC0026247/001	UT East Fork Deep River	Guilford		NA
	Plantation Pipeline (001)	NC0051161/001	UT E Fork Deep River	Guilford		NA
	Plantation Pipeline (002)	NC0051161/002	UT E Fork Deep River	Guilford		NA
	Randleman WWTP	NC0025445/001	Deep River	Randolph	1.745	35.0
	Texaco Refining/Star En.	NC0022209/001	UT Long Branch	Guilford		100.00
	Triad Terminal Co.	NC0042501/001	UT E Fork Deep River	Guilford	VAR	100.00
CPF09	Asheboro WWTP	NC0026123/001	Haskett's Creek	Randolph	6.0	100.00
	Ramseur WWTP	NC0026565/001	Deep River	Randolph	0.48	6.34
	Thomasville Furniture	NC0084816/001	UT Polecat Cr.	Guilford	0.0288	100
CPF10	Robbins WWTP	NC0062855/001	Deep River	Moore	1.0	8.9
	Star WWTP	NC0058548/001	Cotton Creek	Montgomery	0.60	100.00
CPF11	Golden Poultry	NC0072575/001	Deep River	Lee	1.0	9.1
	Sanford-Big Buffalo	NC0024147/001	Deep River	Lee	6.8	39
CPF12	Siler City WWTP	NC0026441/001	Loves Creek	Chatham	4.0	92
CPF13	Dunn/Blackriver WWTP	NC0043176/001	Cape Fear River	Harnett	3.75	0.79
	Erwin WWTP	NC0064521/001	Cape Fear River	Harnett	1.2	0.2
	Swift Textiles	NC0001406/001	Cape Fear River	Harnett	2.50	0.66
CPF14	Fort Bragg WWTP/001	NC0003964/001	Little River	Cumberland	8.0	25.69
	Spring Lake WWTP	NC0030970/001	Lower Little River	Cumberland	1.5	5.5
CPF15	Fayetteville-Cross Creek	NC0023957/001	Cape Fear River	Cumberland	22.00	4.93
	Fayetteville-Rockfish	NC0050105/001	Cape Fear River	Cumberland	12.0	2.7
	Monsanto/001,002	NC0003719/002	Cape Fear R.	Cumberland	0.73	0.14
	Raeford WWTP	NC0026514/001	Rockfish Creek	Hoke	3.0	8.67
CPF16	Carolina Food Proc., Inc.	NC0078344/001	Cape Fear River	Bladen	3.0	0.4
	Cogentrix Leasing /003	NC0058297/003	Cape Fear River	Bladen	0.10	0.02
	Dupont .001&002	NC0003573/001	Cape Fear River	Bladen	17	3.3
	Elizabethtown WWTP	NC0026671/001	Cape Fear River	Bladen	0.70	0.22
	Veeder Root /004	NC0001121/004	Cape Fear River	Bladen	0.152	0.03
	West Point Pepp.-Eliz.	NC0003522/001	Cape Fear River	Bladen	2.50	0.47
CPF17	AAF/McQuay, Inc.	NC0083658/001	UT To Barnards Crk	New Hanover	0.288	100
	Amerada Hess Corp.	NC0066711/001	Cape Fear River	New Hanover		NA
	Arcadian Corporation	NC0003727/001	Ne Cape Fear River	New Hanover	0.28	1.6
	Archer Daniels Midl./001	NC0027065/001	Cape Fear River(tidal)	Brunswick	3.502	0.03
	Campbell Oil Co.	NC0072681/001	UT Burnt Mill Creek	New Hanover	0.005	100.00
	Carolina Beach WWTP	NC0023256/001	Cape Fear River	New Hanover	1.85	NA
	Carter Pharmacy	NC0074179/001	Burnt Mill Creek	New Hanover	0.0014	2.89
	CP&L-Sutton/001	NC0001422/001	Cape Fear River	New Hanover	250.0	25.35
	CTI Of North Carolina	NC0082970/001	Cape Fear River	New Hanover	VAR	NA
	E.I. Dupont Dene./001	NC0000663/001	Cape Fear River	Brunswick	2.3	0.38
	Exxon Wilm. Term.	NC0073181/001	Cape Fear River	New Hanover	VARIES/NA	
	Federal Paper Board .	NC0081507/001	Burnt Mill Creek	New Hanover	10.0	37
	Federal Paperboard Co.	NC0003298/001	Cape Fear River	Columbus	50.00	8.30
	Fortron Industries/001	NC0082295/001	Cape Fear River (tidal)	New Hanover	0.245	1.16
	General Electric Co-001	NC0001228/001	Ne Cape Fear River	New Hanover	1.80	9.37

	Hoechst Celanese-Wilm	NC0001112/001	Northeast Cape Fear R	New Hanover	1.4	7.4
	Hoechst Celanese-Wilm	NC0001112/002	Cape Fear River	New Hanover	0.80	0.13
	JLM Terminals/CFR Ter	NC0028568/001	Cape Fear River	New Hanover	-	NA
	Koch Refining Co, L.P.	NC0076732/001	Cape Fear River	New Hanover	0.100	NA
	Leland Industrial Park	NC0065676/001	Cape Fear River	Brunswick	0.25	0.065
	M.I. Utilities-Clairmont	NC0058599/001	Brunswick River	Brunswick	.10	NA
	New Hanover Landfill	NC0049743/001	Ne Cape Fear River	New Hanover	VAR	NA
	North Side WWTP	NC0081736/001	Cape Fear River	New Hanover	4.0	NA
	Paktank Corp-Wilm. Ter.	NC0073172/001	Cape Fear River	New Hanover	NA	NA
	River Run Utilities	NC0060291/001	Jump And Run Creek	Brunswick	0.025	30.06
	Southport WWTP	NC0021334/001	Intracoastal Waterway	Brunswick	0.80	NA
	Takeda Chemical Prod.	NC0059234/001	Cape Fear River	New Hanover	0.444	0.07
	Wilm. Corp. Ind WWTP	NC0000817/001	Smith Creek	New Hanover	0.10	34.07
	Wilmington Northside	NC0023965/001	Cape Fear River	New Hanover	8.00	1.73
	Wilmington Shipyard,	NC0068004/001	Ne Cape Fear River	New Hanover	VARIED/NA	
	Wilmington Southside	NC0023973/001	Cape Fear River	New Hanover	12.00	1.59
	Wright Chem.Corp/002	NC0003395/002	Livingston Creek	Columbus	0.135	25.8
CPF18	Chevron USA	NC0084646/001	UT To Black River	Harnett	0.0144	100
	National Elec. C Corp.	NC0060747/001	Juniper Creek	Harnett	0.026	100.00
CPF19	Clinton-Larkins WPCF	NC0020117/001	Williams Old Mill Br.	Sampson	3.0	100.00
	Roseboro WWTP	NC0026816/001	Little Coharie Creek	Sampson	0.3	32
CPF21	Mt. Olive Pickle	NC0001074/001	Barlow Branch	Wayne	0.40	100.00
	Mt. Olive WWTP	NC0020575/001	Ne Cape Fear River	Wayne	1.0	100.00
CPF22	Charles F. Cates & Sons	NC0001970/001	UT Panther Branch	Duplin	0.50	100
	Cogentrix Corp.-003	NC0058271/003	Ne Cape Fear River	Duplin	VAR	100.0
	Guilford Mills East	NC0002305/001	Ne Cape Fear River	Duplin	0.965	18.68
	Rose Hill WWTP	NC0056863/001	Island Creek	Duplin	0.45	100.00
	Stevcoknit	NC0003450/002	Little Rockfish Creek	Duplin	5.0	99
	Swift-Eckrich, Inc.	NC0003344/001	Rockfish Crk.	Duplin	1.5	57
	Wallace WWTP	NC0020702/001	Rockfish Creek	Duplin	1.0	20.53
CPF23	Burgaw WWTP	NC0021113/001	Osgood Can. To Burg.Cr	Pender	0.50	100.00
	Occidental Chem./001	NC0003875/001	Ne Cape Fear River	New Hanover	1.04	6
	Thorn Apple Val. Of Car	NC0007757/001	UT To Juniper Swamp	Onslow	0.65	100.0
CPF24	Holly Ridge WWTP	NC0025895/001	UT Kings Creek	Onslow	0.1	100.0

NOTE: IWC Equals instream waste concentration. This is the percent of streamflow in the receiving waters that is composed of WWTP effluent during 7Q10 flow conditions. 7Q10 equals the lowest 7-day average flow expected to occur in a ten-year period.

APPENDIX III

Modeling Information

APPENDIX III

MODELING INFORMATION

INTRODUCTION

In order to assess the impact of pollutants on surface water quality, the Division must often develop and apply water quality models. A water quality model is a simplified representation of the physical, chemical, and biological processes which occur in a water body. The type of model used is dependent on the purpose for which it is needed, the amount of information that is available or attainable for its development, and the degree of accuracy or reliability that is warranted. In most cases, the Division develops and applies a given model to predict the response of the system to a given set of inputs that reflect various management strategies. For example, water quality models such as QUAL2E or the Division's Level B model are used to predict what the instream dissolved oxygen concentration will be under various sets of NPDES wasteflows and discharge limits. The following sections briefly summarize the types of models used by the Division.

Oxygen-Consuming Waste Models

Several factors are considered when choosing an oxygen-consuming waste model including: the type of system (stream, lake, or estuary), whether one, two, or three dimensions are needed, the temporal resolution needed, and the type of data available. Many of the factors are related. For example, in streams, flow usually occurs in one direction and one can assume that a steady state model will result in adequate predictions. A steady state model is one in which the model inputs do not change over time. However, in open water estuaries, the tide and wind affect which way water moves, and they must often be represented by 2 or 3 dimensional models. In addition, the wind and tide can affect the model reaction rates, and therefore a dynamic model must be used rather than one which is steady state. The last factor, the amount of data available, dictates whether an empirical or calibrated model will be used. An empirical model is used when little water quality information is available for a given water body, and hydraulics and decay rates are estimated through the use of equations. For example, in North Carolina's empirical stream model (referred to as a Level B analysis) velocity is determined through a regression equation developed from North Carolina stream time-of-travel (TOT) studies which includes stream slope and flow estimates as independent variables. Stream slope can be measured from a topographic map, and flow is estimated at a given site by the U.S. Geological Survey. Therefore, the empirical model can be run without TOT information specific to a given stream since parameters are estimated through the use of information which can easily be obtained in the office environment. More information regarding the empirical dissolved oxygen model used by DEM can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Field calibration of a BOD/DO model requires collection of a considerable amount of data. For example, in order to develop hydraulics equations specific to a given stream, TOT studies using rhodamine dye are recommended under at least two flow scenarios including one summer low flow period. In addition, during one summer low flow study, dissolved oxygen, temperature, long term BOD and nitrogen series data are collected. Sediment oxygen demand (SOD) data may also be collected. These data are then used to calibrate reaction rates specific to the stream. QUAL2E is the most commonly used calibrated DO/BOD model for streams in North Carolina. A copy of the model guidance can be obtained from EPA's Environmental Research Lab in Athens, Georgia, and further

information on North Carolina's calibration procedures can be found in the Instream Assessment Unit's Standard Operating Procedures Manual.

Data collection for an estuary DO model is even more extensive. Since the system is multi-dimensional and not steady-state, many more data are needed. Dye is often injected into a system over a period of time, and the dye cloud is then followed for a period of time which may last for days. In addition, several tide gages may need to be set up. Due to the stratification which occurs in an estuary, depth integrated data must also be collected. Calibrated estuary models which have been used by DEM include WASP, GAEST, and QUAL2E. WASP is also supported by EPA, and a user manual may be obtained from them. You should note that both GAEST and QUAL2E are one dimensional and are not applicable to many of North Carolina's estuaries.

Lakes are rarely modeled for BOD. Tributary arms of lakes are modeled as slow moving streams. Depending on the system, a one, two, or three dimensional model may be used. If a one dimensional model is needed, the modeler may choose the Level B (if little or no data), or QUAL2E. In multidimensional lake systems, WASP will be used.

The calibrated model will be more accurate than the empirical model since it is based on data collected specifically for a given stream in the State. However, it is much more expensive to develop a calibrated model. Not only do a number of staff spend several days to weeks collecting field data (sometimes having to wait months for appropriate conditions), but it also takes the modeling staff several months to develop and document the calibrated model. An empirical model can be developed and applied in a matter of hours. Therefore, due to resource constraints, the majority of the BOD/DO models developed in North Carolina are empirical.

Eutrophication Models

Eutrophication models are used to develop management strategies to control trophic response of a system to nutrient inputs (usually total phosphorus (TP) or total nitrogen (TN)). Nutrient management strategies are typically needed in areas which are sensitive to nutrient inputs due to long residence times, warm temperature, and adequate light penetration. These characteristics are found in deep slow moving streams, ponds, lakes, and estuaries. Modeling and insitu research are used to relate nutrient loading to the trophic response to the system allowing the manager to establish nutrient targets. Models which may be used include the Southeastern Lakes Model (Reckhow, 1987), Walker's Bathtub Model (Walker, 1981), QUAL2E, and WASP.

Once the nutrient targets are known, watershed nutrient budgets are developed to evaluate the relative nutrient loadings from various point and nonpoint sources. 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 (unknown being solved for in WLA)
Qw = wasteflow
Cd = concentration downstream (set = to standard or criteria)
Qd = flow downstream (= Qup + Qw)

When no data are available concerning the upstream concentration, it is assumed to be equal to zero. The upstream flow is the 7Q10 at the discharge point unless the parameter's standard is based on human health concerns, in which case the average flow is used.

REFERENCES CITED - MODELING APPENDIX

Reckhow, K. H., 1987. "A Cross-Sectional Analysis of Trophic State Relationships in Southeastern Lakes." Duke University School of Forestry and Environmental Studies, Durham, N.C.

Walker, W. W., Jr. 1981. "Empirical Methods for Predicting Eutrophication in Impoundments," Technical Report E-81-9, prepared by William W. Walker, Jr., Environmental Engineer, Concord, Mass., for the U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

APPENDIX IV

SUMMARY OF BASINWIDE PLANNING WORKSHOPS

October 21 and 25, 1994

Pittsboro and Elizabethtown

North Carolina
Cooperative Extension Service
NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES

Department of Biological and Agricultural Engineering • Box 7625 • Raleigh, NC 27695-7625 • Tel: (919) 515-2675 • FAX: (919) 515-6772

December 7, 1994

To Participants in the Cape Fear Basinwide Planning Workshops:

Thank you for participating in the October 21 and 25 Cape Fear Basinwide Planning Workshops. The Cape Fear Basinwide Water Quality Management Plan being developed by the North Carolina Division of Environmental Management will affect all residents of the Cape Fear River Basin. Your input is necessary to make this program successful in meeting its water quality protection goals.

Attached is a summary of the Workshops. Participants identified many issues and recommended actions to address these issues. Some of these recommendations require state action, but many require that local governments and citizens become involved in managing water resources.

The next step in the Basinwide Planning process is development of the Draft Management Plan. The Division of Environmental Management will send you a copy of the Draft Management Plan's Executive Summary to review when it is available. A full Draft Management Plan will be sent to you upon request. A series of public meetings will be conducted in the Cape Fear River Basin to receive public comment on this Plan in 1995.

Thank you again for participating in the Workshops. Please contact me if you have any questions.

Sincerely,

Gregory D. Jennings, Ph.D.
Extension Specialist

cc: Alan Clark, NC Division of Environmental Management
Paula Thomas, NC League of Municipalities

Employment and program opportunities are offered to all people regardless of race, color, national origin, sex, age or handicap.
North Carolina State University, North Carolina A&T State University, U.S. Department of Agriculture, and local governments cooperating.

Cape Fear Basinwide Planning Workshop Summary

Prepared by Greg Jennings, Extension Specialist
North Carolina Cooperative Extension Service, North Carolina State University

Cape Fear Basinwide Planning Workshops were conducted October 21, 1995, at the Chatham County Extension Center in Pittsboro and October 25, 1995, at the Bladen County Extension Center in Elizabethtown, with 191 participants representing the following interests:

54 City & County Government
29 State & Federal Government
34 Business & Industry
18 Farmers & Landowners
33 Citizen Organizations
23 Cooperative Extension Service

Workshop Objectives:

1. Describe local implications of the Cape Fear Basinwide Water Quality Management Plan; and
2. Increase public involvement in developing and implementing the Cape Fear Basinwide Plan.

Workshop Agenda:

9:00 Introduction and Video Presentation - Greg Jennings, CES - NCSU
9:30 Description of DEM Basinwide Water Quality Management Program and Implications for the Cape Fear River Basin - Alan Clark, DEM
10:30 Discussion Groups to Answer: "Based on your knowledge of water quality in the Cape Fear River Basin, what are the key issues and how should they be addressed?"
11:15 Presentations by Discussion Group Facilitators
11:45 Summary of Discussion Group Comments and Wrapup

Workshop participants divided into small discussion groups to address the question: "Based on your knowledge of water quality in the Cape Fear River Basin, what are the key issues and how should they be addressed?" Facilitators summarized responses in brief presentations to Workshop participants.

Priority Issues and Recommended Actions Identified by Two or More Discussion Groups:

- **Increase support for monitoring and enforcement**
- **Increase public education and involvement of local stakeholders**
- **Increase incentives and enforcement for nonpoint sources, including agriculture and forestry**
- **Promote regional land use and wastewater planning**
- **Consider economic implications of environmental protection**
- **Improve monitoring data for a sound basis for regulations**
- **Identify and target critical areas of water quality concerns**
- **Coordinate local and state government programs to maximize effectiveness**
- **Develop and implement new technologies (BMPs) for nonpoint source control**
- **Address urban stormwater runoff through education and enforcement**
- **Improve enforcement of erosion and sedimentation regulations**
- **Evaluate nutrient trading for cost-effective pollutant reductions**
- **Consider impacts on wildlife habitat**

Below are summarized the priority issues and recommended actions of the 6 discussion groups:

Pittsboro Group 1 (Facilitator: Glenn Woolard, CES - Chatham County):

1. Nonpoint sources: Need funding for incentives & education for agriculture & forestry; Need to locate & monitor sources; Evaluate nutrient trading options; Educate youth on social responsibilities & property rights; Educate public servants; Influence public perception with factual information
2. Land use planning: Need to control growth; Evaluate Randleman Dam impacts
3. Point sources
4. Develop & implement Best Management Practices (BMPs) where needed
5. Make water quality & point source data accessible to the public to promote citizen involvement
6. Evaluate effective lot sizes
7. Consider long-term development impacts
8. Septic systems
9. Mining
10. Wildlife habitat

Pittsboro Group 2 (Facilitator: Charles Hammond, CES - Moore County):

1. Education for targeted audiences with feedback on progress: Improve understanding of water quality programs; Target local decision-makers
2. Promote public and local decision-maker participation
3. Promote regional land use and wastewater management planning
4. Identify timber harvesting violations
5. Study dissolved oxygen in Deep River
6. Evaluate impacts of Randleman Dam
7. Study impacts of interbasin transfer
8. Need to continually evaluate and improve water quality protection programs
9. Improve enforcement of existing regulations
10. Improve sedimentation control
11. Promote citizen monitoring
12. Evaluate nutrient trading
13. Protect critical habitats
14. Septic systems
15. Develop and promote new, effective BMPs

Pittsboro Group 3 (Facilitator: Craven Hudson, CES - Chatham County):

1. Education: Need user-friendly basinwide planning documents with indexes of phone numbers
2. Effective Basinwide planning process: Need processe to gain citizen input for setting and refining realistic goals; Need ongoing Workshops and other meetings; Include public comments in appendix
3. Increase DEM enforcement and public notification of violators
4. Nutrients
5. Floodplain protection
6. Wastewater management for small systems
7. Water supply pathogens (input from livestock)
8. Urban stormwater runoff
9. Alternative methods of wastewater treatment
10. Point source discharger compliance
11. Education on existing regulations
12. Agricultural sustainability & water quality protection
13. Economic impacts on "victims"
14. Sediment
15. Timber harvesting

16. Hydropower flow regulation & habitat protection
17. Need for realistic, phased-in regulations with benchmarks
18. Car wash runoff
19. Evaluate hazards of radioactive waste disposal
20. Forecast future discharge limits
21. Industrial waste characterization (pretreatment & final quality)
22. Determine land area lost to development under wetlands protection programs
23. Notify public of discharge & non-discharge permit changes
24. Rainfall deposition

Pittsboro Group 4 (Facilitator: Greg Jennings, CES - NCSU):

1. Education: Citizens, Local officials, Developers, Homeowners, Media
2. Land use planning: Consider stormwater management
3. Agriculture (including animal waste): New technologies; Prevent the source; Address misperceptions
4. Nutrients in Deep River: Determine condition of water; Study impacts of dam
5. Sedimentation: Determine who is responsible; Enforce existing rules
6. Improved monitoring & enforcement by DEM
7. Equitable implementation of regulations
8. Consider economic impacts of regulations
9. Consider impacts on small towns and how to involve local decision-makers
10. Mining (sedimentation)
11. Wastewater treatment plant biosolids
12. Nonpoint source reductions
13. Integrate neighboring river basins
14. Base decisions on sound data
15. Wetland protection
16. Control development
17. Evaluate hazards of radioactive waste disposal

Elizabethtown Group 1 (Facilitator: Kathy Dugan, CES - Bladen County):

1. Balance regulation of point and nonpoint sources
2. Consider impacts of beaver management
3. Study and regulate swine waste lagoons
4. Study removal of locks and dams
5. Provide funding incentives for point sources to work together (similar to Conservation Districts)
6. Study impacts of limits on point sources
7. Study long-term impacts of interbasin transfer
8. Promote stormwater controls for large industries
9. Evaluate pollutant trading
10. Improve enforcement and promotion of BMPs
11. Study waste assimilation in other River Basins (Neuse, Lumber)
12. Explain virtues of Basinwide Management to local governments

Elizabethtown Group 2 (Facilitator: Dan Bailey, CES - Sampson County):

1. Education: Promote citizen involvement; Present a basinwide perspective of pollution; Local officials
2. Enforce NPS regulations uniformly with others
3. Increase local involvement in pollution prevention
4. Study assimilative capacity of River Basin
5. Reduce interagency conflict
6. Study long-term impacts of interbasin transfer
7. Promote political cooperation and bargaining

8. Eliminate overlapping regulations
9. Study and reduce agricultural impacts
10. Address excessive nutrient loadings

Elizabethtown Group 3 (Facilitator: Bobby Clark, CES - Harnett County):

1. Nonpoint sources (animal waste) impacts on water quality and need for BMPs: Incentives; Trading
2. Improve communication among agencies and to citizens
3. Need improved, coordinated water quality monitoring
4. Education: Show public how to get involved; More publicity; Present "state-of-the-river"
5. Study lock and dam operation
6. Consider property rights and taking issues
7. Consider critical habitats
8. Evaluate cost-benefit relationships
9. Determine regulatory impacts on point sources, development, & land use
10. Need effective stormwater management
11. Need to promote factual understanding of water quality, not uninformed perceptions
12. Interbasin transfer impacts
13. Promote regionalized wastewater management and water reuse
14. Study effectiveness of BMPs in protecting water
15. Develop a state land use plan
16. Document water quality improvements
17. Evaluate effectiveness of erosion and sedimentation control program
18. Increase enforcement

Elizabethtown Group 4 (Facilitator: Phil Ricks, CES - New Hanover County):

1. Address stormwater discharges
2. Study long-term impacts of interbasin transfer
3. Study impacts of point source limitations
4. Determine reliability of computer models
5. Promote BMPs
6. Education

Elizabethtown Group 5 (Facilitator: Sandy Maddox, CES - Pender County):

1. Identify specific problem sources
2. Reduce overlap with existing programs & rules
3. Study cost-benefit relationships and feasibility of rules for point & nonpoint sources
4. Consider economic benefit & capacity delegation
5. Determine effective enforcement procedures (who is responsible)
6. Consider linkages with other agencies
7. Study long-term impacts of interbasin transfer
8. Site-specific water quality classifications
9. Compare proposed program with other states to evaluate environmental & economic impacts
10. Evaluate pollutant trading & reduction options (pool funding to address critical areas)
11. Promote local monitoring and problem solving
12. Concentrate funding and enforcement to identified problem areas
13. Improve positive media involvement (success stories)
14. Increase public education and involvement
15. Increase understanding of regulators on "real life" situations
16. Develop a "one-stop" center for education and assistance with water quality problems
17. Resist temptation to develop new regulations until after initial 5-year period
18. Eliminate unnecessary, confusing regulations

APPENDIX V

LISTS OF BEST MANAGEMENT PRACTICES (BMPs) FOR:

- **Agriculture**
- **Urban Runoff**
- **Sedimentation and Erosion Control**
- **Onsite Wastewater Disposal**
- **Forestry**
- **Mining**

Note: The BMPs lists included in this appendix were excerpted from a document entitled North Carolina Nonpoint Source Management Program (Report 89-02). The document was prepared by the North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Management, Water Quality Section.

Agricultural Best Management Practices

Table 4. BMPs for Agriculture

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 BMP's

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

Table 4 Cont.

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

Table 5
BEST MANAGEMENT PRACTICES ELIGIBLE FOR COST SHARING
UNDER THE AGRICULTURE COST SHARE PROGRAM

Practice	Minimum Life Expectancy (years)
Conservation Tillage System	1
Critical Area Planting	10
Cropland Conversion (Trees, Grasses, or Permanent Wildlife Plantings)	10
Diversion	10
Field Border	10
Filter Strip	10
Grassed Waterway	10
Heavy Use Area Protection	10
Livestock Exclusion	10
Pastureland Conversion	10
Rock-lined Waterway or Outlet	10
Sediment Control Structure	10
Sod-based Rotation	4 or 5
Spring Development	10
Stock Trails and Walkways	10
Stripcropping	5
Terrace	10
Trough or Tank	10
Waste Management System	10
Waste Storage Pond	10
Waste Storage Structure	10
Waste Treatment Lagoon	10
Land Application of Waste	1
Grade Stabilization Structure	10
Water Control Structure	10

The minimum life expectancy of the BMPs is also listed in Table 5. Practices designated by a District shall meet the life expectancy requirement established by the Division for that District BMP.

Conservation tillage systems, sod-based rotation, stripcropping, and land application of animal wastes shall be funded under a cost-share incentive payment. Payments for conservation tillage systems and land application of animal wastes are limited to a maximum of three years per farm. Farmers are expected to incorporate BMPs on their own initiative after this time.

The ACSP has a detailed implementation plan that is to be used in conjunction with the rules and regulations for the Program. The following is a list of definition of practices in the plan:

(1) Conservation Tillage System means a form of non-inversion tillage that retains protective amounts of residue mulch on the surface throughout the year. These include no tillage, strip tillage, stubble mulching and other types of non-inversion tillage which maintain a minimum of 50 percent ground cover at planting or a minimum surface residue of 2,000, 1,500, and 1,000 pounds per acre for corn, soybeans, and small grain, respectively.

(2) Critical Area Planting means planting trees, shrubs, grasses, or legumes on critically eroding agricultural areas in order to reduce erosion, sediment delivery and nonpoint source pollution to receiving waters.

(3) Critical Erosion as applied to critical areas means erosion so severe that special agricultural BMPs must be used to stabilize the area of concern.

(4) Cropland Conversion means the establishment of perennial grasses, trees, or permanent wildlife plantings on excessively eroding cropland. Cost share will be based on 75 percent of the average cost of establishing fescue.

(5) Diversion means a channel with a supporting ridge on the lower side constructed across the slope to divert excess water from cropland areas.

(6) Excessive Erosion means sheet, rill and/or concentrated erosion on agricultural lands occurring at an annual rate greater than the soil loss tolerance (T).

(7) Field Border means a strip of perennial vegetation

established at the edge of the field to control erosion.

(8) Filter Strip means a strip or area of perennial vegetation for removing sediment, organic matter, and other pollutants from cropland or as part of waste management systems for treating runoff from concentrated animal areas.

(9) Grade Stabilization Structure means a structure to stabilize the grade of agricultural cropland or pasture land where concentrated and high velocity runoff results in head cutting and gully formation.

(10) Grassed Waterway means a natural waterway or outlet, shaped or graded, established in suitable vegetation and used to route excess water from cropland, reduce gully erosion and reduce nonpoint source pollutant delivery to receiving waters. As a condition for cost sharing, the field or treatment unit draining into the waterway must have installed, or the farmer must agree to install as part of the agreement, erosion control measures necessary to prevent damage from washout or excessive sedimentation in the waterway.

(11) Heavy Use Area Protection means stabilizing high concentration areas for livestock to reduce stream loading of sediment and/or animal waste.

(12) Livestock Exclusion means permanent fencing used to exclude livestock from an area and is to be used in conjunction with livestock waste treatment systems, stream crossings, streambank protection or other areas as needed to protect surface water quality.

(13) Pastureland Conversion means establishing trees or perennial wildlife plantings on excessively eroding pasture that is too steep to mow or maintain with conventional equipment. (Class VII Land)

(14) Rock-lined Waterway or Outlet means a waterway or outlet having an erosion-resistant lining of permanent material which provides safe disposal of runoff where unlined or grassed waterways would be inadequate.

(15) Sediment Control Structure means a temporary or permanent basin constructed to collect and store sediment and other agricultural nonpoint source pollution.

(16) Sod-based Rotation means establishing perennial grasses and/or legumes or a mixture of them on excessively eroding cropland and maintaining at least a four-year rotation. A one-time incentive payment per field will be made for establishment.

(17) Spring Development means improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities. Springs are to be developed as a source for livestock watering in conjunction with livestock exclusion from streams. The SWCD's have been made aware of the potential conflict of spring development with habitat preservation for wetland flora and fauna. Conflicts are reviewed on a case-by-case basis.

(18) Stock Trails and Walkways means a system used to control erosion where livestock cross ditches, streams, or other areas where surface water quality needs to be protected. Trails and walkways must be used in conjunction with livestock exclusion.

(19) Stripcropping means growing crops in a systematic arrangement of strips or bands across the general slope. The crops are arranged so that a strip of grass or close-growing crop is alternated with a clean-tilled crop or a crop under a conservation tillage system. Cost sharing will be based on a one-time payment of 75 percent of the average cost of establishing fescue multiplied by the acres in sod plus an incentive payment for the establishment of the strips.

(20) Terrace means an earth embankment, a channel, or a combination ridge and channel constructed across the slope.

(21) Trough or Tank means constructing a device for livestock watering in conjunction with livestock exclusion from streams.

(22) Waste Management System means a planned system for managing liquid, solid waste, and runoff from concentrated animal areas. System components may include:

(A) Waste Storage Pond means an impoundment made by excavation or earthfill for temporary storage of animal or other agricultural waste.

(B) Waste Storage Structure means a fabricated structure for temporary storage of animal or agricultural waste.

(C) Waste Treatment Lagoon means an impoundment made by excavation or earthfill for biological treatment of animal or other agricultural waste.

(D) Land application of Wastes means the application of agricultural wastes on land in an environmentally acceptable manner.

(23) Water Control Structure means a man-made structure installed in on-farm water management systems to reduce the delivery of nonpoint source pollutants into main water courses.

Best Management Practices

Structural best management practices for urban runoff control typically are designed to reduce sediment, its attached pollutants, and nutrients. In addition, other BMPs provide shade to waterbodies and reduce the likelihood of excessive water temperatures. Nonstructural BMPs, such as a design manual or a public education program, encourage the comprehensive and effective implementation of structural BMPs. Table 6 contains a list of both structural and nonstructural BMPs. This list will become more complete when the design manual for urban BMPs (currently being written by the Water Quality Section of DEM) is available.

Table 6. BMPS for Urban Runoff Control

STRUCTURAL
- Wet Detention Basin
- Infiltration Basin
- Vegetative Practices
  - Filter Strips
  - Swales with Check Dams
- Oil and Grease Separator
- Rollover-Type Curbing

NONSTRUCTURAL
- Design Manual for Urban BMPs
- Public Education
- Identification and Enforcement of Illegal Discharges
- Land-Use Control

Structural BMPs may affect groundwater quality in certain situations. Devices that recharge groundwater pose the risk of passing soluble pollutants, collected from stormwater runoff, into groundwater systems. At present it is not known whether pollutant concentrations in recharged groundwater areas pose a significant environmental or health risk. USGS is presently conducting a study of the groundwater quality effects of urban BMPs. In addition, if funds are made available, DEM could conduct a similar study in North Carolina. It is hoped that monitoring projects, like the USGS project, will clarify the groundwater quality impacts of urban BMPs.

Best Management Practices

The typical or suggested BMPs of the North Carolina Sedimentation Pollution Control Act of 1973 are selected on the basis of performance in providing protection from the maximum peak rate of runoff from a 10-year storm. This allows the developer/designer of the control measures, structures, or devices to determine and submit for approval the most economical and effective means of controlling erosion and preventing sedimentation damage. Practices are therefore reviewed for acceptability based upon the characteristics of each individual site and its erosion potential. Ideally, the erosion control plan will employ both practices and construction management techniques which will provide the most effective and reasonable means of controlling erosion while considering the uniqueness of each site. Table 7 provides a list of practices commonly used in sedimentation and erosion control plans across North Carolina.

Table 7. BMPs for Sedimentation Control

Land Grading
Surface Roughening
Topsoiling
Tree Preservation & Protection
Temporary Gravel Construction Entrance/Exit
Temporary Seeding
Permanent Seeding
Sodding
Trees, Shrubs, Vines & Ground Covers
Mulching
Riprap
Vegetative Dune Stabilization
Temporary Diversions
Permanent Diversions
Perimeter Dike
Right-Of-Way Diversions
Grass-lined Channels
Grass Channels with Liner
Riprap-lined Channels
Paved Channels
Temporary Slope Drains
Paved Flume (Chutes)
Level Spreader
Outlet Stabilization Structure
Temporary Excavated Drop Inlet Protection
Fabric Drop Inlet Protection
Temporary Block & Gravel Inlet Protection
Sod Drop Inlet Protection
Temporary Sediment Trap
Sediment Basin
Sediment Fence
Rock Dam
Temporary Stream Crossing
Permanent Stream Crossing
Vegetative Streambank Stabilization
Structural Streambank Stabilization
Construction Road Stabilization
Subsurface Drain
Grade Stabilization Structure
Check Dam
Dust Control
Sand Fence (Wind Fence)

On-site Wastewater Disposal Best Management Practices

Best Management Practices

In order to protect public health and water quality, best management practices (BMPs) need to be implemented throughout the life cycle of an on-site wastewater disposal system. Life-cycle management problems can be addressed in three phases (Steinbeck, 1984). The first phase includes system siting, design, and installation. The second phase involves the operation of the system and phase three involves maintenance and repair when the system malfunctions or fails. As BMPs are applied in each life-cycle phase, the primary factor influencing the success of the system is the participation of the local health department and the cooperation of the developer, owner, design engineer, system operator, and the state. The following is a summary of the current life-cycle management practices and penalties utilized in North Carolina to implement the on-site sewage systems program (Steinbeck, 1984).

Table 8. BMPs for On-Site Wastewater Disposal

1. Application -- The developer or property owner meets with the staff of the local health department to review the project proposal and submits an application to the local health department that contains information regarding ownership, plat of property, site plan, type of facility, estimated sewage flow, and proposed method of sewage collection, treatment, and disposal.

2. Site Evaluation -- The local health department, with technical assistance from the state, evaluates the proposed sewage effluent disposal site for several factors, including slope, landscape position, soil morphology, soil drainage, soil depth, and space requirements. Next, the local health department will assign a site suitability classification, establish the design sewage flow, and the design loading rate for the soil disposal system.

3. Design Review --The applicant is required to submit plans and specifications for the sewage collection, treatment, and disposal system prepared by a professional engineer, for complex systems, or for systems exceeding 3,000

gal/day. Reviews are made by both state and local health departments. The designer must also include in the plans and specifications, installation procedures, phasing schedules, operation and maintenance procedures, monitoring requirements, and designate the responsible agents for operation and maintenance.

4. Legal Document Review -- For systems with multiple ownership or off-site disposal, the applicant must prepare and submit to state and local health departments for their legal review documents applicable to the project.

5. Improvement Permit -- Issued only after a successful review of the proposed project, including each of the items discussed above and allows construction to begin for the on-site sewage system. The improvement permit must be issued prior to other construction permits and allows only temporary electrical power to the site. This permit contains the necessary conditions for construction of the projects with the plans, specifications, and legal documentation appended to it.

6. Operation Permit -- Issued to the owner of the on-site sewage system by the local health department when it determines that all the requirements in the rules, plans and specifications are met; all conditions on the improvement permit are met; and the design engineer for the sewage collection, treatment, and disposal system certifies in writing to the local health department that the on-site system has been installed in accordance with the approved plans and specifications. The operation permit is also conditioned to establish performance requirements and may be issued for a specific period of time. It allows the on-site sewage system to be placed into use, prevents permanent electrical service to the project and prevents occupancy of the facilities until issued. The operation permit applies to systems larger than 480 gallons per day. A certificate of completion is required for conventional septic tank systems when the design sewage flow is less than 480 gal/day.

7. Surveillance -- Once an on-site sewage system is placed into operation the local health department must make routine inspections at least annually for large systems to determine that the system is performing satisfactorily and not creating a public health nuisance or hazard. Additionally, required monitoring reports are routinely submitted to the local health department as required in the permits. The state provides technical assistance to the local health department and the system operator in assuring adequate performance. While annual inspections are required, frequent performance checks must be made by the local health department.

8. Remedies -- When voluntary compliance with the performance requirements for the on-site system is unsuccessful, the General Statutes (1983) provide for the following remedies:

   a. Right of Entry -- Allows the state or local health department to enter the premises to determine compliance with the laws and rules and provides for an administrative search and inspection warrant when entry is denied.

   b. Injunction -- The state or local health department may institute an action for injunctive relief against the owner to bring the on-site sewage system into compliance.

   c. Order of Abatement -- The state or local health department is empowered to issue an order of abatement directing the owner to take any necessary action to bring the system into compliance. However, if the on-site system is determined to be creating an imminent health hazard, the state or local health department may, after previous unsuccessful attempts at correction, take the necessary action to correct the problem and recover any costs for abatement from the owner. This is the least frequently applied remedy.

   d. Administrative Penalties -- The state may impose administrative penalties up to $300 per day for violation of the laws, rules, or any permit condition for on-site sewage systems serving multi-family residences with a flow greater than 480 gal/day. A penalty of up to $50 per day can be assessed for malfunctioning systems where the flow is less than or equal to 480 gal/day.

   e. Suspension and Revocation of Permits -- The state may suspend or revoke a permit for violations of the laws, rules, or permit conditions upon a finding that a violation has occurred.

   f. Misdemeanor -- The owner who violates the sewage laws or rules shall be guilty of a misdemeanor and punishable by a fine or imprisonment as determined by the courts. This is the most frequently used remedy.

Best Management Practices for Forestry

The North Carolina Forestry Council has prepared a reference document for silvicultural BMPs entitled "Forest Practices Guidelines Related to Water Quality." Table 10 summarizes these BMPs:

Table 10. BMPs for North Carolina Forests

1. Properly design and place access roads, skid trails, and loading areas on forestland.

   a. Avoid streambanks and channels except when crossing streams.
   b. Install water management structures and techniques.
   c. Stabilize bare soil areas.
   d. Prevent steep slopes on roads and trails.

2. Designate streamside management zones (SMZ) which are undisturbed strips of vegetation parallel and adjacent to the stream channels.

3. Avoid placing debris in stream channels (Stream Obstruction Law).

4. Use practices which minimize soil exposure when reforesting.

5. Use environmentally safe procedures when applying chemicals in forested areas.

6. Train forestry related personnel in nonpoint source pollution control methods.

Best Management Practices

Significant environmental damage can and often times does occur during land-disturbing activities of mining operations, especially during the initial stages. The potential for such damage can be substantially reduced with the installation of BMPs. Once the mining has terminated, BMPs are used to reclaim or reasonably rehabilitate the site (for mined lands after June 11, 1971). The basic objective of the reclamation is to establish on a continuing basis the vegetative covers, soil stability, and water and safety conditions appropriate to the area. The BMPs are basically performance oriented allowing the applicant for a mining permit to design and submit for approval the most economical and effective means of a) controlling erosion and preventing off-site sedimentation damage; b) preventing contamination of surface waters and groundwater; and, c) preventing any condition that will have unduly adverse effects on wildlife or freshwater, estuarine, or marine fisheries. BMP selection is site specific and controlled in part by the pre- and post-mining land use(s). The acceptability, therefore, of a BMP is based upon the characteristics of the individual site and its potential for off-site damage.

Table 12 provides a list of BMPs which is virtually the same as apply in the Sedimentation and Erosion Control Program since the problems are similar.

Table 12. BMPs for Mining

Land Grading
Surface Roughening
Topsoiling
Tree Preservation and Protection
Temporary Gravel Construction Entrance/Exit
Temporary Seeding
Permanent Seeding
Sodding
Trees, Shrubs, Vines & Ground Covers
Mulching
Riprap
Vegetative Dune Stabilization
Temporary Diversions
Permanent Diversions
Perimeter Dike
Right-of-Way Diversions
Grass-lined Channel
Grass Channels with Liner

Table 12 (Cont.)

Riprap-lined Channels
Temporary Slope Drains
Paved Flume (Chutes)
Level Spreader
Outlet Stabilization Structure
Temporary Excavated Drop Inlet Protection
Temporary Fabric Drop Inlet Protection
Temporary Block and Gravel Inlet Protection
Sod Drop Inlet Protection
Temporary Sediment Trap
Sediment Basin
Sediment Fence
Rock Dam
Temporary Stream Crossing
Permanent Stream Crossing
Vegetative Streambank Stabilization
Structural Streambank Stabilization
Construction Road Stabilization
Subsurface Drain
Grade Stabilization Structure
Check Dam
Dust Control
Sand Fence (Wind Fence)
Groundwater Monitoring Wells
Mining Newsletter

APPENDIX VI

CONTENTS:

List of 303(d) Waters in the Cape Fear River Basin

APPENDIX VI

List of 303(d) Waters in the Cape Fear River Basin

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 deleted 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.

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 and presents information on how well a waterbody supports its uses. Likely causes (e.g., sediment, nutrients, etc.) and sources (point sources, agriculture, etc.) of impairment are also presented in the report. Only those waterbodies whose use support rating was 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. As more conclusive information on streams rated using older data or best professional judgment is obtained, they will be added to the list if the data indicate impairment. The North Carolina Division of Environmental Management (DEM) will be collecting information on as many of these evaluated waterbodies as staffing and time permit for subsequent updates of basin plans. 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. Federal stormwater - Waters where the federal stormwater regulations apply may have been eliminated from the list if nonpoint sources were the only problem. Exceptions to this include waters in the Jordan Lake watershed as these tributary arms will need a more comprehensive strategy to address the point and nonpoint nutrient issues. Federal stormwater programs exist in Greensboro, Durham, and Cumberland County in the Cape Fear River Basin.

2. Miscellaneous nonpoint programs - Any waterbodies where DEM was aware of nonpoint management studies (e.g. 319 or similar program) were eliminated if nonpoint sources were the only problem.

3. 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.

Finally, the 303(d) list for the Cape Fear River Basin has been prioritized. Any stream in the Deep River and Jordan Lake watersheds may have management strategies developed during the next planning cycle. Each of the watersheds has been identified in Chapter 7 of the Basin Plan as needing future management strategies for nutrients. However, the amount of work that will be completed will depend on available resources. Nutrient management should address some of the sediment issues in these two basins as well, but some specific waterbodies may need additional management than that proposed in the next basin plan.

The DEM has also begun setting up nonpoint source teams for each of the state's 17 major river basins. These teams will have representatives from agriculture, construction, mining, on-site waste disposal, solid waste, wetlands, forestry, groundwater, urban stormwater, and wildlife

agencies. These teams will develop the nonpoint source portions of the Basinwide Water Quality Management Plans. Their tasks will include describing current nonpoint source activities in the basin, conducting assessments of specific nonpoint source controls in targeted watersheds, identifying future monitoring sites, developing five year action plans for nonpoint sources, and developing 319 project proposals for targeted watersheds. DEM plans on recommending to this committee that the Deep River Basin receive high priority for further study.

The 303(d) list for the Cape Fear River Basin is presented in Table A-VI.1 (2 pages).

Table A-VI.1: 303(d) LIST FOR THE CAPE FEAR RIVER BASIN

Name of Stream	Description	Class	Wtrbdy	Problem Parameters	Overall Rating	Major (P,NP)	Sources Subcategory	Priority
HAW RIVER	Source to SR2109, Guilford Co.	C NSW	30601	Fecal(20)	PS	NP,P	10,08	JL
HAW RIVER	From NC 87 to NC 49	C NSW	30602	Fecal(47),Turb(20),Cd(16)	PS	NP,P	10,40,06	JL
Candy Creek	From source to Haw River	C NSW	30601		PS	NP	10	JL
Troublesome Creek	SR 2423 to dam at Lk Reidsville	WS-III NSW CA	30601	Sed	PS	NP	10	JL
Little Troublesome Creek	From source to Reidsville WWTP	C NSW	30601		PS	NP		JL
Little Troublesome Creek	Reidsville WWTP to Haw River	C NSW	30601	Fecal(47),Turb(13)	NS	P	03,08	JL
Reedy Fork (including Lake	.4 mile dstm of Moores Cr to L Townsend Dam	WS-III NSW CA	30602	Sed	PS	P	06,	JL
Brush Creek	Source to 0.5 mile dwstrm of SR 2190	WS-III NSW	30602		PS	NP	10	JL
Brush Creek (Lake Higgins)	0.5 mile dwstrm of SR 2190 to Lk Brandt	WS-III NSW CA	30602		PS	NP	10	JL
Town Branch	From source to Haw River	C NSW	30602	Fecal(60),Turb(13)	PS			JL
Robeson Creek	.7 mi dwnstrm of SR 2159 to ab Pittsbo WWTP	WS-IV NSW	30604		NS	NP	10,40	JL
Robeson Creek	To.3 mile upstream of mouth	WS-IV NSW	30604	pH(12),Fecal(20),Chla(20)	PS	NP	10,40	JL
Third Fork Creek	From source to 2 mi up of NC Hwy 54	C NSW	30605		NS	NP	32,40	JL
Third Fork Creek	2 miles up of NC Hwy 54 to New Hope Cr	WS-IV NSW	30605	Turb(18)	NS	NP	32,40	JL
Bolin Creek (Hogan	From US Hwy 501 Business to Little Creek	WS-IV NSW	30605		PS			JL
Northeast Creek	From source to NC hwy 55	C NSW	30605		PS	NP	30,40	JL
Northeast Creek	From Hwy 55 to SR 1102 Durham	WS-IV NSW	30605		PS	NP	30,40	JL
Northeast Creek	From 1102 to 1100 Durham	WS-IV NSW	30605	Fecal(33),Turb(14),Cu(14),Sed	PS	NP, P	43, 03	JL
Northeast Creek	SR 1100 to .5 mile down of Panther Cr	WS-IV NSW	30605	Sed	PS	NP	43	JL
Morgan Creek (including	From Orange SR 1919 to SR 1109	WS-IV NSW	30606	Sed	PS	NP,P	43, 02	JL
Meeting of the Waters	From source to Morgan Creek	WS-IV NSW	30606		NS	NP	40	JL
Morgan Creek (including	SR1109 to New Hope Cr Arm of Jordan Lk	WS-IV NSW CA	30606	Fecal(19)	PS			JL
White Oak Creek	.3 mi up of NC 751 to New Hope R Arm	WS-IV NSW CA	30605	Sed	PS	NP,P	65,32,08	JL
East Fork Deep River	Source to .4 mile down of SR 1541	WS-IV	30608	Fecal(53),Turb(11)	PS	NP,P	10,08	DR
DEEP RIVER	Dam at High Point Lk to SR 1334	WS-IV	30608		PS	NP	40	DR
DEEP RIVER	SR 1334 to dam at Oakdale Cotton Mills	WS-IV CA	30608		PS	NP	40	DR
DEEP RIVER	Dam at Oakdale Cotton Mills to SR 1113	C	30608		PS	NP	40	DR
DEEP RIVER	SR 1113 to SR1921 near Randleman	C	30608	Fecal(38),Turb(14)	PS	NP	10,30,40	DR
DEEP RIVER	From NC 220 to SR-2122, Randolph Co.	C	30608	Fecal(67),Turb(13),Cu(13),Hg(	PS	NP	18,20	DR
Richland Creek	Source to Deep River/SR-1145, Guilford Co.	C	30608	Fecal(21),Turb(11),Cu(16)	PS	NP,P	62,02	DR
Unnamed Tributary at	From Cone Mills Club Lake Dam to Polecat Cr	WS-III	30609		NS			DR
Haskett Creek	From source to SR 2149 & ab WWTP	C	30609		PS			DR
Haskett Creek	From SR 2149 to Deep R.	C	30609	Fecal(50),Cu(33)	PS	NP	40	DR
Flat Creek	From source to Deep River	C	30609		PS	NP	18,20	DR
Cotton Creek	From Source to SR-1372, Montgomery Co.	WS-III	30610		PS	NP,P	03,	DR
Cotton Creek	from 1372 to Cabin Cr	WS-III	30610		PS	NP	10,40,	DR
Falls Creek	From source to Deep River	C	30610	Sed	PS	NP	10	DR
McLendons Creek	SR 1210 to .4 mile dwnstrm of SR 1628	C	30610		PS			DR
Richland Creek	From Moore County SR 1264 to McLendons	C	30610		PS			DR
McLendons Creek	.4 mile downstream of SR 1628 to Deep River	WS-IV	30610		PS			DR
Big Governors Creek	From Moore Co SR 1651 to Deep R	WS-IV	30610		NS			DR

Table A-VI.1: 303(d) LIST FOR THE CAPE FEAR RIVER BASIN

Name of Stream	Description	Class	Wtrbdy	Problem Parameters	Overall Rating	Rating Major (P,NP)	Sources Subcategory	Priority
Indian Creek	From source to Deep River	WS-IV	30611	Sed	NS	NP	10	DR
Little Pocket Creek	From source to Pocket Creek	C	30611		PS	NP	11,12	DR
Cedar Creek	From source to Deep River	C	30611	Sed	PS	NP	50	DR
Georges Creek	From source to Deep River	C	30611		PS			DR
Little Buffalo Creek	From source to Deep River	WS-IV	30611	Sed	NS	NP	50,40	DR
Rocky River	From dam at lower water supply to US 64	C	30612		PS			Low
Loves Creek	From source to abover WWTP nr SR 2203	C	30612		PS	NP	10	Low
Loves Creek	From above WWTP nr SR 2203 to Rocky River	C	30612		NS	NP,P	03,10	Low
Bear Creek	From source to SR 2189 Chatham	C	30612	Sed	PS			Low
Gulf Creek	From source to .2 mile upstream of mouth	WS-IV	30607	Sed	NS	NP	50	Low
Neill Creek (Neals Creek)	Source to .7 mile up of Wake-Harnett Co Line	C	30607	Sed	PS			Low
Neill Creek (Neals Creek)	.7 mile up of Wake-Harnett Co Line to SR 1441	WS-IV	30607	Sed	PS			Low
Kenneth Creek	From source to .6 mile downstream of 401	C	30607		NS	NP	10,30	Low
Kenneth Creek	.6 mile down of 401 to SR 2772	WS-IV	30607		NS	NP,P	10,30,02	Low
Kenneth Creek	From SR 2772, Be F-V Wake Co to Neils Cr	WS-IV	30607		PS	NP	10,30	Low
Anderson Creek	From source to Little River	C	30614	Sed	PS	NP	10	Low
Pedler Branch	From source to Rockfish Creek	C	30615		NS	NP	40,10	Low
Harrisons Creek (Little	From source to Cape Fear River	C	30616	pH(100), Sed	PS	NP	90	Low
Turnbull Creek	From source to Cape Fear River	C	30616	pH(100), Sed	PS	NP	10	Low
CAPE FEAR RIVER	.6 mi up of Livingston Cr to ab Neils Eddy Land	C Sw	30617		PS	P	01,08	Low
Livingston Creek (Broad-	From source to NC 74 Columbus	C Sw	30617		PS			Low
Livingston Ck (Broad-	From NC 74 Columbus, to Cape Fear River	C Sw	30617	NH3(13)	NS			Low
South River	Source to NC 13	C Sw	30618		PS			Low
Black River	From East of Dunn to I-95	C Sw	30618	Sed	PS	NP	10	Low
Northeast Cape Fear River	Source to SR-1937 nr Mt. Olive	C Sw	30621	DO(39),Fecal(17),NH3(15),Cl(2	NS			Low
Northeast Cape Fear River	SR-1937 nr Mt. Olive, to NC 403	C Sw	30621	Sed	PS	NP	82,	Low
Barlow Branch	Source to NE Cape Fear R/Bell St, Duplin Co	C Sw	30621		NS	NP,P	40,01	Low
Panther Creek	From NC-50, Duplin Co. to Goshen Swamp	C Sw	30622		NS	P	08,	Low
Grove Creek	From source to Northeast Cape Fear River	C Sw	30622		PS	NP	10,42	Low
Persimon Branch	From source to WWTP	C Sw	30622		PS			Low
Persimon Branch	From WWTP to Muddy Creek	C Sw	30622		NS			Low
Rock Fish Creek (New	From SR 1165 to Northeast Cape Fear River	C Sw	30622	Fecal(32),Cu(16),Sed	PS	NP,P	11,18,03	Low
Burgaw Creek	Source to N.E. Cape Fear	C Sw	30623	Sed	NS	NP	41,42,62	Low
Cypress Creek	From source to Long Creek	C Sw	30623		PS	NP	65	Low
Burnt Mill Creek	From source to Smith Creek	C Sw	30617	Sed	NS	NP,P	31,32,65, 08	Low

Key to Priorities

JL: This waterbody lies within the Jordan Lake watershed which has been prioritized for nutrient management. This management may also address sediment and other NPS problems.

DR: This waterbody lies within the Deep River watershed which has some established TMDLs. DEM will also investigate possibility of classifying watershed as NSW.

APPENDIX VII

LIST OF NPDES DISCHARGERS IN THE CAPE FEAR RIVER BASIN

EHNR - DIVISION OF ENVIRONMENTAL MANAGEMENT
NPDES DISCHARGERS IN THE CAPE FEAR RIVER BASIN
DATE RUN: 09/07/95

TYPE / PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW(MGD)
MAJOR-NONMU								
NC0001406	SWIFT TEXTILES (ERWIN MILLS)	2.5000	94/03/14	96/07/31	030613	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	002.5000
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0001422	CP&L SUTTON S.E. (PWR PLT)	.0000	95/01/07	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
						003	COOLING POND-CAPE FEAR RVR/CAPE FEAR	
						004	COOLING POND-CAPE FEAR RVR/CAPE FEAR	
NC0001899	ALLIED SIGNAL, FIBER DIV.	.2440	94/01/28	96/03/31	030607	001	HAW RIVER/ CAPE FEAR RIVER BASIN	000.2440
						002	UT SHADDOX CREEK/CAPE FEAR RIVER BSN	
NC0002305	GUILFORD MILLS,INC./GUIL. EAST	.9650	94/09/26	96/07/31	030622	001	NORTHEAST CAPE FEAR RVR/CAPE FEAR RB	000.9650
NC0003433	CP&L CAPE FEAR S.E. (PWR PLT)	10.0000	92/11/30	96/03/31	030607	001	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
						002	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
						003	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
						005	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
						006	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
						007	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
NC0003450	STEVCOKNIT FABRICS CO.	5.0000	92/10/30	96/07/31	030622	002	LITTLE ROCKFISH CREEK/CAPE FEAR RV B	005.0000
NC0003522	ALAMAC KNIT FABICS, ELIZ'TOWN	2.5000	94/05/03	96/05/31	030616	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	002.5000
NC0003573	DUPONT-FAYETTEVILLE	2.0000	93/11/12	96/05/31	030616	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	002.0000
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0003719	MONSANTO	.8890		96/05/31	030615	002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.8590
						003	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.0300
NC0003875	OCCIDENTAL CHEMICAL CORP.	1.0700	91/10/18	96/07/31	030623	001	NORTHEAST CAPE FEAR RVR/CAPE FEAR RB	001.0400
						002	NORTHEAST CAPE FEAR RVR/CAPE FEAR RB	000.0200
						003	UT NORTHEAST CAPE FEAR RVR/CAPE FEAR	000.0100
NC0003913	GLEN RAVEN MILLS-ALTAMAHAW DIV	.0900	95/07/24	00/08/31	030601	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0900
						002	HAW RIVER/CAPE FEAR RIVER BASIN	
						003	HAW RIVER/CAPE FEAR RIVER BASIN	
						004	HAW RIVER/CAPE FEAR RIVER BASIN	
						005	HAW RIVER/CAPE FEAR RIVER BASIN	
NC0003964	US ARMY-FT BRAGG WWTP & WTP	.0000	91/08/01	96/05/31	030614	001	LITTLE RIVER/CAPE FEAR RIVER BASIN	008.0000
						002	LITTLE RIVER/CAPE FEAR RIVER BASIN	
NC0007064	CP&L BRUNSWICK S.E. (PWR PLT)	.0550	93/02/15	96/06/30	030617	001	ATLANTIC OCEAN/	
						002	ATLANTIC OCEAN/	
						003	ATLANTIC OCEAN/	
						004	ATLANTIC OCEAN	000.0550
						005	ATLANTIC OCEAN	
NC0027065	ARCHER DANIELS MIDLAND CO.	3.5020	93/07/15	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	003.5020
NC0039586	CP&L SHEARON HARRIS NUCLEAR	.0500	91/09/16	96/03/31	030607	001	HARRIS RESERVOIR/CAPE FEAR RIVER BSN	017.0000
						002	HARRIS RESERVOIR/CAPE FEAR RIVER BSN	000.0500
						003	HARRIS RESERVOIR/CAPE FEAR RIVER BSN	000.0500
NC0039586	CP&L SHEARON HARRIS NUCLEAR	.0500	91/09/16	96/03/31	030607	004	HARRIS RESERVOIR/CAPE FEAR RIVER BSN	001.5000
						005	HARRIS RESERVOIR/CAPE FEAR RIVER BSN	
NC0059234	TAKEDA CHEMICAL PROD. USA,INC.	1.0000	94/12/13	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.6920

EHNR - DIVISION OF ENVIRONMENTAL MANAGEMENT
NPDES DISCHARGERS IN THE CAPE FEAR RIVER BASIN
DATE RUN: 09/07/95

TYPE / PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW (MGD)
				MAJOR-MUNICIPAL				
NC0020117	CLINTON WWTP, TOWN OF	3.0000	92/08/28	96/07/31	030619	001	WILLIAMS OLD MILL BRNCH/CAPE FEAR RB	003.0000
NC0020575	MOUNT OLIVE WWTP, TOWN OF	1.0000	93/04/18	96/07/31	030621	001	NE CAPE FEAR RIVER/CAPE FEAR RVR BSN	001.0000
NC0021211	GRAHAM WWTP, CITY OF	3.5000		96/07/31	030602	001	HAW RIVER/CAPE FEAR RIVER BASIN	003.5000
NC0021474	MEBANE WWTP, CITY OF	2.5000		96/01/31	030602	001	MOADAMS CREEK/CAPE FEAR RIVER BASIN	001.2000
NC0023256	CAROLINA BEACH WWTP, TOWN OF	1.8500	95/05/30	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	001.8500
NC0023868	BURLINGTON (EAST WWTP)	12.0000		96/01/31	030602	001	HAW RIVER/CAPE FEAR RIVER BASIN	012.0000
NC0023876	BURLINGTON (SOUTH WWTP)	12.0000		96/01/31	030602	001	BIG ALAMANCE CREEK/CAPE FEAR RVR BAS	012.0000
NC0023957	FAYETTEVILLE-CROSS CRK WWTP	22.0000	93/03/29	96/05/31	030615	001	CAPE FEAR RIVER/CAPE FEAR RIVER BSN	022.0000
NC0023965	WILMINGTON-NORTHSIDE WWTP	8.0000	91/08/01	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	008.0000
NC0023973	WILMINGTON-SOUTHSIDE WWTP	12.0000	91/08/01	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	012.0000
NC0024147	SANFORD WWTP, CITY OF	5.0000	93/04/23	96/04/30	030611	001	DEEP RIVER/CAPE FEAR RIVER BASIN	005.0000
NC0024210	HIGH POINT, CITY-EAST SIDE WWT	16.0000		96/03/31	030608	001	RICHLAND CREEK/CAPE FEAR RIVER BASIN	016.0000
NC0024325	GREENSBORO (N BUFFALO CK WWTP)	16.0000		96/01/31	030602	001	NORTH BUFFALO CRK/CAPE FEAR RVER BSN	016.0000
NC0024881	REIDSVILLE WWTP, CITY OF	7.5000		96/01/31	030601	001	LITTLE TROUBLESOME CRK/CAPE FEAR R B	005.0000
NC0025241	OWASA - MASON FARM WWTP	8.0000		96/03/31	030606	001	MORGAN CREEK/CAPE FEAR RIVER BASIN	008.0000
NC0025445	RANDLEMAN WWTP, CITY OF	1.7450	93/10/31	96/03/31	030609	001	DEEP RIVER/CAPE FEAR RIVER BASIN	001.7450
NC0026051	DURHAM CO TRIANGLE WWTP	6.0000	90/07/20	96/02/29	030605	001	NORTHEAST CREEK/CAPE FEAR RIVER BASN	006.0000
NC0026123	ASHEBORO WWTP, CITY OF	6.0000	94/12/16	96/04/30	030609	001	HASKETTS CREEK/CAPE FEAR RIVER BASIN	006.0000
NC0026441	SILER CITY WWTP, TOWN OF	4.0000	91/11/04	96/04/30	030612	001	LOVES CREEK/CAPE FEAR RIVER BASIN	004.0000
NC0026514	RAEFORD WWTP, CITY OF	3.0000	91/11/01	96/05/31	030615	001	ROCKFISH CREEK/CAPE FEAR RIVER BASIN	003.0000
NC0028118	FUQUAY-VARINA, TOWN-KENNETH CK	1.2000	93/01/29	96/03/31	030607	001	KENNETH CREEK/CAPE FEAR RIVER BASIN	001.2000
NC0030970	SPRING LAKE WWTP, TOWN OF	1.5000	91/06/05	96/05/31	030614	001	LOWER LITTLE RIVER/CAPE FEAR RVR BSN	001.5000
NC0043176	DUNN WWTP, CITY OF	3.0000	93/10/29	96/07/31	030613	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	003.0000
NC0047384	GREENSBORO T. Z. OSBORNE WWTP	20.0000		96/01/31	030602	001	SOUTH BUFFALO CRK/CAPE FEAR RVR BASN	020.0000
NC0047597	DURHAM, SOUTH WTR. RECLAM. FAC	20.0000	93/03/10	96/02/29	030605	001	NEW HOPE CREEK/CAPE FEAR RIVER BASIN	020.0000
NC0050105	FAYETTEVILLE - PWC ROCKFISH CK	12.0000	92/10/28	96/05/31	030615	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	012.0000
NC0062855	ROBBINS WWTP (TOWN OF)	1.0000	93/02/11	96/04/30	030610	001	DEEP RIVER/CAPE FEAR RIVER BASIN	001.0000
NC0064521	ERWIN, TOWN OF	1.2000	91/05/01	96/05/31	030613	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	001.2000
NC0081736	NEW HANOVER CO-AIRPORT WWTP	4.0000	93/07/30	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	004.0000
MAJOR-NONMUNICIPAL								
NC0000663	DUPONT-WILMINGTON	3.5000	94/04/29	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	003.5000
						002	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
						003	UT BAY BRANCH/CAPE FEAR RIVER BASIN	
NC0000876	CONE MILLS-GREENSBORO	1.2500		96/01/31	030602	001	NORTH BUFFALO CRK/CAPE FEAR RVR BSN	001.2500
NC0000892	NESTE RESINS CORPORATION	.1000	91/09/30	96/03/31	030607	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.1000
NC0001074	MT. OLIVE PICKLE COMPANY	.4000	95/07/01	96/07/31	030621	002	BARLOW BRANCH/CAPE FEAR RIVER BASIN	
NC0001112	HOECHST CELANESE POLYESTER INT	1.7000	95/03/13	96/06/30	030617	001	NORTHEAST CAPE FEAR RVR/CAPE FEAR RB	001.4000
						002	CAPE FEAR RVR/CAPE FEAR RIVER BASIN	000.9400
NC0001210	MONARCH HOSIERY MILLS, INC.	.0500		96/01/31	030602	001	REEDY FORK CREEK/CAPE FEAR RVR BASIN	000.0500
NC0001228	GENERAL ELECTRIC-WILMINGTON	1.8750	94/12/30	96/06/30	030617	001	NE CAPE FEAR RIVER/CAPE FEAR RVR BSN	001.8000
						002	NE CAPE FEAR RIVER/CAPE FEAR RVR BSN	000.0750

EHNR - DIVISION OF ENVIRONMENTAL MANAGEMENT
NPDES DISCHARGERS IN THE CAPE FEAR RIVER BASIN
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TYPE / PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW (MGD)
MAJOR-NONMU								
NC0078344	CAROLINA FOOD PROCESSORS, INC.	3.0000		96/02/29	030616	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	003.0000
NC0082295	FORTRON INDUSTRIES	.2450	93/05/21	98/04/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.2450
MINOR-MUNICIPAL								
NC0020346	MAGNOLIA WWTP, TOWN OF	.0900	93/03/19	96/07/31	030619	001	UT MILLERS CREEK/CAPE FEAR RIVER BSN	000.0900
NC0020354	PITTSBORO WWTP, TOWN OF	.7500		96/02/29	030604	001	ROBERSON CREEK/CAPE FEAR RIVER BASIN	000.7500
NC0020702	WALLACE WWTP, TOWN OF	1.0000	93/03/29	96/07/31	030622	001	ROCKFISH CREEK/CAPE FEAR RIVER BASIN	001.0000
NC0021113	BURGAW WWTP, TOWN OF	.5000		96/07/31	030623	001	OSGOOD CANAL/CAPE FEAR RIVER BASIN	000.5000
NC0021334	SOUTHPORT WWTP, TOWN OF	.8000	94/07/29	96/06/30	030617	001	COTTAGE CREEK/CAPE FEAR RIVER BASIN	000.8000
NC0021636	LILLINGTON WWTP, TOWN OF	.6000	94/01/14	96/03/31	030607	001	CAPE FEAR RIVER/CAPE FEAR RIVER BSN	000.6000
NC0021903	WARSAW WWTP, TOWN OF	.6100	92/09/14	96/07/31	030619	001	STEWARTS CREEK/CAPE FEAR RIVER BASIN	000.6100
NC0023353	WHITE LAKE WWTP, TOWN OF	.6000		96/07/31	030620	001	UT COLLY CREEK/CAPE FEAR RIVER BASIN	000.6000
NC0025569	GARLAND WWTP, TOWN OF	.1260	91/07/01	96/07/31	030619	001	GREAT COHARIE CREEK/CAPE FEAR RVR BS	000.1260
NC0025763	KURE BEACH WWTP, TOWN OF	.2850	93/08/20	96/07/31	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.2850
NC0025895	HOLLY RIDGE WWTP, TOWN OF	.1000	92/12/23	96/07/31	030624	001	UT KINGS CREEK/CAPE FEAR RIVER BASIN	000.1000
NC0026018	BEULAVILLE WWTP, TOWN OF	.2600	92/03/16	96/07/31	030622	001	PERSIMMON BRANCH/CAPE FEAR RIVER BSN	000.2600
NC0026565	RAMSEUR WWTP, TOWN OF	.4800	93/02/15	96/04/30	030609	001	DEEP RIVER/CAPE FEAR RIVER BASIN	000.4800
NC0026671	ELIZABETHTOWN WWTP, TOWN OF	.7000	95/02/16	96/05/31	030616	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.7000
NC0026816	ROSEBORO WWTP, TOWN OF	.3000	91/04/15	96/07/31	030619	001	LITTLE COHARIE CRK/CAPE FEAR RVR BSN	000.3000
NC0030091	BUIES CREEK WWTP	.5000	93/07/30	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.5000
NC0035866	CHATHAM COUNTY-BYNUM WWTP	.0250	94/03/24	96/02/28	030604	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0250
NC0036668	KENANSVILLE WWTP, TOWN OF	.1700	94/05/31	96/07/31	030622	001	GROVE CREEK/CAPE FEAR RIVER BASIN	000.1700
NC0056863	ROSE HILL WWTP, TOWN OF	.4500	94/07/22	96/07/31	030622	001	REEDY BRANCH/CAPE FEAR RIVER BASIN	000.4500
NC0058548	STAR WWTP, TOWN OF	.6000	91/08/31	96/04/30	030610	001	COTTON CREEK/ CAPE FEAR RIVER BASIN	000.6000
NC0059242	BROADWAY WWTP, TOWN OF	.1450	94/03/31	96/03/31	030607	001	DANIELS CREEK/CAPE FEAR RIVER BASIN	000.1450
NC0063096	HOLLY SPRINGS-UTLEY BRANCH	.2500	93/11/02	96/03/31	030607	001	UTLEY CREEK/CAPE FEAR RIVER BASIN	000.2500
NC0065676	BRUNSWICK CO-LELAND IND PARK	.2500	94/04/29	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.2500
NC0072877	NEWTON GROVE WWTP	.2000	93/06/28	96/07/31	030619	001	BEAVERDAM SWAMP/CAPE FEAR RIVER BASN	000.2000
NC0074373	MOORE WATER AND SEWER AUTH.	.0600	93/08/27	96/05/31	030614	001	LITTLE RIVER/CAPE FEAR RIVER BASIN	000.0600
NC0075540	BELVILLE WWTP, TOWN OF	.4000	94/04/19	96/06/30	030617	001	BRUNSWICK RIVER/CAPE FEAR RIVER BASN	000.4000
MINOR-NONMUNICIPAL								
NC0000639	SAPONA MANUFACTURING COMPANY	.0100	94/12/29	96/04/30	030609	001	DEEP RIVER/CAPE FEAR RIVER BASIN	000.0100
						002	DEEP RIVER/CAPE FEAR RIVER BASIN	
						003	DEEP RIVER/CAPE FEAR RIVER BASIN	
NC0000795	EXXON CO-GREENSBORO	.0000	91/07/25	96/03/31	030608	001	UT EAST FORK DEEP RVR/CAPE FEAR RV B	
NC0000817	WILMINGTON ASSOCIATES L.P.	.1000	94/01/28	96/06/30	030617	001	SMITH CREEK/CAPE FEAR RIVER BASIN	000.1000
NC0001091	LA QUE CNTR FOR CORROSION TECH	.0000	91/05/31	96/07/31	030624	001	BANKS CHANNEL/CAPE FEAR RIVER BASIN	
						002	BANKS CHANNEL/CAPE FEAR RIVER BASIN	
NC0001121	VEEDER-ROOT COMPANY	5.0000	93/08/13	96/03/31	030616	001	CAPE FEAR RIVER/CAPE FEAR RIVER BSN	000.1700
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BSN	
						003	CAPE FEAR RIVER/CAPE FEAR RIVER BSN	000.1520

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TYPE / PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW (MGD)
MINOR-NONMUNICIPAL								
NC0001171	HOOKER FURNITURE CORPORATION	.0200	93/09/10	96/04/30	030609	001	UT POLECAT CREEK/CAPE FEAR RVR BASIN	000.0200
						002	UT POLECAT CRK/CAPE FEAR RIVER BASIN	000.0200
NC0001384	BURLINGTON IND., WILLIAMSBURG	.0250		96/01/31	030602	001	UT BUTTERMILK CREEK/CAPE FEAR RVR BS	000.0250
NC0001384	BURLINGTON IND., WILLIAMSBURG	.0250		96/01/31	030602	002	UT BUTTERMILK CREEK/CAPE FEAR RVR BS	
						003	UT GRAYS BRANCH/CAPE FEAR RIVER BASN	
NC0001970	CHARLES F. CATES & SONS	.5000		96/07/31	030622	001	UT PANTHER BRANCH/CAPE FEAR RVR BASN	000.5000
NC0002763	NATIONAL SPINNING CO - WARSAW	.0000	93/01/29	96/07/31	030622	001	UT GROVE CREEK/CAPE FEAR RIVER BASIN	
						002	UT GROVE TO CREEK/CAPE FEAR RV BASIN	
NC0002861	SANFORD WTP	.0000	91/03/01	96/03/31	030607	001	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
						002	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
NC0002879	WILMINGTON-SWEENEY WTP	.0000	93/05/19	96/06/30	030617	001	NORTHEAST CAPE FEAR RVR/CAPE FEAR RB	
NC0002933	CALYPSO WTP, TOWN OF	.0000	93/01/13	96/07/31	030622	001	UT DICKS BRANCH/CAPE FEAR RVR BASIN	
NC0003140	C.B. CAROON CRAB COMPANY	.0135	93/07/26	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.0135
NC0003344	SWIFT-ECKRICH, INC.	1.5000	92/07/27	96/07/31	030622	001	ROCKFISH CREEK/CAPE FEAR RIVER BASIN	001.5000
NC0003352	FINA OIL & CHEMICAL CO.-	.0000	91/01/16	96/01/31	030602	001	UT HORSEPEN CREEK/CAPE FEAR RVR BASN	
NC0003395	WRIGHT CORPORATION	.1350	93/02/15	96/06/30	030617	002	LIVINGSTON CREEK/CAPE FEAR RIVER BSN	000.1350
NC0003671	AMOCO OIL CO.- GREENSBORO	.0000		96/01/31	030602	001	UT HORSEPEN CRK/CAPE FEAR RIVER BASN	
NC0003727	ARCADIAN FERTILIZER	.2800	92/06/18	96/06/30	030617	001	NE CAPE FEAR RIVER/CAPE FEAR RVR BSN	000.2800
NC0003794	CORNING INCORPORATED	.0000	94/11/23	96/06/30	030617	001	SPRING BRANCH/CAPE FEAR RIVER BASIN	
						002	SPRING BRANCH/CAPE FEAR RIVER BASIN	
NC0007684	NORTHEAST METROPOLITAN WTR DIS	.0000	93/10/20	96/03/31	030607	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0007757	THORN APPLE VALLEY OF CAROLINA	.6500	93/10/29	96/07/31	030623	001	UT JUNIPER SWAMP/ CAPE FEAR RVR BASN	000.6500
NC0007838	MOORE WATER & SEWER AUTHORITY	.0200	93/08/19	96/05/31	030614	001	UT LITTLE RIVER/CAPE FEAR RIVER BASN	000.0200
NC0022098	CEDAR VALLEY MOBILE HOME PARK	.0100		96/02/29	030603	001	LITTLE ALAMANCE CRK/CAPE FEAR RVR BS	000.0100
NC0022209	STAR ENTERPRISE - GREENSBORO	.0000	91/07/22	96/03/31	030608	001	UT LONG BRANCH/CAPE FEAR RIVER BASIN	
NC0022446	RAYCO UTIL.INC./QUARRY HILLS	.0500		96/01/31	030602	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0500
NC0022489	DILTON MHP	.0150	91/05/01	96/05/31	030614	001	LITTLE RIVER/CAPE FEAR RIVER BASIN	000.0150
NC0022675	COUNTRY CLUB MHP	.0430	91/06/12	96/02/29	030603	001	UT LT ALAMANCE CRK/CAPE FEAR RVR BSN	000.0430
NC0022691	AUTUMN FOREST MOBILE HOME PARK	.0820		96/01/31	030602	001	UT REEDY FORK CRK/CAPE FEAR RVR BASN	000.0820
NC0023299	WOODLAKE MHP-GREENSBORO	.0700	91/11/15	96/04/30	030609	001	UT POLECAT CREEK/CAPE FEAR RIVER BSN	000.0700
NC0023442	WILLAMETTE INDUSTRIES,INC.	.0080	93/04/30	96/03/31	030607	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0080
NC0023477	KOCH SULFUR PROD - ACID PLANT	.0000	95/03/13	96/06/30	030617	001	NE CAPE FEAR RIVER/CAPE FEAR RVR BSN	
NC0023639	HOLTRACHEM MFG. CO., L.L.C.	.0000	94/02/25	96/05/31	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0024481	DAYS INN - FAYETTEVILLE	.0250	92/12/04	96/05/30	030615	001	BAKERS SWAMP/CAPE FEAR RIVER BASIN	000.0250
NC0024791	DOT-SAMPSON CO. US 421 REST AR	.0060	91/06/17	96/07/31	030619	001	SIX RUNS CREEK/CAPE FEAR RIVER BASIN	000.0060
NC0025305	UNC-CHAPEL HILL S.E. PWR PLT	.0922	94/05/31	96/03/31	030606	001	UT MORGAN CREEK/CAPE FEAR RIVER BSN	000.0922
NC0026247	LOUIS DREYFUS ENERGY CORP.	.0000		96/03/31	030608	001	UT E. FORK DEEP RVR/CAPE FEAR RVR BS	
NC0026735	CP&L SHEARON HARRIS ENV CTR	.0140	94/03/25	96/03/31	030607	001	HARRIS LAKE/CAPE FEAR RIVER BASIN	000.0200
NC0027758	DOC - SANDY RIDGE CORR CTR4435	.0175		96/03/29	030608	001	UT W. FORK DEEP RVR/CAPE FEAR RVR BS	000.0175
NC0028568	JLM TERMINALS, INC.	.0000	93/06/30	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0029122	US ARMY-SUNNY POINT	.0300	92/04/20	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.0100
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.0100

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TYPE / PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW(MGD)
MINOR-NONMUNICIPAL								
						003	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.0100
NC0029173	NEW HANOVER CO-M. HEIGHTS WWTP	.0500	94/04/29	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.0500
NC0029351	ARROWHEAD MOTOR LODGE	.0070	94/03/22	96/01/31	030602	001	UT HAW CREEK/CAPE FEAR RIVER BASIN	000.0070
NC0029726	DOC-GUILFORD CORRECTIONAL CTR.	.0250		96/01/31	030602	001	UT N.BUFFALO CREEK/CAPE FEAR RVR BSN	000.0250
NC0030384	HAYWOOD-MONCURE HEALTH CENTER	.0025	92/10/30	96/04/30	030611	001	DEEP RIVER/CAPE FEAR RIVER BASIN	000.0025
NC0031046	COLONIAL PIPELINE - GREENSBORO	.0000	92/01/31	96/03/31	030608	001	UT E.FORK-DEEP RIVER/CAPE FEAR RV BS	
						002	UT E.FORK DEEP RIVER/CAPE FEAR RV BS	
						003	UT E.FORK DEEP RIVER/CAPE FEAR RV BS	
						004	UT E.FORK DEEP RIVER/CAPE FEAR RV BS	
						005	UT E.FORK DEEP RIVER/CAPE FEAR RV BS	
						006	UT E FORK DEEP RIVER/CAPE FEAR RV BS	
NC0031470	COOPER RANCH MOBILE HOME PARK	.4000	93/07/15	96/05/31	030614	001	JUMPING RUN CREEK/CAPE FEAR RVR BASN	000.4000
NC0031607	ALAMANCE CO SCH-WESTERN MIDDLE	.0150		96/01/31	030602	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0150
NC0031895	TRIANGLE CARE CENTER, INC.***	.0100	93/03/12	96/02/29	030605	001	UT NEW HOPE CREEK/CAPE FEAR RVR BASN	000.0100
NC0032913	BLADEN CO SCH-E ARCADIA ELEM.	.0060	91/05/16	96/05/31	030616	001	CAPE FEAR RVR/CAPE FEAR RIVER BASIN	000.0060
NC0032948	MOORE CO. SCH.-HIGHFALLS ELEM.	.0040		96/04/30	030610	001	UT DEEP RIVER/CAPE FEAR RIVER BASIN	000.0040
NC0032956	MOORE CO. SCH.-SANDHILLS ELEM.	.0045	93/03/01	96/05/31	030614	001	UT LITTLE RIVER/CAPE FEAR RIVER BASN	000.0045
NC0032964	MOORE CO. SCH.-N.MOORE H.S.	.0100	93/03/12	96/04/30	030610	001	UT BEAR CREEK/CAPE FEAR RIVER BASIN	000.0100
NC0035815	OLDE BRUNSWICK TOWNE COOKERY	.0026	93/02/26	96/03/31	030617	001	BRUNSWICK RIVER/CAPE FEAR RIVER BASN	000.0026
NC0036366	LCP CHEMICALS PLASTICS, INC.	.0000	94/10/21	96/03/31	030608	001	UT WEST FORK DEEP RV/CAPE FEAR RV B	
						002	UT W FORK DEEP RIVER/CAPE FEAR RV BS	
NC0036404	LAKE CREEK CORPORATION	.0200	93/01/13	96/07/31	030620	001	BAY TREE LK TO COLLY CK/CAPE FEAR RB	000.0200
NC0036994	ROCKINGHAM CO SCH-MONROETON	.0042		96/01/31	030601	001	UT TROUBLESOME CREEK/CAPE FEAR RVR B	000.0042
NC0037117	GUILFORD CO SCH-SUMNER ELEM.	.0090		96/03/31	030608	001	UT HICKORY CREEK/CAPE FEAR RIVER BSN	000.0090
NC0038091	GUILFORD CO SCH-SOUTHERN ELEM	.0075		96/03/31	030608	001	UT HICKORY CRK/CAPE FEAR RIVER BASIN	000.0075
NC0038105	GUILFORD CO SCH-E GUILFORD HS	.0150		96/02/29	030603	001	UT LITTLE ALAMANCE CRK/CAPE FEAR R B	000.0150
NC0038130	GUILFORD CO SCH-NORTHWEST J&HS	.0310		96/01/31	030602	001	UT MOORES CREEK/CAPE FEAR RIVER BASN	000.0310
NC0038156	GUILFORD CO SCH-NE SENIOR HS	.0320		96/01/31	030602	001	UT REEDY FORK CRK/CAPE FEAR RVR BASN	000.0320
NC0038164	GUILFORD CO SCH-NATH'NL GREENE	.0045		96/02/29	030603	001	UT N.PRONG-STINKING QTR.CK/CAPE FEAR	000.0045
NC0038172	GUILFORD CO SCH-MCLEANSVILLE	.0113			030602	001	UT S.BUFFALO CRK/CAPE FEAR RVR BSN	000.0113
NC0038181	GUILFORD CO SCH- ALAMANCE ELEM	.0095		96/02/29	030603	001	UT LITTLE ALAMANCE CRK/CAPE FEAR R B	000.0095
NC0038229	GUILFORD CO SCH-S GUILFORD HS	.0120		96/03/31	030608	001	UT HICKORY CRK/CAPE FEAR RIVER BASIN	000.0120
NC0038300	S.S. CONSTRUCTION & RENTAL INC	.0100	93/12/03	96/04/30	030609	001	UT BRUSH CREEK/CAPE FEAR RIVER BASIN	000.0100
NC0038831	CAROLINA TRACE UTILITIES, INC.	.3250	92/09/25	96/05/31	030613	001	UPPER LITTLE RIVER/CAPE FEAR RVR BSN	000.3250
NC0038849	HILL FOREST REST HOME	.0030	92/12/11	96/04/30	030612	001	BEAR CREEK/CAPE FEAR RIVER BASIN	000.0030
NC0039331	CHATHAM CO SCH-BONLEE ELEM	.0070	91/06/17	96/04/30	030612	001	UT BEAR CREEK/CAPE FEAR RIVER BASIN	000.0070
NC0039349	CHATHAM CO SCH-WATERS ELEM	.0090	91/04/01	96/04/30	030611	001	UT CEDAR CREEK/CAPE FEAR RIVER BASIN	000.0090
NC0039357	CHATHAM CO SCH-NORTHWOODS HIGH	.0160	91/06/20	96/02/29	030604	001	UT HAW RIVER/CAPE FEAR RIVER BASIN	000.0160
NC0039381	CHATHAM CO SCH-CENTRAL H.S.	.0100	92/06/30	96/04/30	030612	001	UT BEAR CREEK/CAPE FEAR RIVER BASIN	000.0100
NC0039471	CHATHAM CO SCH-BENNETT ELEM	.0050	91/06/03	96/04/30	030609	001	UT FLAT CREEK/CAPE FEAR RIVER BASIN	000.0050
NC0039527	NEW HANOVER CO-W. HILLS WWTP	.1000	94/04/29	96/07/31	030617	001	UT N.E. CAPE FEAR /CAPE FEAR RVR BSN	000.1000
NC0040061	BRUNSWICK CO-BEAVERDAM CK WTP	.0000	93/02/26	96/06/30	030617	001	BEAVERDAM CREEK/CAPE FEAR RIVER BASN	
NC0040703	HOLIDAY INN EXPRESS	.0200		96/01/31	030602	001	SOUTH BUFFALO CREEK/CAPE FEAR RVR BS	000.0200

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TYPE / PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW (MGD)
MINOR-NONMUNICPAL								
NC0040711	WEYERHAEUSER, MONCURE	.0000	92/06/30	96/03/31	030607	001	HAW RIVER/CAPE FEAR RIVER BASIN	
NC0040860	ROYAL PALMS MOBILE HOME PARK	.0450	92/10/30	96/06/30	030617	001	MOTT CREEK/CAPE FEAR RIVER BASIN	000.0450
NC0040924	RANDOLPH CO SCH-SEAGROVE ELEM	.0088	93/01/13	96/04/30	030609	001	UT FORK CREEK/CAPE FEAR RIVER BASIN	000.0088
NC0040941	RANDOLPH CO SCH-GRAYS CHAPEL	.0090	93/06/30	96/04/30	030609	001	UT SANDY CREEK/CAPE FEAR RIVER BASIN	000.0090
NC0040967	RANDOLPH CO SCH-E RANDOLPH ***	.0170	93/01/29	96/04/30	030609	001	UT REED CREEK/CAPE FEAR RIVER BASIN	000.0170
NC0040975	RANDOLPH CO SCH-COLERIDGE ELEM	.0056	93/01/13	96/04/30	030609	001	DEEP RIVER/CAPE FEAR RIVER BASIN	000.0056
NC0040983	RANDOLPH CO SCH-BROWER ELEM	.0014	94/07/22	96/03/30	030609	001	UT FORK CREEK/CAPE FEAR RIVER BASIN	000.0014
NC0041483	PLAZA MOBILE HOME PARK	.0030	93/06/30	96/03/31	030608	001	UT HICKORY CREEK/CAPE FEAR RIVER BSN	000.0030
NC0041505	HUNTINGTON PROPERTIES, LLC	.0350	95/08/09	96/03/31	030608	001	UT BULL RUN CREEK/CAPE FEAR RVR BASN	000.0350
NC0042030	FAITH CHRISTIAN SCH	.0053	93/11/12	96/04/30	030609	001	UT DEEP RIVER/CAPE FEAR RIVER BASIN	000.0053
NC0042251	PENDER CO SCH-PENDER HIGH SCH	.0200	93/02/15	96/07/31	030623	001	LONG CREEK/CAPE FEAR RIVER BASIN	000.0200
NC0042285	TRAILS PROPERTY OWNERS ASSOC.	.0400		96/02/28	030604	001	UT COLLINS CREEK/CAPE FEAR RIVER BSN	000.0400
NC0042501	TRIAD TERMINAL COMPANY	.0000	93/08/19	96/03/31	030608	001	UT EAST FORK DEEP RV/CAPE FEAR R BAS	
NC0042528	DIXIE YARNS-SAXAPAHAW PLANT	.0150		96/01/31	030602	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0150
NC0042803	BIRCHWOOD MOBILE HOME PARK	.0180		96/02/28	030605	001	UT NEW HOPE CREEK/CAPE FEAR RVR BASN	000.0180
NC0043257	NATURE TRAILS MHP CARLYLEGROUP	.0400		96/02/28	030606	001	CUB CREEK/CAPE FEAR RIVER BASIN	000.0400
NC0043362	GUILFORD CO SCH-PLE'SNT GARDEN	.0050		96/01/31	030603	001	UT LITTLE ALAMANCE CRK/CAPE FEAR R B	000.0050
NC0043559	FEARRINGTON UTILITIES	.1800		96/02/29	030605	001	UT BUSH CREEK/CAPE FEAR RIVER BASIN	000.2700
NC0043788	COLUMBUS CO SCH-ACME DELCO HS	.0100	94/07/22	96/06/30	030617	001	UT LINDSCOMB BRNCH/CAPE FEAR RVR BSN	000.0100
NC0043796	COLUMBUS CO SCH-ACME DELCO ELE	.0090	94/05/31	96/06/30	030617	001	UT PRETTY CREEK/CAPE FEAR RIVER BASN	000.0090
NC0044385	GUILFORD CO SCH-SOUTHEAST HS	.0320		96/02/29	030603	001	UT BIG ALAMANCE CRK/CAPE FEAR RVR BS	000.0320
NC0045128	ALAMANCE CO SCH-SYLVAN ELEM	.0014		96/02/29	030604	001	CANE CREEK/CAPE FEAR RIVER BASIN	000.0014
NC0045144	ALAMANCE CO SCH-W ALAMANCE HS	.0115		96/01/31	030602	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0115
NC0045152	ALAMANCE CO SCH-JORDAN ELEM	.0075		96/01/31	030602	001	HAW RIVER/ CAPE FEAR RIVER BASIN	000.0075
NC0045161	ALAMANCE CO SCH-ALTAMAHAW-OSSI	.0120		96/01/31	030601	001	HAW RIVER/CAPE FEAR RIVER BASIN	000.0120
NC0045292	GRAHAM MEBANE WTP-GRAHAM	.0000		96/01/31	030602	001	BACK CREEK/CAPE FEAR RIVER BASIN	
NC0046019	EPISCOPAL DIOCESE-CONF. CENTER	.0150		96/01/31	030601	001	UT HAW RIVER/CAPE FEAR RIVER BASIN	000.0150
NC0046043	OAK RIDGE ACADEMY	.0400	91/11/01	96/01/31	030601	001	UT HAW RIVER/CAPE FEAR RIVER BASIN	000.0400
NC0046299	COASTAL CAROLINA UTILITIES,INC	.1000	91/05/31	96/06/30	030617	001	SMITH CREEK/CAPE FEAR RIVER BASIN	000.1000
NC0046345	REIDSVILLE, CITY OF (WTP)	.0000		96/01/31	030601	001	REID LAKE/CAPE FEAR RIVER BASIN	
						002	TROUBLESOME CREEK/CAPE FEAR RVR BASN	
NC0046809	PENTECOSTAL HOLINESS CHURCH	.0040		96/01/31	030601	001	UT BENAJA CREEK/CAPE FEAR RIVER BASN	000.0200
NC0048101	PIERCE & HALL REST HOME	.0070	92/12/30	96/03/31	030607	001	U T KENNETH CREEK/CAPE FEAR RVR BASN	000.0070
NC0048241	STALEY HOSIERY MILLS	.0050	93/08/19	96/02/28	030603	001	UT BIG ALAMANCE CREEK/CAPE FEAR RV B	000.0050
NC0048429	CEDAR VILLAGE APARTMENTS	.0050	91/06/03	96/03/31	030604	001	UT CUB CREEK/CAPE FEAR RV BSN	000.0050
NC0049115	LEE CO. SCH.-DEEP RIVER ELEM.	.0060	91/07/19	96/03/31	030607	001	UT COOPER MINE CREEK/CAPE FEAR RV BS	000.0060
NC0049743	NEW HANOVER CO-LANDFILL WWTP	.0500	93/07/26	96/06/30	030617	001	NE CAPE FEAR RVR/CAPE FEAR RVR BASIN	000.0500
NC0050024	FOREST OAKS COUNTRY CLUB	.0100		96/02/28	030603	001	UT BEAVER CRK/CAPE FEAR RIVER BASIN	000.0100
NC0050792	RAYCO UTILITIES-MELBILLE HGHTS	.0315	93/01/13	96/03/31	030608	001	MUDDY CREEK/CAPE FEAR RIVER BASIN	000.0315
NC0051161	PLANTATION PIPE LINE COMPANY	.0000	93/10/20	96/03/31	030608	001	UT EAST FORK DEEP RV/CAPE FEAR RV BS	
						002	UT EAST FORK DEEP RVR/CAPE FEAR RV B	
NC0051314	COLE PARK PLAZA SHOPPING CTR	.0150	93/03/29	96/03/31	030606	001	UT CUB CREEK/CAPE FEAR RIVER BASIN	000.0150
NC0051331	CHAPEL HILL WEST - TOWER AP***	.0016	92/10/30	96/02/28	030604	001	UT MEADOW BRANCH/CAPE FEAR RIVER BSN	000.0016
NC0051969	HERMITAGE HOUSE REST HOME	.0120	93/07/26	96/07/31	030623	001	UT PRINCE GEORGE CREEK/CAPE FEAR R B	000.0120

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TYPE PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW(MGD)
NC0055051	COUNTRY LAKE ESTATES ASSOC.	.0900	91/02/28	96/03/31	030607	001	UT BUCKHORN CREEK/CAPE FEAR RVR BASN	000.0900
NC0055107	INLET BAY UTILITY-DOLPHIN BAY	.0800	92/10/30	96/06/30	030617	001	SNOWS CUT/CAPE FEAR RIVER BASIN	000.0800
NC0055191	RAYCO UTILITIES, INC.-PENMAN	.0250	93/08/31	96/03/31	030608	001	UT MUDDY CREEK/CAPE FEAR RIVER BASIN	000.0250
NC0055255	CROWN MOBILE HOME PARK	.0420	93/07/15	96/03/31	030608	001	UT HICKORY CREEK/CAPE FEAR RIVER BSN	000.0420
NC0055271	SHIELDS MOBILE HOME PARK	.0060		96/01/31	030602	001	TRAVIS CREEK/CAPE FEAR RIVER BASIN	000.0060
NC0055913	MONROE'S MOBILE HOME PARK	.0300	93/09/03	96/04/30	030609	001	POLECAT CREEK/CAPE FEAR RIVER BASIN	000.0300
NC0056413	CAROLINA MEADOWS INC.	.0900	94/04/27	96/03/31	030606	001	UT MORGAN CREEK/CAPE FEAR RIVER BASN	000.0900
NC0057525	FREEMAN INV/CRYSTAL LAKE CONDO	.0120	93/11/12	96/05/31	030614	001	MILL CREEK/CAPE FEAR RIVER BASIN	000.0120
NC0057533	BRUNSWICK CO-HOOD CREEK WTP	.0000	91/05/31	96/06/30	030617	001	HOOD CREEK/CAPE FEAR RIVER BASIN	
NC0057703	FAIRWAYS UTILITIES/THE CAPE	.2600	92/02/17	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.3500
NC0058271	COGENTRIX - KENANSVILLE	.0000	91/11/19	96/07/31	030622	001	UT NE CAPE FEAR RVR/CAPE FEAR RVR BS	
						002	UT NE CAPE FEAR RVR/CAPE FEAR RVR BS	
						003	UT NE CAPE FEAR RVR/CAPE FEAR RVR BS	
NC0058297	COGENTRIX - ELIZABETHTOWN	.0000	91/12/03	96/05/31	030616	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
						003	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0058599	CLAIRMONT SHOPPING CENTER	.1000	93/11/02	96/06/30	030617	001	BRUNSWICK RIVER/CAPE FEAR RIVER BASN	000.1000
NC0058793	FALCON CHILDREN'S HOME, INC.	.0500	94/01/31	96/07/31	030618	001	SOUTH RIVER/CAPE FEAR RIVER BASIN	000.0500
NC0058971	NEW HANOVER CO-REFUSE TO STEAM	.0000	94/06/30	96/06/30	030617	001	UT NE CAPE FEAR RVR/CAPE FEAR RVR BS	
NC0059323	CP&L BIOASSAY-NEW HILL	.0000		96/03/31	030607	001	UT THOMAS CRK/CAPE FEAR RIVER BASIN	
NC0059625	SOUTH SAXAPAHAW HOME OWNERS	.0000	94/10/11	96/01/31	030602	001	UT HAW RIVER/CAPE FEAR RIVER BASIN	
NC0059978	FAIRWAYS UTILITIES, INC.	.4000	92/05/29	96/07/31	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.4000
NC0060259	WILLOW OAK ACRES MHP	.0175		96/01/31	030601	001	LITTLE TROUBLESOME CRK/CAPE FEAR R B	000.0175
NC0060291	RIVER RUN UTILITIES, INC.	.0250	94/05/31	96/06/30	030617	001	JUMP & RUN CREEK/CAPE FEAR RIVER BSN	000.0250
NC0060747	NAT'L ELECTRICAL CARBON CORP	.0260	93/09/30	96/07/31	030618	001	JUNIPER CREEK/CAPE FEAR RIVER BASIN	000.0260
NC0061045	BROOKSIDE HOUSING DEVELOPMENT	.0150	91/02/18	96/02/29	030603	001	UT LITTLE ALAMANCE CRK/CAPE FEAR R B	000.0150
NC0061271	CHURCHILL ESTATES	.0250	91/05/31	96/06/30	030617	001	SMITH CREEK/ CAPE FEAR RIVER BASIN	000.0420
NC0061379	CP&L VISITOR/MEDIA CENTER	.0020	91/07/19	96/06/30	030617	001	ATLANTIC OCEAN-BRUNSWICK/CAPE FEAR R	000.0020
NC0061719	WOODLAKE WATER & SEWER CO.INC.	1.0000	91/04/23	96/05/31	030614	001	CRANE CREEK/CAPE FEAR RIVER BASIN	001.0000
NC0062804	NEW HANOVER CO-N'CHASE WWTP	.2000	93/12/15	96/07/31	030623	001	NE CAPE FEAR RIVER/CAPE FEAR RVR BSN	001.0000
NC0064700	CREEKSIDE TOWNHOMES-II	.0270	92/02/06	96/06/30	030617	001	JACKEYS CREEK/CAPE FEAR RIVER BASIN	000.0270
NC0065099	COGENTRIX - SOUTHPORT	.0000	92/09/11	96/06/30	030617	001	CP&L-BRUNSWICK CANAL/CAPE FEAR RV BS	
						002	CP&L-BRUNSWICK CANAL/CAPE FEAR RV BS	
NC0065111	AMERICAN CRANE CORP. (THE)	.0000	94/11/23	96/06/30	030617	001	UT BARNARDS CREEK/CAPE FEAR RVR BASN	
NC0065307	WORSLEY COMPANIES-DIXIE BOY#6	.0040	92/03/02	96/06/30	030617	001	NE CAPE FEAR RIVER/CAPE FEAR RVR BSN	000.0040
NC0065358	HIDDEN FOREST ESTATES MHP	.0270	91/08/26	96/04/30	030608	001	UT DEEP RIVER/CAPE FEAR RIVER BASIN	000.0270
NC0065412	PONDEROSA MOBILE HOME PARK	.0235		96/01/31	030601	001	LITTLE TROUBLESOME CRK/CAPE FEAR R B	000.0235
NC0065480	BEAU RIVAGE PLANTATION	.5000	91/07/01	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.5000
NC0065803	ASHLAND PETROLEUM CO./GRNSBORO	.0000	93/06/30	96/03/31	030608	001	UT EAST FORK DEEP RIVER/CAPE FEAR RB	
NC0066010	WILLIAMSBURG ELEMENTARY SCHOOL	.0040		96/01/31	030601	001	UT HAW RIVER/ CAPE FEAR RIVER BASIN	000.0040
NC0066711	AMERADA HESS CORPORATION	.0000	93/04/08	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RVR BASIN	
NC0066966	QUARTERSTONE FARM WWTP	.2000		96/01/31	030602	001	BUFFALO CREEK/CAPE FEAR RIVER BASIN	000.2000
NC0068004	WILMINGTON SHIPYARD, INC.	.0000	92/11/04	96/06/30	030617	002	NORTHEAST CAPE FEAR RVR/CAPE FEAR RB	
NC0068314	COASTAL CAROLINA UTILITIES,INC	.0300	92/05/27	96/06/30	030617	001	SMITH CREEK/CAPE FEAR RIVER BASIN	000.0300
NC0069256	AMERADA HESS CORPORATION	.0000	94/06/30	96/03/31	030608	001	UT E. FORK DEEP RVR/CAPE FEAR RVR BS	

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TYPE PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW (MGD)
NC0069451	RIMMER MOBILE HOME COURT	.0204	94/09/27	96/03/31	030608	001	MUDDY CREEK/CAPE FEAR RIVER BASIN	000.0204
NC0070378	HYDRAULICS LTD.	.0005	93/01/29	96/03/31	030604	001	UT POKEBERRY CREEK/CAPE FEAR RIVER B	
NC0070769	UNITED HOLY CHURCH OF AMERICA	.0100		96/01/31	030602	001	UT NORTH BUFFALO CK/CAPE FEAR RV BSN	000.0100
NC0071463	PETROLEUM FUEL AND TERMINAL CO	.0000		96/01/31	030602	001	UT HORSEPEN CREEK/CAPE FEAR RVR BASN	
NC0072575	GOLDEN POULTRY, INC.	1.0000	93/05/07	96/04/30	030611	001	DEEP RIVER/CAPE FEAR RIVER BASIN	
NC0072681	CAMPBELL OIL COMPANY	.0000	94/04/29	96/06/30	030617	001	UT BURNT MILL CRK/CAPE FEAR RVR BSN	
NC0072796	B.F. GOODRICH COMPANY	.0000	93/08/19	96/06/30	030617	001	SMITH CREEK/CAPE FEAR RIVER BASIN	
NC0073172	PAKTANK CORPORATION	.0000	94/04/04	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0073181	EXXON CHEMICAL COMPANY	.0000	93/09/30	96/06/28	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0073571	COUNTRYSIDE VIL. RETIRE. CTR.	.0150	94/01/31	96/01/31	030601	001	TROUBLESOME CREEK/CAPE FEAR RVR BASN	000.0150
NC0074179	CLARK ENVIRONMENTAL SERVICE	.0144	93/11/12	96/06/30	030617	001	BURNT MILL CREEK/CAPE FEAR RIVER BSN	
NC0074292	DOWTIN INVESTMENT CO. ***	.0300	94/07/29	96/01/31	030601	001	BENAJA CREEK/CAPE FEAR RIVER BASIN	000.0300
NC0074446	HILLTOP MOBILE HOME PARK	.0120	93/10/29	96/02/28	030605	001	OLD FIELD CREEK/CAPE FEAR RIVER BASN	000.0120
NC0074454	RAMSEUR WTP TOWN OF	.0000	94/01/18	96/04/30	030609	001	SANDY CREEK/CAPE FEAR RIVER BASIN	
NC0074578	CONOCO INC-GREENSBORO PROD TER	.0000		95/05/31	030608	001	UT LONG BRANCH/CAPE FEAR RIVER BASIN	
NC0075850	PAGE, KENDALL H. -MHP	.0016	94/08/31	96/03/31	030606	001	UT BIG BRANCH/CAPE FEAR RIVER BASIN	000.0016
NC0076732	KOCH REFINING CO.INC./NORTH T.	.1000	94/09/12	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.1000
NC0076783	P.O. HOFFER WATER TREATMENT	.0000	94/04/29	96/05/31	030615	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
NC0077101	CAROLINA WTR SERV.-WHISPERIN 4	.0000	94/12/12	96/05/31	030614	001	UT LITTLE RIVER/CAPE FEAR RIVER BASN	
NC0077691	S&W READY MIX CONCRETE CO.,INC	.0003	94/06/30	96/07/31	030617	001	N.E. CAPE FEAR RVR/CAPE FEAR RVR BSN	000.0003
NC0077968	HORNER INVESTMENT GROUP	.0400		96/01/31	030602	001	REEDY FORK/CAPE FEAR RIVER BASIN	000.0400
NC0078000	WORTH CHEMICAL CORPORATION	.2160		96/01/31	030602	001	UT SOUTH BUFFALO CK/CAPE FEAR RV BAS	000.2160
NC0078221	PIEDMONT CONCRETE COMPANY ***	.0000	93/04/07	95/05/31	030602	001	UT MILE RUN CREEK/CAPE FEAR RVR BASN	
NC0078955	DUNN WTP, CITY OF	2.0000	91/04/01	96/03/31	030613	001	JUNIPER CREEK/CAPE FEAR RIVER BASIN	
NC0079286	GENERAL WOOD PRESERVING CO.INC	.0000	92/03/02	96/06/30	030617	001	UT STURGEON CREEK/CAPE FEAR RVR BASN	
NC0079707	SOUTHERN PRODUCTS DISTRIB. INC	.0490	94/07/29	96/07/31	030622	001	UT PANTHER CREEK/CAPE FEAR RIVER BSN	
NC0080560	ERWIN WTP, TOWN OF	.0000	91/12/02	96/05/31	030613	001	UT CAPE FEAR RIVER/CAPE FEAR RVR BSN	
NC0080896	PITTSBORO WTP, TOWN OF	.0000	92/05/22	96/02/29	030604	001	HAW RIVER/CAPE FEAR RIVER BASIN	
NC0081256	HIGH POINT, CITY OF	.0000		96/03/31	030608	001	UT RICHLAND CREEK/CAPE FEAR RVR BASN	
NC0081426	GREENSBORO/N.L.MITCHELL WTP	.0000		96/01/31	030602	001	NORTH BUFFALO CREEK/CAPE FEAR RVR BS	
NC0081493	BOST DISTRIBUTING CORP.	.0030	92/05/01	96/04/30	030611	001	PURGATORY BRANCH/CAPE FEAR RIVER BSN	000.0030
NC0081507	FEDERAL PAPER BOARD - WILMNTON	.0500	92/06/15	96/06/30	030617	001	BURNT MILL CREEK/CAPE FEAR RIVER BSN	000.0500
NC0081591	CARY WATER TREATMENT PLANT	.0000	93/06/07	96/02/29	030605	001	UT WHITE OAK CREEK/CAPE FEAR RVR BSN	
NC0081671	GREENSBORO-LAKE TOWNSEND W FAC	1.5000		96/01/31	030602	001	REEDY FORK CREEK/CAPE FEAR RIVER BSN	
NC0081795	GOLDSTON GULF SANITARY DIST.	.0060	92/10/28	96/04/30	030611	001	DEEP RIVER/CAPE FEAR RIVER BASIN	000.0060
NC0082082	UNC-GREENSBORO	.0000		96/01/31	030602	001	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						002	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						003	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						004	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						005	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						006	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						007	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						008	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						009	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						010	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	

EHNR - DIVISION OF ENVIRONMENTAL MANAGEMENT
NPDES DISCHARGERS IN THE CAPE FEAR RIVER BASIN
DATE RUN: 09/07/95

TYPE / PERMIT	FACILITY	DESIGN FLOW	ISSUED	EXPIRES	BASIN	PIPE#	STREAM DESCRIPTION	PERMITTED FLOW(MGD)
						011	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						012	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						013	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						014	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						015	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						016	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						017	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						018	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						019	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						020	NORTH BUFFALO CRK/CAPE FEAR RVR BASN	
						021	SOUTH BUFFALO CRK/CAPE FEAR RVR BASN	
NC0082210	ORANGE WATER & SEWER AUTHORITY	15.0000	93/04/30	96/03/31	030606	001	UT MORGAN CREEK/CAPE FEAR RIVER BASN	
NC0082406	CROSS RESIDENCE (ANNE)	.0003	93/03/12	96/03/31	030606	001	UT BOOKER CREEK/CAPE FEAR RIVER BASN	000.0003
NC0082597	ANGIER WWTP, TOWN OF	.5000	93/07/30	96/03/31	030607	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.5000
NC0082872	BRUNSWICK COVE NURSING CENTER	.0168	93/11/30	96/06/30	030617	001	BRUNSWICK RIVER/CAPE FEAR RIVER BASN	000.0168
NC0082970	CTI OF NORTH CAROLINA	.0144	94/08/12	96/06/30	030617	001	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	
						002	CAPE FEAR RIVER/CAPE FEAR RIVER BASN	000.0144
NC0083062	CONE MILLS CORP. - HAW R. ***	.0000	93/07/30	96/01/31	030602	001	HAW RIVER/CAPE FEAR RIVER BASIN	
NC0083135	B&B PRODUCE INC	.0250	94/02/18	96/07/31	030618	001	UT MINGO SWAMP/CAPE FEAR RIVER BASIN	000.0250
NC0083658	AAF/MCQUAY, INC.	.2880	94/10/12	96/06/30	030617	001	UT BARNARDS CREEK/CAPE FEAR RVR BASN	000.2880
NC0083828	BURLINGTON, CITY OF	.0000	94/02/08	96/02/28	030603	001	BIG ALAMANCE CREEK/CAPE FEAR RVR BSN	
NC0083852	LEE COUNTY WATER TREATMENT	.0000	94/02/28	96/04/30	030611	001	UT DEEP RIVER/CAPE FEAR RIVER BASIN	
NC0083895	CP&L BRUNSWICK S.E. (WWTP)	.0360	94/04/26	96/06/30	030617	001	BRUNSWICK CHANNEL-ATLANTIC/CAPE FEAR	000.0360
NC0084018	EXXON FRANKLIN STREET	.0080	94/07/29	96/03/31	030606	001	BOLIN CREEK/CAPE FEAR RIVER BASIN	000.0080
NC0084077	HANCOCK COUNTRY HAMS INC.	.1000		96/04/30	030609	001	UT SANDY CREEK/CAPE FEAR RIVER BASIN	000.1000
NC0084093	JORDAN LAKE WTP	.0000		96/02/28	030605	001	NEW HOPE RVR(JORDAN LAKE)/CAPE FEAR	
NC0084328	LAWRENCE INDUSTRIES	.1200	94/11/14	96/06/30	030602	001	UT HAW RIVER/CAPE FEAR RIVER BASIN	000.1200
NC0084492	CAROLINA STEEL CORPORATION	.0000	95/01/24	96/03/31	030608	001	UT W.FORK DEEP RVR/CAPE FEAR RVR BSN	
NC0084522	EXXON COMPANY, USA -GREENSBORO	.0020	94/12/19	96/03/31	030608	001	UT JENNY BRANCH/CAPE FEAR RIVER BASN	
NC0084603	KENAN OIL COMPANY	.0072	95/06/30	00/07/31	030606	001	UT CHAPEL CREEK/CAPE FEAR RIVER BASN	000.0072
NC0084646	CHEVRON USA PRODUCTS CO	.0144	95/05/01	96/07/31	030618	001	UT BLACK RIVER/CAPE FEAR RIVER BASIN	000.0144
NC0084778	BRIN-MONT CORPORATION	.1100	95/08/07	00/08/31	030602	001	UT N.BUFFALO CREEK/CAPE FEAR RVR BSN	000.1100
NC0084816	THOMASVILLE FURNITURE IND.	.0288	95/07/12	00/07/31	030609	001	UT POLECAT CREEK/CAPE FEAR RIVER BSN	000.0288

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