Chapter 3 -
Summary of Water Quality Information for the Roanoke River Basin

3.1 General Sources of Pollution

Human activities can negatively impact surface water quality, even when the activity is far removed from the waterbody. With proper management of wastes and land use activities, these impacts can be minimized. Pollutants that enter waters can be grouped into two general categories: *point sources* and *nonpoint sources*.

Point Sources

- Piped discharges from municipal wastewater treatment plants
- Industrial facilities
- Small package treatment plants
- Large urban and industrial stormwater systems

Point sources are typically piped discharges and are controlled through regulatory programs administered by the state. All regulated point source discharges in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state.

Nonpoint Sources

- Stormwater runoff
- Agricultural lands
- Rural residential development
- Hydrologic modifications
- Septic systems
- Timber harvesting

Nonpoint sources are from a broad range of land use activities. Nonpoint source pollutants are typically carried to waters by rainfall, runoff or snowmelt. Sediment and nutrients are most often associated with nonpoint source pollution. Other pollutants associated with nonpoint source pollution include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or deposited from the atmosphere into surface waters.

Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur intermittently, depending on rainfall events and land disturbance. Given the diffuse nature of nonpoint source pollution, it is difficult and resource intensive to quantify nonpoint contributions to water quality degradation in a given watershed. While nonpoint source pollution control often relies on voluntary actions, the state has many programs designed to reduce nonpoint source pollution.

Every person living in or visiting a watershed contributes to impacts on water quality. Therefore, each individual should be aware of these contributions and take actions to reduce them.

Cumulative Effects

While any one activity may not have a dramatic effect on water quality, the cumulative effect of land use activities in a watershed can have a severe and long-lasting impact.

3.2 Description of Surface Water Classifications and Standards

North Carolina's Water Quality Standards program adopted classifications and water quality standards for all the state's river basins by 1963. The program remains 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.

Statewide Classifications

All surface waters in the state are assigned a *primary* classification that is appropriate to the best uses of that water. In addition to primary classifications, surface waters may be assigned a *supplemental* classification. Most supplemental classifications have been developed to provide special protection to sensitive or highly valued resource waters. Table A-20 briefly describes the best uses of each classification. A full description is available in the document titled: *Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina*. Information, including a database of North Carolina's stream classifications, is also available on DWQ's website at http://h2o.enr.state.nc.us/csu/.

Table A-20 Primary and Supplemental Surface Water Classifications

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.
SA	Waters classified for commercial shellfish harvesting.
WS	*Water Supply watershed*. There are five WS classes ranging from WS-I through WS-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. WS-I provides the highest level of protection and WS-IV provides the least protection. 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.
Tr	*Trout Waters*: Provides protection to freshwaters for natural trout propagation and survival of stocked trout.
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 excessive plant growth resulting from nutrient enrichment.

* Primary classifications beginning with a "S" are assigned to saltwaters.

Statewide Water Quality Standards

Each primary and supplemental classification is assigned a set of water quality *standards* that establish the level of water quality that must be maintained in the waterbody to support the uses associated with each classification. Some of the standards, particularly for HQW and ORW waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. These strategies are discussed briefly below. The standards for C and SC waters establish the basic protection level for all state surface waters. With the exception of Sw, all of the other primary and supplemental classifications have more stringent standards than for C and SC, and therefore, require higher levels of protection.

Some of North Carolina's surface waters are relatively unaffected by pollution sources and have water quality higher than the standards that are applied to the majority of the waters of the state. In addition, some waters provide habitat for sensitive biota such as trout, juvenile fish, or rare and endangered aquatic species.

Trout Waters

Different water quality standards for some parameters, such as dissolved oxygen, temperature and turbidity, have been developed to protect freshwaters for natural trout propagation and survival of stocked trout. These water quality standards result in more restrictive limits for wastewater discharges to trout waters (Tr). There are no watershed development restrictions associated with the Tr classification. However, the NC Division of Land Resources does require a 25-foot vegetated buffer between Tr waters and graded construction sites.

A state fishery management classification, Designated Public Mountain Trout Waters, is administered by the NC Wildlife Resources Commission. It provides for public access to streams for fishing and regulates fishing activities (seasons, size limits, creel limits, and bait and lure restrictions). Although many of these waters are also classified Tr by DWQ, this is not the same classification.

High Quality Waters

Special HQW protection management strategies are intended to prevent degradation of water quality below present levels from both point and nonpoint sources. HQW requirements for new wastewater discharge facilities and 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.

Criteria for HQW Classification

- Waters rated as Excellent based on DWQ's chemical and / or biological sampling.
- Streams designated as native and special native trout waters or primary nursery areas by the Wildlife Resources Commission (WRC).
- Waters classified by DWQ as WS-I and WS-II are HQW by definition, but these waters are not specifically assigned the HQW classification because the standards for WS-I and WS-II waters are sometimes more stringent than those classified HQW.

For nonpoint source pollution, development activities which require a Sedimentation and Erosion Control Plan in accordance with rules established by the NC Sedimentation Control Commission or an approved local erosion and sedimentation control program, and which drain to and are within one mile of HQWs, are required to control runoff from the development using either a low density or high density option. The low density option requires a 30-foot vegetated buffer between development activities and the stream; whereas, the high density option requires structural stormwater controls. In addition, the Division of Land Resources requires more stringent erosion controls for land-disturbing projects within one mile and draining to HQWs.

Outstanding Resource Waters

A small percentage of North Carolina's surface waters have excellent water quality (rated based on biological and chemical sampling as with HQWs) and an associated outstanding resource.

The ORW rule defines outstanding resource values as including one or more of the following:

- an outstanding fisheries resource;
- a high level of water-based recreation;
- a special designation such as National Wild and Scenic River or a National Wildlife Refuge;
- within a state or national park or forest; or
- a special ecological or scientific significance.

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 .0225. At a minimum, no new discharges or expansions are permitted, and a 30-foot vegetated buffer or stormwater controls for new developments are required. In some circumstances, the unique characteristics of the waters and resources that are to be protected require that a specialized (or customized) ORW management strategy be developed.

Water Supply Watersheds

The purpose of the Water Supply Watershed Protection Program is to provide an opportunity for communities to work with the state to strengthen protection of their water supplies. There are five water supply classifications (WS-I to WS-V) that are defined according to the amount and types of permitted point source discharges, as well as requirements to control nonpoint sources of pollution (Table A-20). Watersheds draining to waters classified WS carry some restrictions on point source discharges and on many land use activities including urban development, agriculture, forestry and highway sediment control. Minimum requirements for WS-I to WS-IV include a 30-foot undisturbed vegetated buffer. The WS-I and WS-II classifications are HQW by definition because requirements for these levels of water supply protection are at least as stringent as for HQWs.

Classifications and Standards in the Roanoke River Basin

The waters of the Roanoke River basin have a variety of surface water quality classifications applied to them. Water supply watersheds range from WS-II to WS-IV. There are currently no designated High Quality Waters in the basin and only two small segments of Outstanding Resource Waters which are discussed in the following section. Several miles of stream, including the Dan River mainstem, in the upper portion of the Dan River watershed are classified

Trout Waters. Portions of the Roanoke River basin that contain these special classifications are shown on Figures A-15 and A-16.

Pending and Recent Reclassifications in the Roanoke River Basin

In August of 1998, a portion of two streams, Cascade and Indian Creeks, inside the Hanging Rock State Park were reclassified Outstanding Resource Waters. In addition to excellent water quality found in both streams, rare benthic macroinvertebrate species were found in both Cascade Creek and an unnamed tributary. Both streams were also found to be "important components of a state park" that have "special ecological significance" in the area.

Parts of some streams located in the lower portion of the Roanoke River basin may qualify for the Outstanding Resource Waters designation and/or a special set of management strategies based on their ecological and scientific significance, their presence as part of a National Wildlife Refuge, and their unique recreational value. Management strategies associated with these reclassifications would take into account natural variations in these complex swamp stream systems. Citizens, organizations or local governments can recommend waters for reclassification at any time, and DWQ will consider them for these protective classifications.

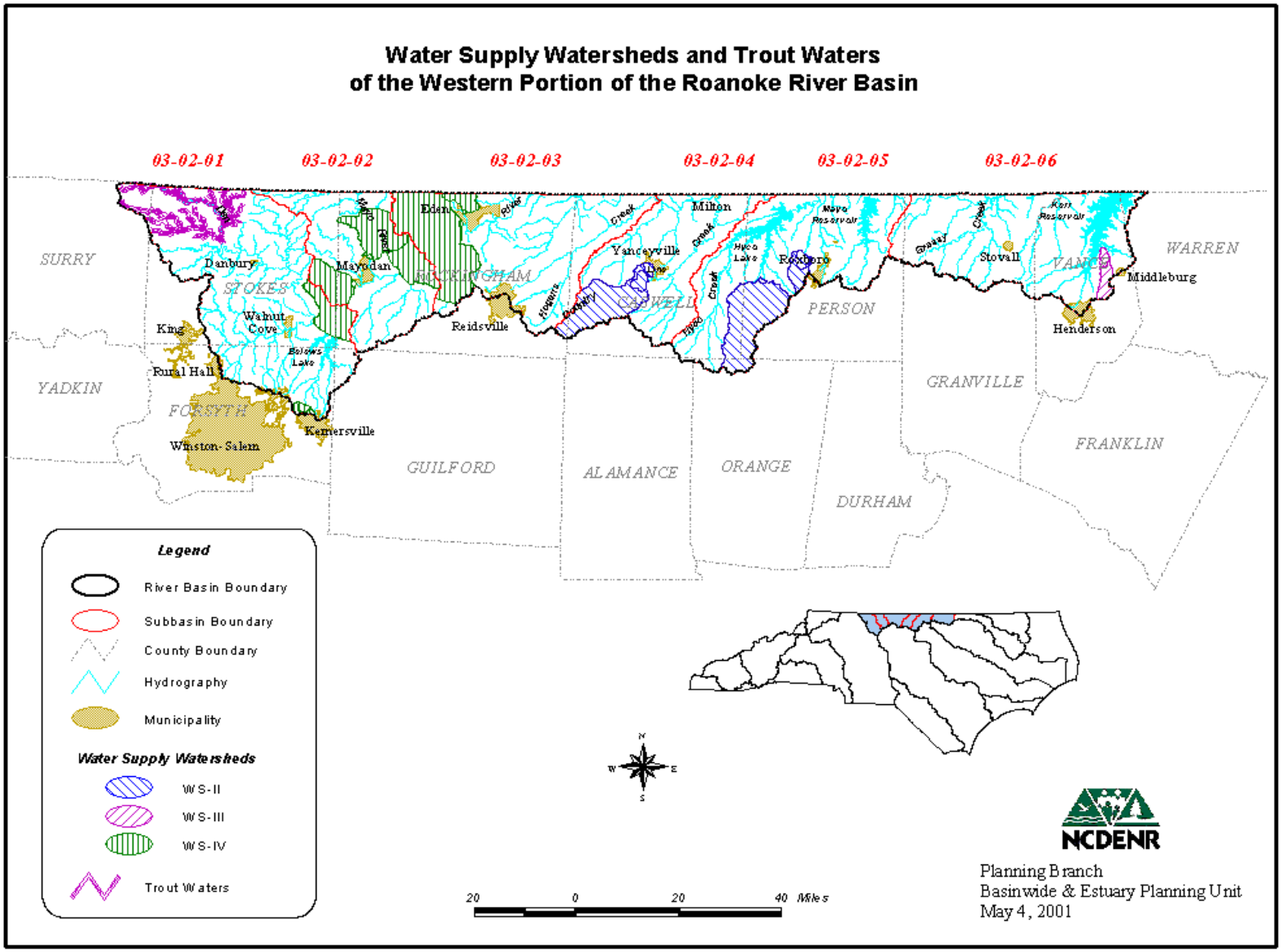

Figure A-15 Water Supply Watersheds and Designated Trout Waters in the Western Portion of the Roanoke River Basin

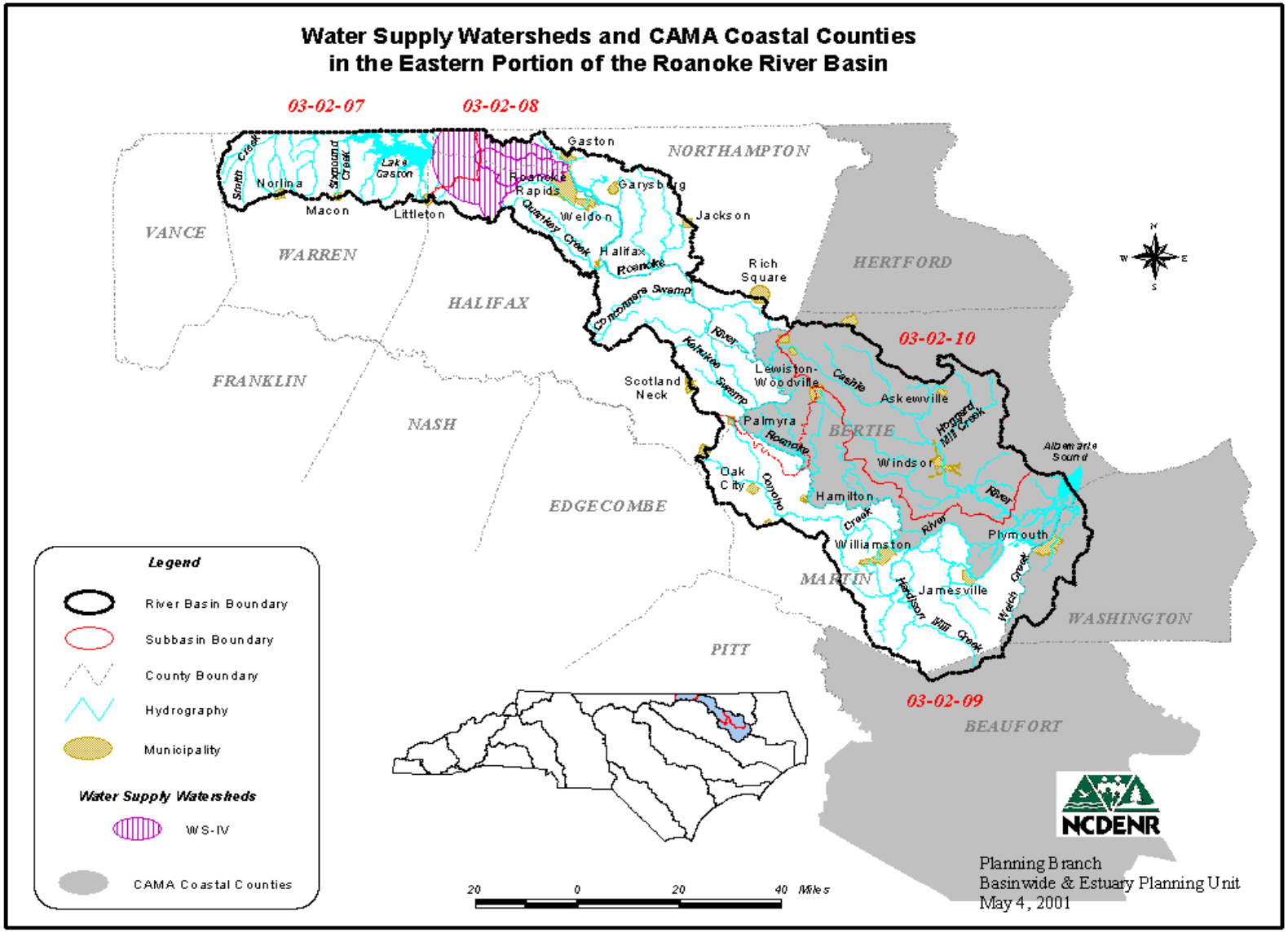

Figure A-16 Water Supply Watersheds and CAMA Coastal Counties in the Eastern Portion of the Roanoke River Basin

3.3 DWQ Water Quality Monitoring Programs in the Roanoke River Basin

Staff in the Environmental Sciences Branch and Regional Offices of DWQ collect a variety of biological, chemical and physical data. The following discussion contains a brief introduction to each program, followed by a summary of water quality data in the Roanoke River basin for that program. For more detailed information on sampling and assessment of streams in this basin, refer to the *Basinwide Assessment Report* for the Roanoke River basin, available from the Environmental Sciences Branch website at http://www.esb.enr.state.nc.us/bar.html or by calling (919) 733-9960.

DWQ monitoring programs for the Roanoke River Basin include:

- benthic macroinvertebrates (Section 3.3.1)
- fish assessments (Section 3.3.2)
- aquatic toxicity monitoring (Section 3.3.3)
- lakes assessment (Section 3.3.4)
- ambient monitoring system (Section 3.3.5)

3.3.1 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data has proven to be a reliable monitoring tool, as benthic macroinvertebrates are sensitive to subtle changes in water quality. Since macroinvertebrates have life cycles of six months to over 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 a bioclassification to each benthic sample based on the number of different species present in the pollution intolerant groups of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies), commonly referred to as EPTs, and a Biotic Index value, which gives an indication of overall community pollution tolerance. Different benthic macroinvertebrate criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina. Bioclassifications fall into five categories ranging from Poor to Excellent.

Extensive evaluation of swamp streams across eastern North Carolina suggests that current coastal plain criteria are not appropriate for assessing the condition of water quality in these special systems. Swamp streams are characterized by slower flow, lower dissolved oxygen, lower pH, and sometimes very complex braided channels and dark-colored water. DWQ is working to refine biological criteria that may be used in the future to assign bioclassifications to these streams. Refer to Chapter 4 of this section for more detailed information.

Overview of Benthic Macroinvertebrate Data

Appendix II lists all the benthic macroinvertebrate collections in the Roanoke River basin between 1983 and 1999, giving site location, collection date, taxa richness, biotic index values

and bioclassifications. Benthic macroinvertebrates have been collected at 79 sites in the Roanoke River basin since 1983. Table A-21 lists the most recent ratings since 1983, by subbasin, for all 79 benthos sites. Most of the streams listed as "Not Rated" are swamp streams in subbasins 03-02-08, 03-02-09 and 03-02-10. Benthos sampling may slightly overestimate the proportion of Fair and Poor sites, as DWQ special studies often have the greatest sampling intensity (number of sites/stream) in areas where it is believed that water quality problems exist.

Table A-21 Summary of Bioclassifications for All Freshwater Benthic Macroinvertebrate Sites (using the most recent rating for each site) in the Roanoke River Basin

Subbasin	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Total
03-02-01	3	7	7	2	1	0	20
03-02-02	0	2	3	0	0	0	5
03-02-03	1	4	0	2	0	0	7
03-02-04	0	1	1	0	0	0	2
03-02-05	0	0	0	2	0	0	2
03-02-06	0	0	2	3	0	2	7
03-02-07	0	0	1	1	0	0	2
03-02-08	0	3	0	3	0	5	11
03-02-09	0	0	2	0	0	10	12
03-02-10	0	0	0	0	0	8	8
Total (#)	**4**	**17**	**16**	**13**	**1**	**28**	**79**
Total (%)	**5%**	**22%**	**20%**	**16%**	**2%**	**35%**	100%

Sampling was hampered by extremes in streamflows in 1999. Many streams ceased flowing during the summer drought, while other sites could not be sampled because of high flow events. Therefore, only 35 sites were sampled during 1999 basinwide surveys or special studies. For the 1999 collections, Figure A-17 presents the following bioclassifications: Excellent – 0, Good – 6 (17%), Good-Fair – 5 (14%), Fair – 7 (20%), Poor – 0, Not Rated – 17 (49%).

Long-term trends (>5 years of data) in water quality were evaluated at six sites in the Roanoke River basin. None of the sites showed a decline in water quality. One site showed positive changes related to improvements in wastewater treatment. Subbasin chapters in Section B contain more specific information regarding these streams.

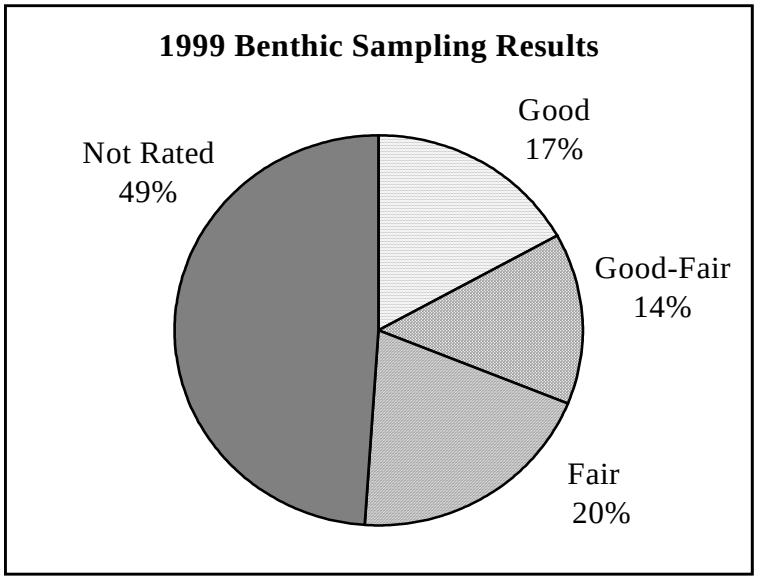

Figure A-17 Bioclassifications for 35 Roanoke River Basin Benthic Macroinvertebrate Sites Sampled by DWQ in 1999

3.3.2 Fish Assessments

Historical studies of fish communities in the Roanoke River basin were conducted primarily by the North Carolina Wildlife Resources Commission (NCWRC) in the 1960s and late 1970s. Approximately 102 species have been collected from the Roanoke River basin in North Carolina. Several streams were sampled by DWQ during the last basinwide planning cycle (1994), and two samples were collected in 1999. Scores are assigned to these samples using the North Carolina Index of Biotic Integrity (NCIBI). The NCIBI uses a cumulative assessment of twelve parameters or metrics. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. Appendix II contains more information regarding the NCIBI.

During the late 1990s, application of the NCIBI has been restricted to wadeable streams that can be sampled by a crew of 2-4 persons using backpack electrofishers and following the DWQ Standard Operating Procedures (NCDEHNR, 1997). Work began in 1998 to develop a fish community boat sampling method that could be used in non-wadeable coastal plain streams. Plans are to sample 10-15 reference sites with the boat method once it is finalized. As with other biological monitoring programs, many years of reference site data will be needed before solid criteria can be developed to evaluate biological integrity of large streams and rivers using the fish community assessment. Refer to Chapter 4 of this section for further information.

Overview of Fish Community Data

Appendix II lists all of the fish community collections in the Roanoke River basin between 1990 and 1999, giving site location, collection date and NCIBI rating. Fish community samples have been collected at 16 sites in the Roanoke River basin since 1990. Table A-22 lists the most recent ratings since 1990, by subbasin, for all fish community sites.

Table A-22 Summary of NCIBI Categories for All Freshwater Fish Community Sites (using the most recent rating for each site) in the Roanoke River Basin

Subbasin	Excellent	Good	Good-Fair	Fair	Poor	Not Rated	Total
03-02-01	0	0	0	0	0	0	0
03-02-02	0	1	0	0	0	0	1
03-02-03	1	0	0	0	0	0	1
03-02-04	0	2	1	0	0	0	3
03-02-05	0	0	1	0	0	0	1
03-02-06	1	1	1	0	0	0	3
03-02-07	0	0	2	0	0	0	2
03-02-08	0	1	1	0	0	2	4
03-02-09	0	0	0	0	0	0	0
03-02-10	0	0	0	0	0	1	1
Total (#)	**2**	**5**	**6**	**0**	**0**	**3**	**16**
Total (%)	**13%**	**31%**	**37%**	**0%**	**0%**	**19%**	100%

No basinwide fish community surveys were conducted during 1999 because of ongoing special studies and additional reference site sampling. Only 2 sites were sampled in 1999: Grassy Creek received a Good NCIBI score and Island Creek received an Excellent score.

Roanoke River Basin Fish Kills

DWQ has only systematically tracked reported fish kill events across the state since 1996. From 1994 to 1999, DWQ field investigators reported five fish kill events in the Roanoke River basin. Fish kills occurred on the Roanoke River from Roanoke Rapids to Jamesville and along the Cashie River near Windsor and Sans Souci. Mortality estimates ranged from 30 to more than 10,000 fish per event.

Two of these fish kills were extensive and occurred in the Roanoke River between July 25 and August 2, 1995 as a result of operations at the Roanoke Rapids dam. The first kill occurred directly below the dam after spillway gates were closed leaving fish stranded in isolated pools where water temperature increased rapidly. The second kill began after water release rates from the dam were rapidly curtailed causing waters which had inundated thousands of acres of wetlands adjacent the Roanoke River, and which had become anoxic, to empty into the river. This fish kill occurred over approximately 76 miles and killed an estimated 7,000 striped bass as well as approximately 16,000 other species. Dissolved oxygen in the kill area ranged from 0.4 to 2.0 mg/l (Kornegay and Jones, 1995).

The magnitude of these events led Dominion (formerly North Carolina Power) to implement, in cooperation with the NC Wildlife Resources Commission and the US Army Corps of Engineers, a plan to incrementally "step down" flood control flow reductions (refer to Part 2.9.4 of this

section for more information). Since the plan was put into effect, no additional fish kills have been reported related to reduction of water releases. Fish kills were also reported following Hurricane Fran and Hurricane Bonnie in 1996 and 1998, respectively.

Overview of Fish Tissue Sampling

Fish tissue surveys were conducted by DWQ at eight stations within the basin from 1994 to 1999. These surveys were conducted as part of special mercury contamination assessments in the eastern part of the state and during routine basinwide assessments.

The majority of fish tissue samples collected from the Roanoke River basin in 1994 and 1999 contained metal and organic contaminants at undetectable levels or at levels less than the EPA, Food and Drug Administration, and State of North Carolina consumption criteria. Figure A-18 shows the number of fish tissue samples that exceeded one or more of these consumption criteria. Only six sites are represented on the figure because none of the samples collected from the Dan River at Eden or from Lake Gaston exceeded any consumption criteria. More detailed information regarding these sampling events and streams can be found in the appropriate subbasin chapter in Section B.

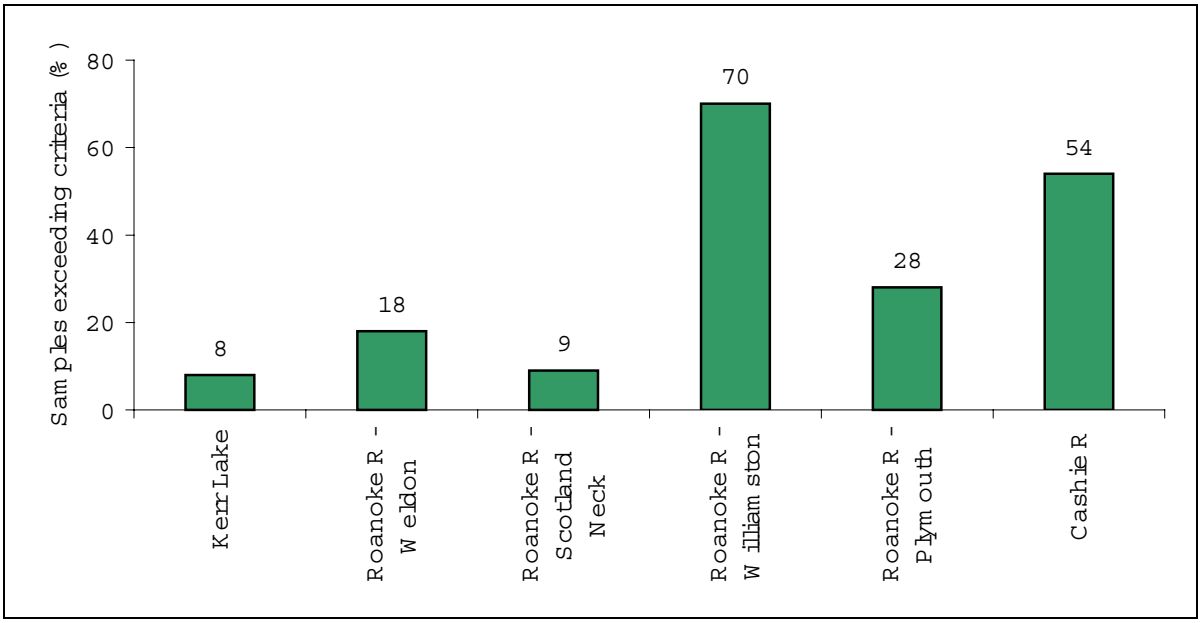

Figure A-18 Fish Tissue Samples Exceeding Consumption Criteria at Six Sites Sampled by DWQ in 1994 and 1999

Elevated mercury concentrations were most often detected in largemouth bass and bowfin. These two species are at the top of the food chain and are most often associated with mercury bioaccumulation in fish tissue in North Carolina. More than 50 percent of samples collected from the Roanoke River at Williamston and the Cashie River at Windsor contained mercury concentrations exceeding the state criteria. Presently, the only consumption advisory for mercury-contaminated fish in the Roanoke River basin is the statewide advisory for bowfin.

No samples from the above referenced eight stations contained concentrations greater than consumption criteria of any other metals of concern (arsenic, cadmium, chromium, copper, lead, nickel, selenium and zinc). Samples collected by Duke Power Company and Carolina Power & Light Company in Belews Lake and Hyco Reservoir, respectively, have shown high concentrations of selenium. However, contamination levels have declined in recent years. More information regarding causes and sources of the selenium, as well as recommended management strategies for these waters, can be found in Section B.

Weyerhaeuser Company monitors dioxin levels in fish tissue in the lower Roanoke River and Welch Creek. Fish consumption advisories for almost all species of fish due to dioxin contamination are in effect in these waters, as well as the western portion of Albemarle Sound, although levels of dioxin have also been declining in recent years. Refer to Chapter 9 of Section B for more information regarding these waters.

3.3.3 Aquatic Toxicity Monitoring

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

The Aquatic Toxicology Unit maintains a compliance summary (Figure A-19) 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.

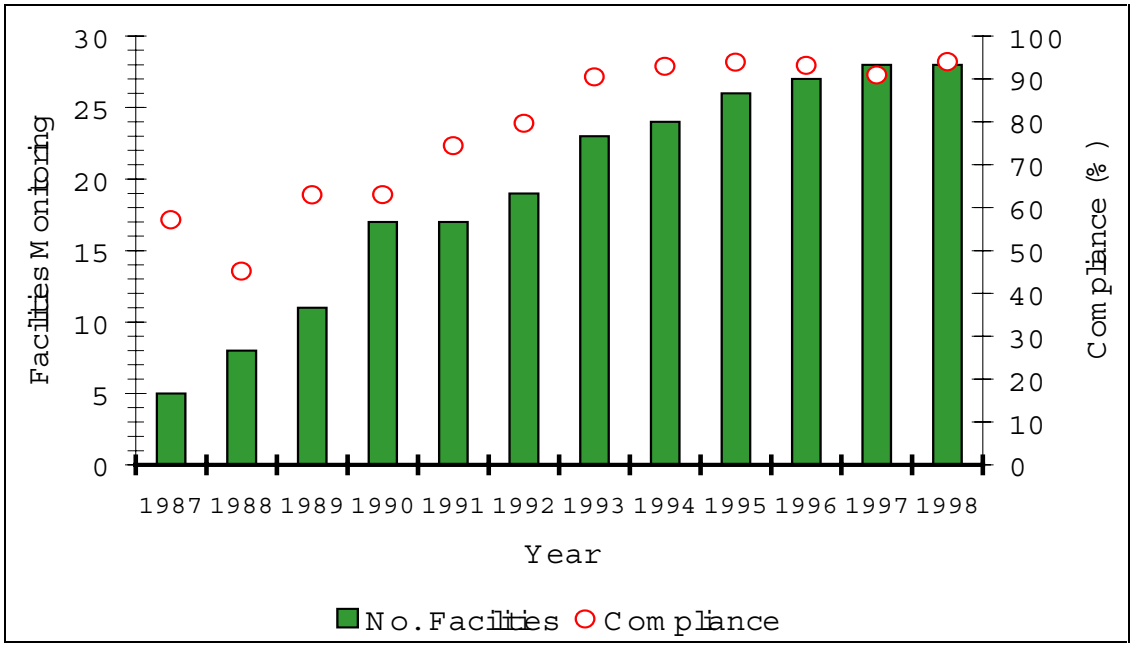

Figure A-19 Summary of Compliance with Aquatic Toxicity Tests in the Roanoke River Basin

Twenty-nine NPDES permits in the Roanoke River basin currently require whole effluent toxicity (WET) testing. Twenty-seven permits have a WET limit; the other two facilities have episodic discharges and their permits specify monitoring but with no limit.

The number of facilities required to monitor whole effluent toxicity has increased steadily since 1987, the first year that whole effluent toxicity limits were written into permits in North Carolina. The compliance rate has risen as well. Since 1993, the compliance rate has stabilized at approximately 90-95 percent. Facilities with toxicity problems during the most recent two-year review period are discussed in the subbasin chapters in Section B

3.3.4 Lakes Assessment Program

Eleven lakes in the Roanoke River basin were sampled as part of the Lakes Assessment Program in summer of 1999. These data are used to determine the trophic state of each lake, a relative measure of nutrient enrichment and biological productivity. Five lakes (Hanging Rock, Belews Lake, Hyco Lake, Mayo Reservoir and Lake Gaston) exhibited low biological productivity. The North Carolina portion of John H. Kerr Reservoir and Roanoke Rapids Lake demonstrated moderate biological productivity. The remaining four lakes (Kernersville Reservoir, Farmer Lake, Lake Roxboro and Roxboro Lake) were found to be very biologically productive. Lakes for which one or more uses are impaired are listed in Part 3.5.3 of this section (Table A-31) and are discussed in the appropriate subbasin chapter in Section B.

3.3.5 Ambient Monitoring System

The Ambient Monitoring System (AMS) is a network of stream, lake and estuarine sample stations strategically located for the collection of physical and chemical water quality data. North Carolina has 21 stations in the Roanoke River basin listed in Table A-23 and shown on individual subbasin maps in Section B. These stations are sampled monthly for 27 parameters.

Overall, measurements of water quality parameters in the Roanoke River basin showed few temporal patterns. An exception is the site located on Nutbush Creek, where water quality improved greatly during the mid-1980s as improvements to the Town of Henderson's WWTP were put into place. At other sites, distinct spatial differences occurred depending upon whether or not the sites were located upstream or downstream of wastewater dischargers.

Fecal coliform bacteria are widely used as an indicator of the potential presence of pathogens typically associated with the intestinal tract of warm-blooded animals. The water quality standard for fecal coliform bacteria is based on a geometric mean of 200 colonies/100ml. Fecal coliform bacteria concentrations, represented by geometric means, showed few temporal patterns. The only ambient monitoring station with a geometric mean greater than 200 colonies/100 ml for this five-year assessment period was Marlowe Creek (N4400000). Most stations in the basin (67 percent) had geometric means of less than 100 colonies/100ml.

Table A-23 Ambient Monitoring System Stations within the Roanoke River Basin

Subbasin/ Station code	Station	County	Classification*
03-02-01			
N0150000	Dan River at NC Hwy 704, near Francisco	Stokes	C Tr
03-02-02			
N1400000	Mayo River at SR 1358, near Price	Rockingham	WS-IV
03-02-03			
N2300000	Dan River at SR 2150, near Wentworth	Rockingham	WS-IV
N2450000	Smith River at NC Hwy 14, at Eden	Rockingham	WS-IV
N3000000	Dan River at SR 1716, near Mayfield	Rockingham	C
03-02-04			
N3500000	Dan River at NC Hwy 62 at NC-VA state line	Caswell	C
03-02-05			
N4110000	Hyco Creek at US Hwy 158, near Leasburg	Caswell	C
N4250000	Hyco River below afterbay dam, near McGhees Mill	Person	C
N4400000	Marlowe Creek at SR 1322, near Woodsdale	Person	C
N4510000	Hyco River at US Hwy 501, near Denniston, VA	Halifax	Virginia
N4590000	Mayo Creek at SR 1501, near Bethel Hill	Person	C
03-02-06			
N5000000	Nutbush Creek at SR 1317, near Henderson	Vance	C
03-02-07			
N6400000	Smith Creek at US 1, near Paschall	Warren	C
03-02-08			
N7300000	Roanoke River at Roanoke Rapids	Halifax	C
N8200000	Roanoke River near Scotland Neck	Halifax	C
N8300000	Roanoke River at NC Hwy 11	Martin	C
03-02-09			
N8550000	Roanoke River at Williamston	Martin	C
N9250000	Roanoke River near Plymouth	Martin	C Sw
N9600000	Roanoke River at Sans Souci	Bertie	C Sw
N9700000	Albemarle Sound (Batchelor Bay) near Black Walnut	Bertie	B Sw
03-02-10			
N8950000	Cashie River at SR 1219, near Lewiston	Bertie	C Sw

* An index for DWQ freshwater classifications can be found in Part 3.2 of this section (Table A-20).

Elevated turbidity measurements were observed often in streams in the Dan River subbasins over the past five years. The turbidity standard for trout waters (10 NTU) was exceeded in 35 percent of 54 samples collected from the upper Dan River (N0150000) near Fransico. The turbidity standard (50 NTU) was exceeded at the Dan River near Wentworth station (N2300000) in 18 percent of 55 samples between 1995 and 1999. Concentrations in this segment of the Dan River ranged from 2.6 to 200 NTU, compared with 1.4 to 90 NTU near Francisco upstream. The turbidity water quality standard was only exceeded in 9 percent of samples at the downstream station near Mayfield (N3000000). More information regarding causes and sources of turbidity, as well as recommended management strategies for the Dan River, can be found in Section B.

Figure A-20 depicts nearly 20 years of dissolved oxygen data collected from DWQ Ambient Monitoring Stations in the Roanoke River basin. (Appendix V contains an explanation of box plots.) Dissolved oxygen (DO) concentrations were low at the Smith Creek station in the Dan River watershed. Approximately 25 percent of measurements were less than the 5.0 mg/l water quality standard between September 1994 and August 1999. The stream at this sampling location is slow moving, a factor which could contribute to these sample results. In the eastern portion of the basin, the Cashie River exhibited very low DO concentrations; however, the monitoring site is located in swamp waters where DO is naturally lower.

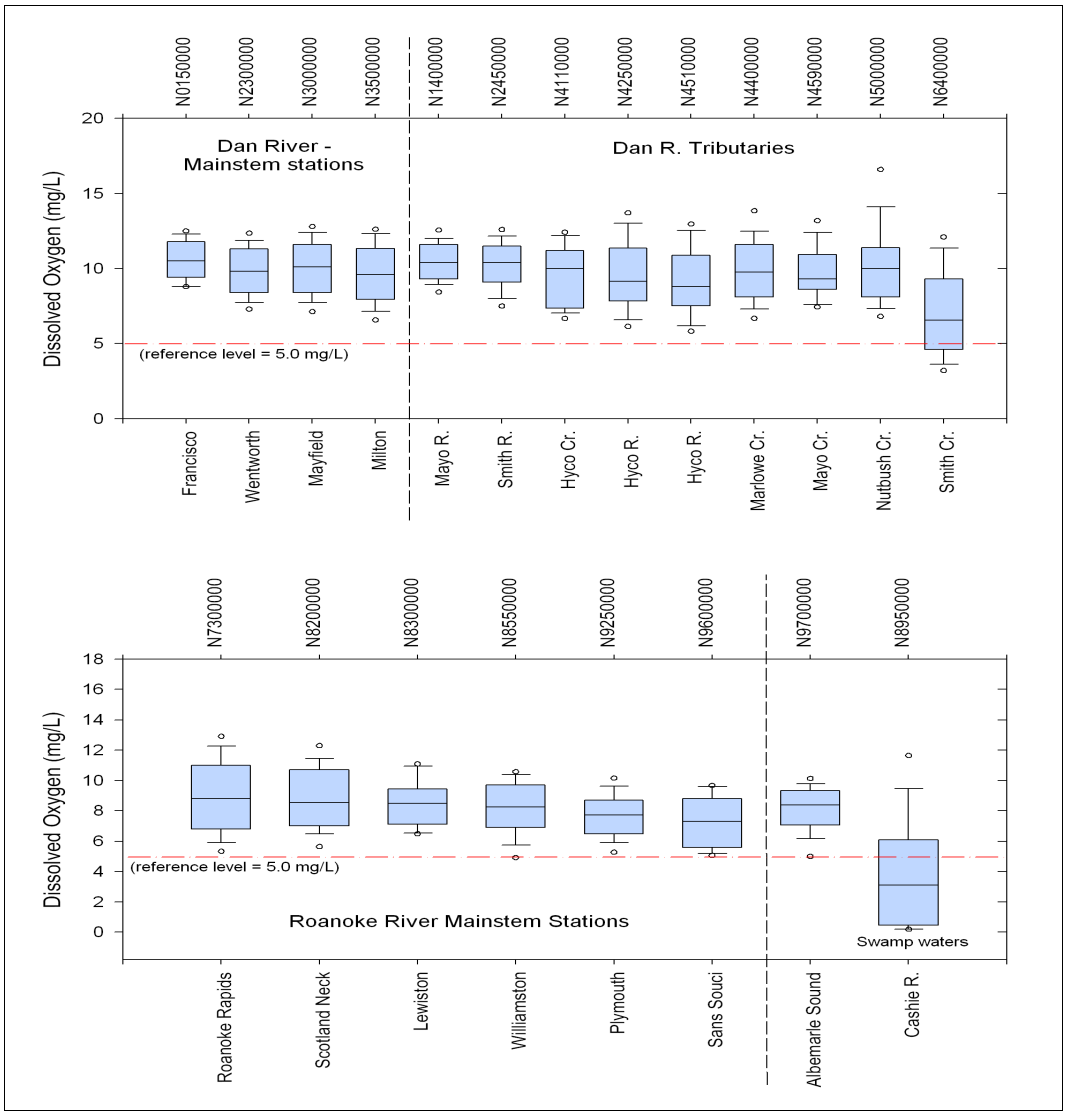

Figure A-20 Dissolved Oxygen Concentrations at Ambient Monitoring Stations in the Roanoke River Basin (1980-1999)

Dissolved oxygen fell below the water quality standard in less than seven percent of samples collected between September 1994 and August 1999 from any station on the Roanoke River mainstem. DWQ Ambient Monitoring System data showed no significant difference between

DO data collected above (N9250000) and below (N9600000) Plymouth over the same five-year period.

Copper and iron were the only two metals that often exceed their action levels. Iron is a common element in clay soils; therefore, elevated concentrations may reflect the geochemistry of the watershed. In general, elevated concentrations of copper were found at sites located downstream of wastewater discharges.

3.4 Other Water Quality Research

North Carolina actively solicits "existing and readily available" data and information for each basin as part of the basinwide planning process. Data meeting DWQ quality assurance objectives are used in making use support determinations. Data and information indicating possible water quality problems are investigated further. Both quantitative and qualitative information are accepted during the solicitation period. High levels of confidence must be present in order for outside quantitative information to carry the same weight as information collected from within DWQ. This is particularly the case when considering waters for the §303(d) list. Methodology for soliciting and evaluating outside data is presented in *North Carolina's Draft 2000 § 303(d) List* (DENR-DWQ, October 2000). The next data solicitation period for the Roanoke River is planned for fall 2003.

DWQ data solicitation includes the following:

- Information, letters and photographs regarding the uses of surface waters for boating, drinking water, swimming, aesthetics and fishing.
- Raw data submitted electronically and accompanied by documentation of quality assurance methods used to collect and analyze the samples. Maps showing sampling locations must also be included.
- Summary reports and memos, including distribution statistics and accompanied by documentation of quality assurance methods used to collect and analyze the data.
- Contact information must accompany all data and information submitted.

Continuous monitoring data (dissolved oxygen and temperature) were submitted by the US Fish and Wildlife Service from five US Geological Survey stations on the Roanoke River: Halifax (station #0208062765); Oak City (station #02081022); Grabtown (station #0208102855); Jamesville (station #02081094); and Westover (station #020811450). Data are collected from each of these stations at 15-minute intervals. Data summarized below are from January 1, 1998 (when the stations were put into operation) through August 31, 1999. August 31, 1999 is the end of the five-year window for data collected during this five-year planning cycle and reported in this plan.

The dissolved oxygen (DO) water quality standard for Class C waters is "not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l". Swamp waters (Class C Sw) "may have lower values if caused by natural conditions" (DENR, August 2000). Table A-24 presents the number of samples representing daily averages and the number and percent of samples less than the 5.0 mg/l DO standard for each monitoring station. Table A-25 presents the number of samples representing instantaneous measurements and the number and percent of samples less than the 4.0 mg/l DO standard for each monitoring station.

Table A-24 USGS Continuous Monitoring Station Daily Average Dissolved Oxygen (DO) Data Summary for the Roanoke River Basin (1/98-8/99)

USGS Station Name	Stream Class	Water Quality Standard	Number of Samples	Number of Samples DO <5.0 mg/l	% of total Samples DO <5.0 mg/l
Halifax	C	5.0 mg/l	512	0	--
Oak City	C	5.0 mg/l	389	0	--
Grabtown	C	5.0 mg/l	494	0	--
Jamesville	C	5.0 mg/l	524	30	5.7%
Westover	C Sw	5.0 mg/l*	501	107	21.4%

* Swamp waters may have lower values if caused by natural conditions.

Table A-25 USGS Continuous Monitoring Station Instantaneous Dissolved Oxygen (DO) Data Summary for the Roanoke River Basin (1/98-8/99)

USGS Station Name	Stream Class	Water Quality Standard	Number of Samples	Number of Samples DO <4.0 mg/l	% of total Samples DO <4.0 mg/l
Halifax	C	4.0 mg/l	48,790	0	--
Oak City	C	4.0 mg/l	36,852	0	--
Grabtown	C	4.0 mg/l	47,068	0	--
Jamesville	C	4.0 mg/l	49,966	561	1.1%
Westover	C Sw	4.0 mg/l*	47,575	5,077	10.7%

* Swamp waters may have lower values if caused by natural conditions.

Although, according to a strict interpretation, the data presented above show numerous violations of the water quality standards for dissolved oxygen at the Jamesville monitoring station, this station is located a short distance upstream of the boundary between the Class C and Class C Sw portions of the Roanoke River. It is possible that some "swamp stream" characteristics are being observed at this location.

Additional DWQ analyses show that an increase in temperature does not always accompany a decrease in DO at the Oak City, Grabtown and Jamesville stations. Therefore, there are factors other than temperature influencing DO concentrations at these stations. Refer to Chapter 4 of this section for a discussion of studies designed to provide further information about dissolved oxygen in the lower Roanoke River.

Water quality monitoring data for Nutbush Creek and the Nutbush Creek Arm of Kerr Reservoir were submitted by the City of Henderson in hardcopy form only. Unfortunately, due to staff time constraints, DWQ is unable to use raw data that is not submitted electronically.

3.5 Use Support Summary

3.5.1 Introduction to Use Support

Waters are classified according to their best intended uses. Determining how well a water supports its uses (*use support* status) is an important method of interpreting water quality data and assessing water quality. Surface waters are rated *fully supporting* (FS), *partially supporting* (PS) or *not supporting* (NS). The terms refer to whether the classified uses of the water (such as water supply, aquatic life protection and recreation) are being met.

For example, waters classified for fishing and secondary contact recreation (Class C for freshwater) are rated as fully supporting if data used to determine use support did not exceed specific criteria. However, if these criteria were exceeded, then the waters would be rated as PS or NS, depending on the degree of degradation. Waters rated PS or NS are considered to be impaired. Waters lacking data, or having inconclusive data, are listed as not rated (NR).

Use support ratings for surface waters:

- *fully supporting (FS)*
- *partially supporting (PS)*
- *not supporting (NS)*
- *not rated (NR)*

Impaired waters categories:

- partially supporting
- not supporting

Historically, the non-impaired category was subdivided into fully supporting and fully supporting but threatened (ST). ST was used to identify waters that were fully supporting but had some notable water quality concerns and could represent constant, degrading or improving conditions. North Carolina's past use of ST was very different from that of the US Environmental Protection Agency (EPA), which uses it to identify waters that demonstrate declining water quality (EPA Guidelines for Preparation of the Comprehensive State Water Quality Assessments [305(b) Reports] and Electronic Updates, 1997). Given the difference between the EPA and North Carolina definitions of ST and the resulting confusion that arises from this difference, North Carolina no longer subdivides the non-impaired category. However, these waters and the specific water quality concerns remain identified in the subbasin chapters in Section B so that data, management and the need to address the identified concerns are not lost.

Beginning in 2000 with the Roanoke River basin, an approach to assess ecosystem health and human health risk is applied to use support categories. Six categories are used to assess this approach: aquatic life and secondary recreation, fish consumption, shellfish harvesting, primary recreation, water supply and "other" uses. Each of these categories relates to the primary classifications applied to NC rivers and streams. A single water could have more than one use support rating corresponding to one or more of the multiple use support categories, as shown in Table A-31. For many waters, a use support category will not be applicable (NA) to the best use classification of that water (e.g., drinking water supply is not the best use of a Class C water). This method of determining use support differs from that done prior to 2000; in that, there is no longer an *overall* use support rating for a water. For more detailed information regarding use support methodology, refer to Appendix III.

3.5.2 Comparison of Use Support Ratings to Streams on the Section 303(d) List

Section 303(d) of the Clean Water Act requires states to identify waters not meeting standards. EPA must then provide review and approval of the listed waters. A list of waters not meeting standards is submitted to EPA biennially. Waters placed on this list, termed the §303(d) list, require the establishment of total maximum daily loads (TMDLs) intended to guide the restoration of water quality. See Appendix IV for a description of §303(d) listing methodology.

Waters are placed on North Carolina's §303(d) list primarily due to a partially or not supporting use support rating. These use support ratings are based on biological and chemical data and, for some categories, human health advisories. When the state water quality standard is exceeded, then this constituent is listed as the problem parameter. TMDLs must be developed for problem parameters on the §303(d) list. Other strategies may be implemented to restore water quality; however, the waterbody must remain on the §303(d) list until improvement has been realized based on either biological bioclassifications or water quality standards.

The §303(d) list and accompanying data are updated as the basinwide plans are revised. In some cases, the new data will demonstrate water quality improvement and waters may receive a better use support rating. These waters may be removed from the §303(d) list since water quality improvement has been attained. In other cases, the new data will show a stable or decreasing trend in overall water quality resulting in the same, or lower, use support rating. Attention remains focused on these waters until water quality standards are being met.

3.5.3 Use Support Ratings for the Roanoke River Basin

Aquatic Life/Secondary Recreation

The aquatic life/secondary recreation use support category is applied to all waters in North Carolina. Therefore, this category is applied to the total number of stream miles (2213.0) in the North Carolina portion of the Roanoke River basin. Table A-25 presents use support ratings by subbasin for both monitored and evaluated streams in the aquatic life/secondary recreation category. A basinwide summary of current aquatic life/secondary recreation use support ratings is presented in Table A-26.

Approximately 29 percent of stream miles (638) were monitored for the protection of aquatic life and secondary recreation by DWQ during this basinwide planning cycle. All waters rated impaired in the aquatic life/secondary recreation use support category were monitored within the past five years. Impaired waters accounted for 2.6 percent of the total stream miles and 8.9 percent of monitored stream miles.

Table A-25 Aquatic Life/Secondary Recreation Use Support Ratings for Monitored and Evaluated Waters Listed by Subbasin in Miles (1995-1999)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-02-01	276.5	0	8.0	148.9	433.4
03-02-02	76.4	0	0	55.6	132.0
03-02-03	154.6	19.5	0	68.8	242.9
03-02-04	112.0	0	0	39.6	151.6
03-02-05	84.8	10.8	0	99.3	194.9
03-02-06	127.0	4.6	0	53.0	184.6
03-02-07	41.7	10.4	0	49.4	101.5
03-02-08	167.9	3.4	0	180.6	351.9
03-02-09	72.8	0	0	198.3	271.1
03-02-10	0	0	0	149.1	149.1
TOTAL	**1113.7**	**48.7**	**8.0**	**1042.6**	**2213.0**
Percent	50.3%	2.2%	0.4%	47.1%	100%

Table A-26 Aquatic Life/Secondary Recreation Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Aquatic Life/Secondary Recreation Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**1113.7**	**50.3%**		**357.0**	**56.0%**
Impaired	**56.7**	**2.6%**		**56.7**	**8.9%**
Partially Supporting	*48.7*	*2.2%*		*48.7*	*7.6%*
Not Supporting	*8.0*	*0.4%*		*8.0*	*1.3%*
Not Rated	**1042.6**	**47.1%**		**223.9**	**35.1%**
TOTAL	**2213.0**			**637.6**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Fish Consumption

Like the aquatic life/secondary recreation use support category, the fish consumption use support category is also applied to all waters in the state. Approximately 14 percent of stream miles (308.0 miles) in the Roanoke River basin were monitored for the fish consumption category during this basinwide cycle. Fish consumption use support ratings are based on fish consumption advisories issued by the NC Department of Health and Human Services (DHHS). Currently, there is a statewide advisory limiting consumption of bowfin due to elevated mercury concentrations. Because of this advisory, all waters in the state are considered partially supporting the fish consumption use. However, samples collected by DWQ in 1999 from some waters in the basin, including the Dan River, Kerr Reservoir and Lake Gaston (where bowfin are

not typically found), revealed concentrations of metals and PCBs below federal and state consumption criteria.

Table A-27 presents use support ratings by subbasin for monitored streams in the fish consumption use support category. A basinwide summary of current fish consumption use support ratings is presented in Table A-28.

Table A-27 Fish Consumption Use Support Ratings for Monitored Waters Listed by Subbasin in Miles (1995-1999)

Subbasin	Fully Supporting	Partially Supporting	Not Supporting	Not Rated	Total
03-02-01[1,2]	0	55.8	0	0	55.8
03-02-02[1]	0	9.3	0	0	9.3
03-02-03[1]	0	14.8	0	0	14.8
03-02-04[1]	0	7.5	0	0	7.5
03-02-05[3]	0	0.2	0	0	0.2
03-02-06[4]	0	5.1	0	0	5.1
03-02-07[4]	0	5.4	0	0	5.4
03-02-08	0	123.7	0	0	123.7
03-02-09	0	25.3	13.3	0	38.6
03-02-10	0	47.6	0	0	47.6
TOTAL	**0**	**294.7**	**13.3**	**0**	**308.0**
Percent	0%	95.7%	4.3%	0%	100%

[1] Analysis of fish tissue samples, collected by DWQ in 1999 from the Dan River, did not reveal elevated concentrations of any metals, including mercury, in any species of fish collected.

[2] Belews Lake (4,030 acres) is also included in the monitored waters in this subbasin.

[3] Hyco Lake (3,750 acres) is also included in the monitored waters in this subbasin.

[4] Analysis of fish tissues samples, collected by DWQ in 1999 from Kerr Reservoir and Lake Gaston, did not reveal elevated concentrations of any metals or PCBs in any species of fish collected.

Table A-28 Fish Consumption Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Fish Consumption Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**0.0**			**0.0**	
Impaired	**2213.0**	**100%**		**308.0**	**100%**
Partially Supporting	*2199.7*	*99.4%*		*294.7*	*95.7%*
Not Supporting	*13.3*	*0.6%*		*13.3*	*4.3%*
Not Rated	**0.0**			**0.0**	
TOTAL	**2213.0**			**308.0**	

* = Percent based on total of all streams, both monitored and evaluated.

** = Percent based on total of all monitored streams.

Primary Recreation

There are 120.2 stream miles currently classified for primary recreation in the Roanoke River basin. Approximately 15 percent were monitored by DWQ over the past five years; all are fully supporting the primary recreation use. Monitored waters include Hyco Lake, Kerr Reservoir and Lake Gaston. A basinwide summary of current primary recreation use support ratings is presented in Table A-29.

Table A-29 Primary Recreation Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Primary Recreation Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**18.5**	**15.4%**		**18.5**	**100%**
Impaired	**0.0**			**0.0**	
Not Rated	**101.7**	**84.6%**		**0.0**	
TOTAL	**120.2**			**18.5**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Water Supply

There are 270.4 stream miles currently classified for water supply in the Roanoke River basin. All were monitored within the past five years; all are fully supporting the water supply use. Monitored waters include Belews Lake, Hyco Lake, Kerr Reservoir and Lake Gaston. A basinwide summary of current water supply use support ratings is presented in Table A-30.

Table A-30 Water Supply Use Support Summary Information for Waters in the Roanoke River Basin (1999)

Water Supply Use Support Ratings	Monitored and Evaluated Streams*			Monitored Streams Only**	
	Miles	%		Miles	%
Fully Supporting	**270.4**	**100%**		**270.4**	**100%**
Impaired	**0.0**			**0.0**	
Not Rated	**0.0**			**0.0**	
TOTAL	**270.4**			**270.4**	

* = Percent based on total of all streams, both monitored and evaluated. ** = Percent based on total of all monitored streams.

Impaired Waters

Table A-31 presents impaired waters (in all categories), listed by subbasin, in the Roanoke River basin that were monitored by DWQ within the last five years. Ratings for each applicable use support category are shown, even though only one use may be impaired. Impaired ratings are shown in bold followed by the number of miles (streams and rivers) or acres (lakes) where the

corresponding use is impaired. Descriptions of impaired segments, as well as problem parameters, are outlined in Appendix III. Management strategies for each water are discussed in detail in the appropriate subbasin chapter.

Color maps showing current use support ratings for the Roanoke River basin are presented in Figures A-21 and A-22. Only waters where fish tissue has been monitored during this basinwide cycle are shown as impaired for fish consumption on the maps. When use support ratings have been assigned to more than one category for a particular water, the rating that represents the most severe impairment is shown on the map (e.g., Hyco Lake is fully supporting aquatic life/secondary recreation, but is partially supporting fish consumption. The lake is shown on Figure A-21 as partially supporting.)

Table A-31 Monitored Impaired Waters within the Roanoke River Basin (as of 2000)[1]

				Use Support Categories/Rating– Impaired Miles (or Acres)				
Impaired Water	**Subbasin**	**Chapter in Section B**	**Classification[2]**	**Aquatic Life/ Secondary Recreation**	**Fish Consumption**	**Primary Recreation**	**Water Supply**	**Potential Sources**
Town Fork Creek	03-02-01	1	C	NS – 8.0 mi	*	*N/A*	*N/A*	NP, P
Dan River	03-02-03 03-02-04	2 & 3	C	PS – 14.2 mi	[3]	*N/A*	*N/A*	NP, P
Smith River	03-02-03	3	C WS-IV	PS – 5.4 mi	*	*N/A*	FS	P
Hyco Lake	03-02-05	5	B WS-V	FS	PS – 3,750 ac	FS	FS	P
Marlowe Creek	03-02-05	5	C	PS – 10.9 mi	*	*N/A*	*N/A*	NP, P
Nutbush Creek	03-02-06	6	C	PS – 4.6 mi	*	*N/A*	*N/A*	NP, P
Smith Creek	03-02-07	7	C	PS – 10.4 mi	*	*N/A*	*N/A*	NP
Quankey Creek	03-02-08	8	C	PS – 3.4 mi	*	*N/A*	*N/A*	NP, P
Roanoke Rapids Lake	03-02-08	8	B WS-IV CA	PS – 4,893 ac	*	FS	FS	NP
Roanoke River	03-02-08 03-02-09	8 & 9	C C Sw	FS	PS – 137.8 mi	*N/A*	*N/A*	NP, P
Albemarle Sound	03-02-09	9	B Sw	FS	PS – 2,586 ac	FS	*N/A*	NP. P
Welch Creek	03-02-09	9	C Sw	NR	NS – 13.3 mi	*N/A*	*N/A*	P
Cashie River	03-02-10	10	C Sw B Sw	NR	PS – 54.6 mi	FS	*N/A*	NP

* These waters are impaired because of a statewide fish consumption advisory for bowfin. However, they were not monitored for the fish consumption category during this basinwide cycle. Refer to Section A, Part 4.8.4 for further information.

FS	Fully Supporting	NR	Not Rated	P	Point Sources
PS	Partially Supporting	N/A	Not Applicable	NP	Nonpoint Sources
NS	Not Supporting				

Notes

[1] These waters are currently, or will be placed, on the §303(d) list, and a TMDL and/or management strategy will be developed to address causes and sources of impairment. Refer to Appendix IV for further information regarding §303(d) listing methodology.

[2] An index for DWQ freshwater classifications can be found in Part 3.2 of this section (Table A-20).

[3] Analysis of fish tissues samples, collected by DWQ in 1999 from the Dan River, did not reveal elevated concentrations of any metals in any species of fish collected.

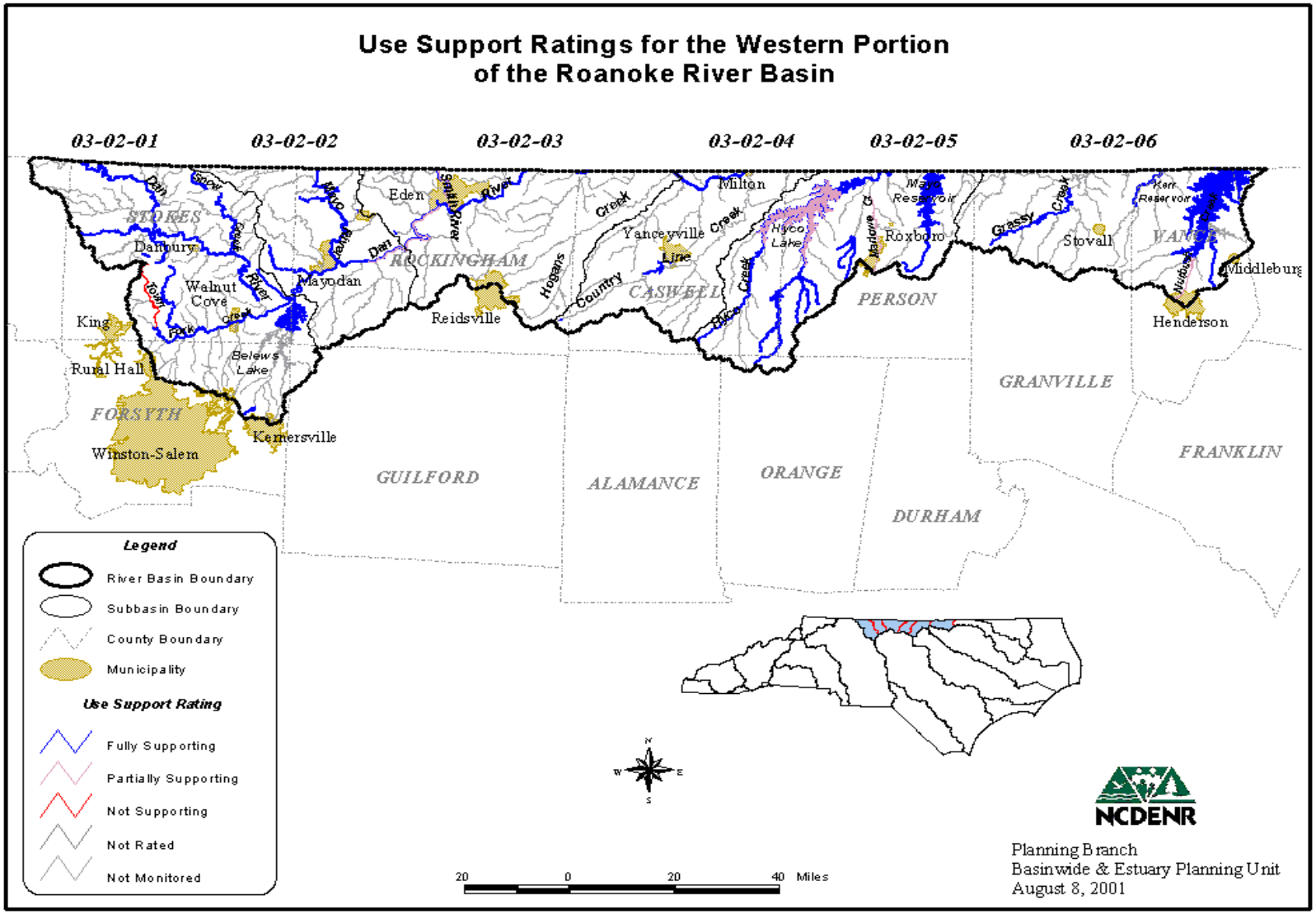

Figure A-21 Use Support Ratings for the Western Portion of the Roanoke River Basin

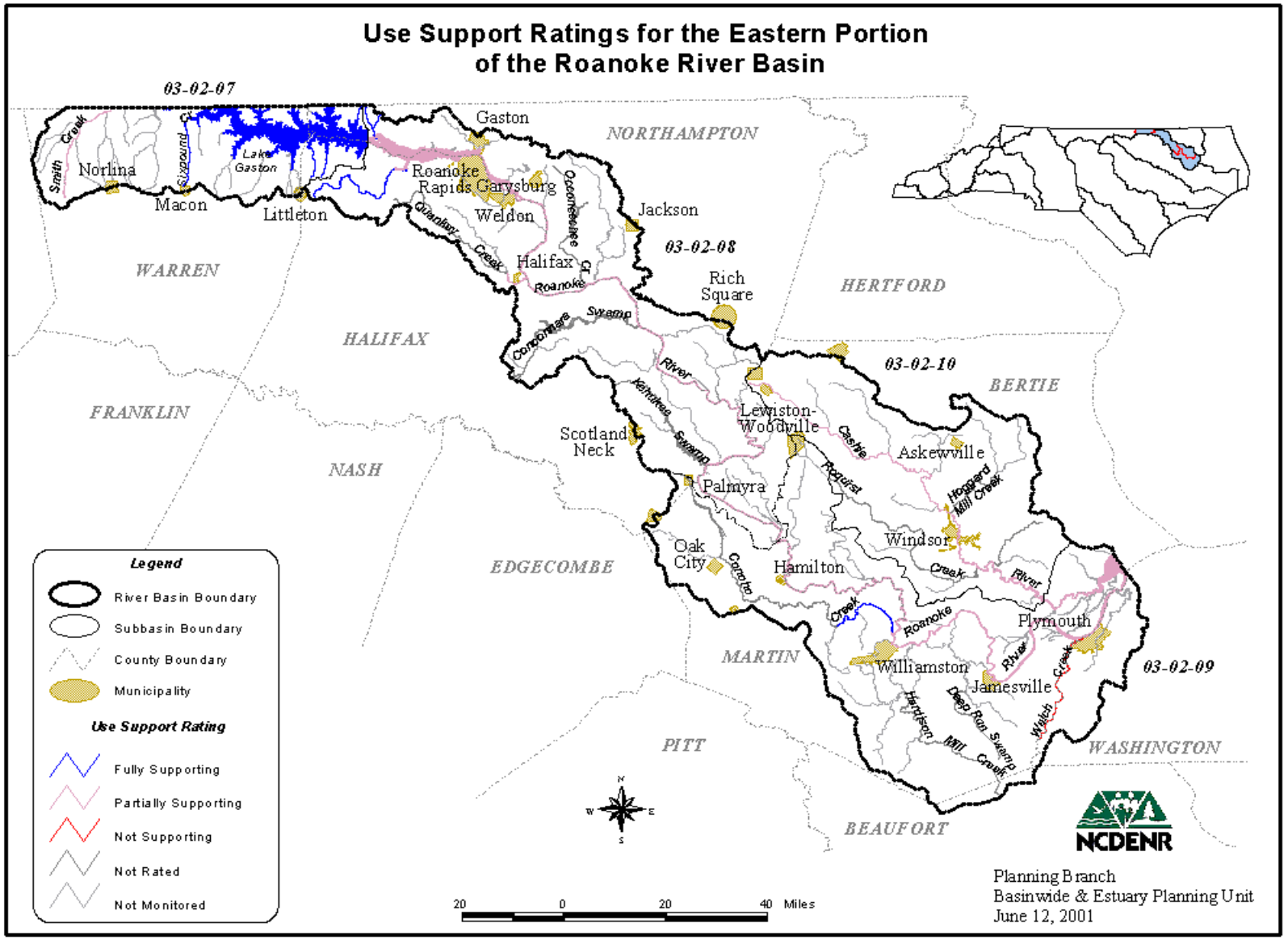

Figure A-22 Use Support Ratings for the Eastern Portion of the Roanoke River Basin