CHAPTER 4

WATER QUALITY IN THE HIWASSEE RIVER BASIN

4.1 INTRODUCTION

This chapter provides a detailed overview of water quality and use support ratings in the Hiwassee River Basin.

<u>DWQ Water Quality Monitoring and Assessment</u>

- **Section 4.2** presents a summary of seven water quality monitoring programs conducted by DWQ's Environmental Sciences Branch including consideration of information reported by researchers and other agencies (NCDEM, 1994).
- **Section 4.3** presents a narrative summary of water quality findings for both of the subbasins. The summary is based on the monitoring approaches described in Section 4.2. Subbasin maps showing the locations of monitoring sites are also included.

<u>Use-Support Ratings</u>

- **Section 4.4** describes the use-support concept and the methodology for developing use-support ratings. Using this approach, surface waters in the basin are assigned one of four ratings: fully supporting, fully supporting but threatened, partially supporting, or not supporting uses.
- **Section 4.5** presents a series of tables, figures, and a color-coded use-support map for many of the streams in the basin.

4.2 WATER QUALITY MONITORING PROGRAMS IN THE HIWASSEE RIVER BASIN

DWQ's monitoring program integrates biological, chemical, and physical data assessment to provide information for basinwide planning. Below is a list of the five major monitoring programs that have been performed in the Hiwassee River basin. Each of these is briefly described in the following sections.

- Benthic macroinvertebrate monitoring (Section 4.2.1),
- Fish tissue monitoring (Section 4.2.2),
- Lakes assessment (including phytoplankton monitoring) (Section 4.2.3),
- Aquatic toxicity monitoring (Section 4.2.4),
- Ambient water quality monitoring (covering the period 1988-1994) (Section 4.2.5).

In addition, Section 4.2.6 briefly describes other water quality and acid rain studies conducted by other agencies in the Hiwassee River basin. These studies include:

- Acid Deposition and Sensitivity Studies
- Tennessee Valley Authority
- Duke Power

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 monitoring tool because 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 a bioclassification rating 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); or commonly referred to as EPTs. The ratings fall into five categories ranging from Poor to Excellent. Likewise, ratings can be assigned with a Biotic Index (Appendix III). This index summarizes tolerance data for all species in each collection. The two rankings are given equal weight in final site classification. Higher taxa richness values are associated with better water quality. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is poorly assessed by a taxa richness analysis. Different criteria have been developed for different ecoregions (mountains, piedmont and coastal plain) within North Carolina.

Macroinvertebrate Sampling in the Hiwassee River Basin

Macroinvertebrate data were collected at 15 basin assessment sites during 1994. A total of 37 sites (73 samples) were rated using benthic macroinvertebrate data since 1983. Overall water quality was Excellent at most sampling sites in the basin. The fifteen 1994 sites resulted in a bioclassification of Excellent at 9 sites, Good at 3 sites, Good-Fair at 2 sites, and Fair at 1 site (Brasstown Creek). Of the 73 samples collected since 1983, 66% were given an Excellent bioclassification.

4.2.2 Fisheries Monitoring

The condition of the fishery is one of the most meaningful indicators of ecological integrity to the public. 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 (such as macroinvertebrates) will affect the abundance, species composition, and condition of the fish population. Two types of fisheries monitoring are conducted by DWQ; fish community assessment and fish tissue analysis. Only fish tissue analyses were conducted in the Hiwassee River basin.

Fish tissue analyses involve examining fish tissues to determine whether they are accumulating chemicals. This information is also useful as a water quality indicator and can be used to determine whether human consumption of fish poses a potential health risk.

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, chemicals in the water can be identified. 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 ingested by fish or shellfish tissues either directly or through aquatic food webs (defined as bioaccumulation). Results from fish tissue monitoring can serve as an important indicator of contamination of sediments and surface water. Fish tissue analyses 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.

Fish Tissue Analysis in the Hiwassee River Basin

Fish samples collected within the Hiwassee River basin were analyzed for metals contaminants only. Fish tissue samples were collected from Hiwassee River and Hiwassee Lake (13 observations) from 1981 to 1986. Fish species collected for analyses included catfish, walleye and bass. Results of fish tissue analyses indicated that mean levels of metals contaminants were non-detectable or present at levels below FDA and EPA criteria.

4.2.3 Lakes Assessment Program (including Phytoplankton)

Lakes are valued for the multiple benefits they provide to the public. These benefits include 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 general health, or trophic state, of each lake. The North Carolina Trophic State Index (NCTSI) is a measure of nutrient enrichment and productivity. Lakes are evaluated on whether the designated uses of the lake have been threatened or impaired by pollution. This index is explained more fully in Appendix III.

Lakes Assessed in the Hiwassee River Basin

There were three lakes in the Hiwassee River Basin sampled as part of the Lakes Assessment Program. These lakes are: Chatuge Lake, Apalachia Lake and Hiwassee Lake. Hiwassee Lake was the only lake intensively monitored during the growing seasons of 1991 through 1993 as part of the reference lake program. The purpose of this program was to identify lakes in each of the four regions of the state (Mountain, Piedmont, Sandhills and Coastal Plains) which were representative of minimally impacted lakes by which similar lakes in the same region could be compared.

Each lake is individually discussed in the appropriate subbasin section with a focus on the most recent available data.

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. Many facilities are required to monitor whole effluent toxicity by their NPDES permit or by administrative letter. Other facilities may be tested by DEM's Aquatic Toxicology Laboratory. The Aquatic Survey 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 DEM administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

Aquatic Toxicity Monitoring in the Hiwassee River Basin

There are four facilities in this basin required to conduct whole effluent toxicity testing. A list of each NPDES facility is provided later in this Chapter in the Aquatic Toxicity Monitoring section.

4.2.5 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 (or water quality parameters). Sampling stations are sited under one or more of the following monitoring designations:

<u>Fixed Monitoring Stations</u>	<u>Rotating Monitoring Stations</u>
Point Source	Basinwide Information
Nonpoint Source	HQW & ORW
Baseline	Water Supply

Water quality parameters are arranged by freshwater or saltwater waterbody classification and by corresponding water quality standards. Under this arrangement, Class C waters are assigned minimum monthly parameters. Additional parameters are assigned to waters with additional classifications such as trout waters and water supplies. Water quality parameters are organized as shown in Table 4.1.

Table 4.1 Ambient Monitoring System Parameters

<u>C WATERS</u> (minimum monthly coverage for all stream stations)
Field Parameters: dissolved oxygen, pH, conductivity, temperature, chlorine
Nutrients: total phosphorus, ammonia, total Kjeldahl nitrogen, nitrate+nitrite
Physical Measurements: total suspended solids, turbidity, hardness
Bacterial: fecal coliform (Millipore Filter method)
Metals: aluminum (no present water quality standard), arsenic, cadmium, chromium, copper*, iron*, lead, mercury, nickel, silver*, zinc*

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

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

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

PLUS any additional parameters of concern for individual station locations.

* Action level water quality standard

Water quality data collected at two sites in the Hiwassee River basin were evaluated for the period 1990 - 1994 since basinwide permitting is done in five year cycles. These data were downloaded from STORET for analysis. Because the methodology for determining parametric coverage within the AMS program has recently been revised, some stations have little or no data for several parameters. however, for the purpose of standardization it was felt that data summaries for each station should include all parameters that will be sampled in the future. These data summaries are found below. AMS stations for the Hiwassee River basin are listed in Table 4.2.

Table 4.2 Ambient Monitoring System Stations Within the Hiwassee Basin.

Primary No	STORET No	Station Name	Subbasin
Hiwassee River Drainage			
03548500	F2500000	HIWASSEE RIVER ABOVE MURPHY NC	040502
03550000	F4000000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	040502

Ambient Monitoring Summary

Table 4.3 summarizes data collected at the ambient stations in the Hiwassee River basin. Each station is listed with associated parameter, the total number of samples, those samples with less than detection level recorded, and the number of excursions from a water quality criterion. It should be noted that the criteria are presented as numerical and represent instantaneous measurements. The actual standard may include a narrative, such as turbidity and, as in some metals criteria, may be based on extended exposure at or above the criteria to expect chronic toxicity of the most sensitive species of organism. Therefore the table is useful for relative comparisons between locations and screening areas where frequent excursions of individual or multiple parameters suggest waters that might be targeted for more detailed evaluations and/or specific management strategies. A more thorough evaluation can include review of temporal and spatial trends, association of concentrations to flow, degree of excursion from the criterion, or use of other analytical methods.

Table 4.3 Summary of Ambient Monitoring System Station Data Excursions from the NC Water Quality Criteria by Parameter. January 1990 to December 1994.

Station Number	Station Name	Parameter/Criterion	Samples All	Samples <Det	Excur
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Arsenic (µg/l) [50]	2727	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Arsenic (µg/l) [50]	2727	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Cadmium (µg/l) [2]	2727	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Cadmium (µg/l) [2]	2727	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Chlorophyll a (Corr)(µg/l) [40]	N/S		
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Chlorophyll a (Corr)(µg/l) [40]	N/S		
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Chromium (µg/l) [50]	2727	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Chromium (µg/l) [50]	2727	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Dissolved Oxygen (mg/l) [4]	270	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Dissolved Oxygen (mg/l) [4]	560	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Fecal Coliform (#/100ml) [200]	198	1	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Fecal Coliform (#/100ml) [200]	222	3	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Hardness (mg/l) [100]	270	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Lead (µg/l) [25]	2727	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Lead (µg/l) [25]	2727	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Manganese (µg/l) [200]	6	0	0
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Mercury (µg/l) [0.012]	2727	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Mercury (µg/l) [0.012]	2727	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Nickel (µg/l) [25]	2727	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Nickel (µg/l) [88]	2726	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	pH (SU) [6.0-9.0]	270	0	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	pH (SU) [6.0-9.0]	530	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Total Residue (mg/l) [500]	250	0	
03548500	HIWASSEE RIVER ABOVE MURPHY NC	Turbidity (NTU) [50]	270	1	
03550000	VALLEY RIVER AT SR 1373 AT TOMOTLA NC	Turbidity (NTU) [50]	370	0	

Hiwassee River Drainage

Two AMS sites are located in the Hiwassee River drainage. One on the Hiwassee River and one on the Valley River. There were very few excursions from the water quality criterion. Four of the five total excursions were from the fecal coliform criterion and this parameter is addressed in the section below on fecal coliform bacteria. There are some historic anomalies in the data that should be noted.

Figure 4.1 shows pH concentrations in the Hiwassee River Basin. As mentioned in the Little Tennessee River Basinwide Assessment Report Support Document, there were low pH concentrations recorded in the basin beginning in the summer of 1991. These readings were consistent throughout the whole basin and extended through 1994. There was a similar pattern for the Hiwassee River basin from 1991 through 1994. In 1995, the pH values were slightly higher

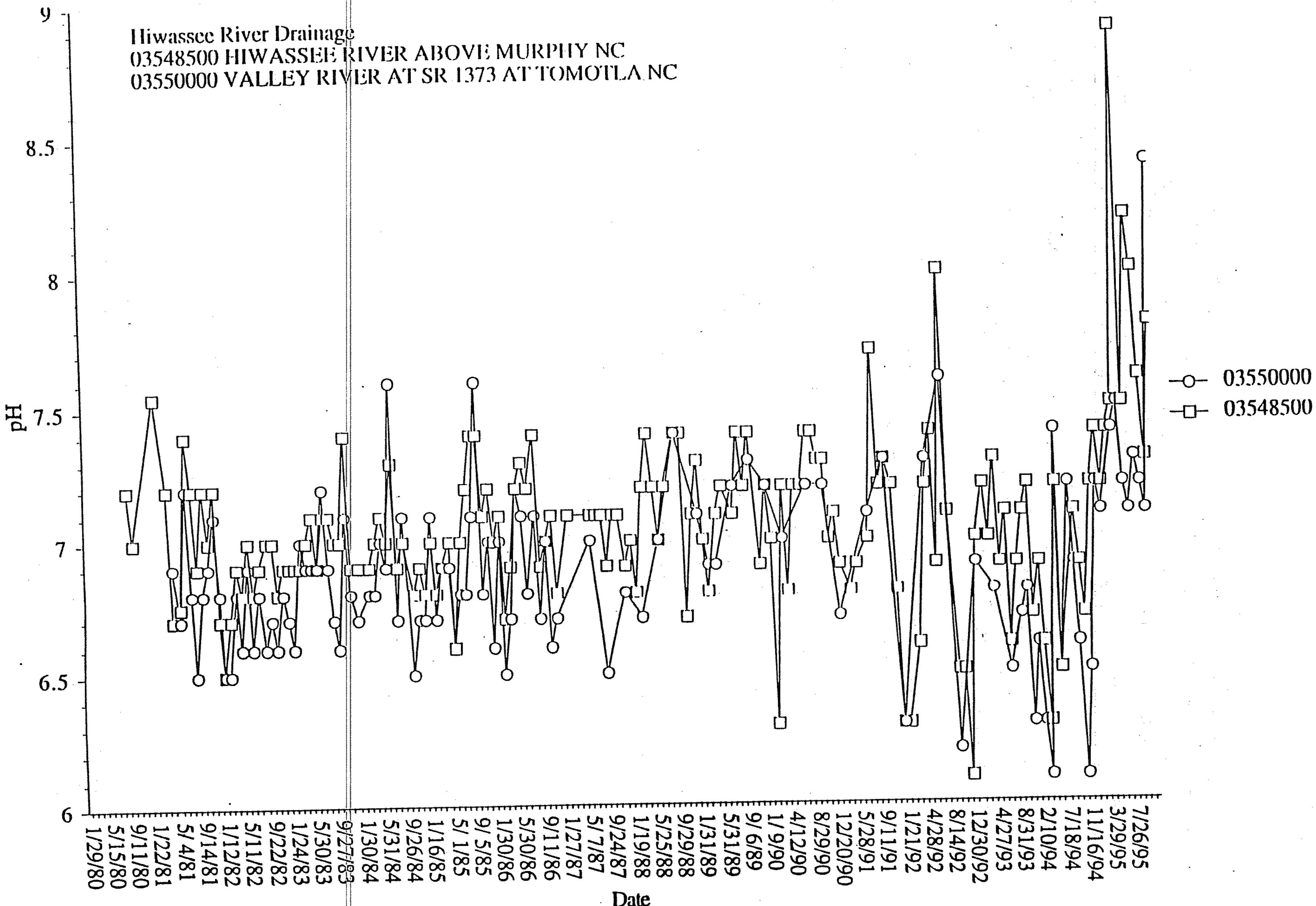


Figure 4.1 pH Concentrations for the Hiwassee River Basin. 1980 to 1995.

than normal. As in the Little Tennessee River basin, the upper range of pH does not change during this time. Air sampling stations in and around this area of the state recorded no abnormal data for this time period and as of the writing of this plan, no apparent reason for the lower pH values has been found.

Fecal Coliform Bacteria

Fecal coliform bacteria are most useful as a screening tool to estimate the cumulative inputs from multiple sources, but in some instances can be used to locate a single large source of bacteria. Summaries of fecal coliform results were provided each regional office in May of 1995. These data will be updated in this and each subsequent Basinwide Assessment Report and will include any additional data collected by staff during the five year cycle.

Summary fecal coliform information is listed in Table 4.4. The primary screening tool used in establishing priority is the geometric mean. Sites with 10 or more fecal coliform samples within the last 5 years, that have a geometric mean exceeding 200 /100ml, are considered highest priority. This information will be reflected in the Use Support Rating for that stream or river. In the Hiwassee River, there were no stations with a geometric mean greater than 200/100ml.

Table 4.4 Fecal Coliform summary data for the Hiwassee River Basin. 1990 to 1995.

Site	Total Samples	Geometric Mean	Samples > 200/100ml	Percent >200/100ml	First Sample	Last Sample
Hiwassee River	19	5.23	1	5.3	6/18/91	12/28/94
Valley River	22	23.47	3	13.6	6/18/91	12/28/94

4.2.6 Other Water Quality Monitoring Programs

Acid Deposition and Sensitivity Studies

The Southern Appalachian Man and Biosphere (SAMAB) was established to address concerns about the adverse effects of air pollution on the environmental resources unique to the Southern Appalachian mountains. Interagency assessment teams were formed to gather and interpret information about the status, management and ecosystem use. The teams prepared status reports on Terrestrial, Aquatic, Social/Cultural/Economic and Atmospheric ecosystems. Of particular interest to this basinwide plan are the effects of acid deposition on the surface waters of the Southern Appalachian mountains. The Hiwassee River basin lies within the boundaries of SAMAB (Figure 5.1). Discussion of SAMAB in this plan is limited to water quality issues as they pertain to the Hiwassee River basin. The National Acid Precipitation Assessment Program (NAPAP) also studied the effects of acid deposition on surface waters. These reports are the basis for the following summaries made by SAMAB (SAMAB 1996).

Based on these studies, several conclusions are made about the effects of acid deposition on streams within the Great Smoky Mountains National Park. The results of these studies are applicable here due to the high elevations within the Hiwassee River basin and the potential for the effects of acid deposition to affect areas outside of the GSMNP.

Perhaps the most important factor is the low acid neutralizing capacity (ANC) of streams throughout the GSMNP. ANC is considered to be the measure of the ability of the stream to neutralize (or buffer) acid inputs. A low ANC is an indicator that the stream is sensitive to acid inputs. The ANC of streams tends to be lower at higher elevations. This makes streams at higher elevations more vulnerable to acid deposition . Therefore, these high elevation streams tend to have a lower pH (at or below 5.5 (Flum and Nodvin 1985)). Fish and amphibian populations need to have pH levels above 5.5 to survive and reproduce. The levels of stream pH are currently not detrimental to fish, however, the low buffering capacity of these streams makes the waters very vulnerable to chronic acid deposition.

Increasing stream acidity may result in the loss of aquatic species richness and diversity. Nitrates and sulfates are deposited into the forest ecosystem through acid deposition. The concentrations of these inputs can play a major role in ANC. Nitrate and sulfate concentrations tend to be higher at higher elevations. The GSMNP receives some of the highest nitrate concentrations (and the lowest soil nitrogen retention ability) from the atmosphere of any region of SAMAB. Thus, nitrate is entering streams in concentrations as great or greater than sulfate concentrations.

ANC is also affected by bedrock geology. In areas with underlying limestone, ANC is higher and the streams are more buffered from the effects of acid deposition. However, in many watersheds of the GSMNP there are non-limestone areas and Anakeesta rock formations. When Anakeesta is exposed to air and water, the rock reacts to leach sulfuric acid and heavy metals into the watershed. If a stream is nearby (as is the case with Beech Flats Prong, a Support-Threatened HQW in the GSMNP), the effects of the acidification can be long-term and severe.

Some watersheds with long-term monitoring sites show a trend of increasing streamwater sulfate concentrations between 1975 and 1995. Soils in these areas have gradually become saturated with sulfates. Nitrates in streams have also likely increased. In the GSMNP, stream nitrate concentrations are highest at high elevations where forests are older (forest demand for nitrogen is lower). Fifty year projections using a 1985 deposition rate show an increase in the percentage of acidic streams from 0% to 10% (SAMAB 1996).

Acid deposition sensitivity has been broadly determined for the Southern Appalachian Assessment area (Peper et. al.., open file report) by federal agencies of the Southern Appalachian Man and Biosphere Cooperative. Sensitivities to acid deposition are assigned on the basis of bedrock compositions and associated soils, along with their capacity to neutralize acid precipitation. Acid-base status is defined as the balance between acids and bases in the soils and surface waters. This issue is of particular concern in the SAA region due to the low ANC of higher elevation streams, the high rate of acid deposition as compared to other areas in the U.S., the area is affected by surface water acidification due to acid deposition, and the potential for further decreases in pH values in streams as a consequence of continued acidic deposition. Bedrock geology and associated soil types are known to play an important role on the chemical composition of surface water and on the sensitivity of aquatic ecosystems to acidic deposition. This work was done on a broad scale and can only be applied in a general sense to the waters of the Hiwassee River basin. As reported in the SAA report, approximately 363, 536 acres (80.8%) of the Hiwassee River basin are considered to be highly sensitive to acid deposition. An additional 30,982 acres (6.9%) have medium sensitivity and 17,596 acres (3.9%) have low sensitivity to acid deposition.

The Integrated Forest Study (IFS) demonstrated in the 1980's that high elevation spruce-fir ecosystems (common to the GSMNP) receive the highest loadings of nitrogen and sulphur (Nodvin, et. al.. 1985). Nitrification of soils have been known to elevate soil aluminum concentration to values that inhibit calcium uptake in red spruce (Nodvin, et. al.. 1985), thereby altering the forest canopy to a degree that can have additional impacts on water quality and aquatic ecosystems.

An extensive water quality monitoring program within the GSMNP determined that the area receives high rates of both sulfates and nitrogen inputs and that the nitrogen loading has the greatest effect on stream chemistry since sulfate retention by the forest and the soils is high. Nitrogen loading to streams is especially elevated in watersheds with aged growth forests and high elevations. With the likelihood of continued loadings to the ecosystem, it is also likely that nitrogen saturation will extend downslope and downstream as catchments mature and soil saturation is reached (Flum and Nodvin 1985). It is likely that without drastic reductions in acid deposition that further changes in stream chemistry toward more acidic streamwater will occur in high elevations (greater than 5000 feet).

The National Biological Service has documented low pH problems in some of the streams within the Great Smoky Mountains National Park, including many streams in the Lower Little Tennessee subbasin. They have information on 350 sites in North Carolina and Tennessee, including almost 2500 measurements of stream pH. These data are summarized as follows:

About 5% of the samples were found to have pH values less than 5.0, 11% had pH values less than 5.5, and 22% had pH values less than 6.0. Low pH values were found in two types of streams:

1. *Streams in catchments with Anakeesta rock deposits.* A characteristic symptom of this problem is high sulphate levels, as the weathering of the Anakeesta rock produces sulfuric acid. High concentrations of heavy metals is also indicative of the weathering of Anakeesta rock. Road cuts or landslides in areas of Anakeesta rock can result in stream pH values <5.0.
2. *Streams above 3500' in old-growth (undisturbed) forest.* These terrestrial systems may become nitrogen saturated after many years of acid rain, and the acid-neutralizing capacity of the catchment becomes used up. A characteristic of this problem is high nitrate levels in stream water, especially after rainfall. Lower elevation sites rarely have records of pH < 6.2, but this may reflect monthly or biannual sampling frequency. It is possible that these lower elevation sites may have occasional pH values less than 6.0, but for a period of only a few days.

Tennessee Valley Authority (TVA)

TVA has developed an extensive monitoring program that combines the expertise of water quality professionals with the interests and dedication of local citizens, interest groups, businesses and industry, and other governmental agencies. Refer to Chapter 5 for a more complete summary of this TVA water quality initiative.

Within the Hiwassee River basin, TVA has maintained two sampling sites on both Hiwassee Lake (one near the dam and another mid-lake) and Chatuge Lake (both near the dam). Following is a brief summary of the results of the TVA monitoring.

Hiwassee Lake

While the overall health of Hiwassee Lake was rated fair, there were some changes in water quality observed. For example, algae levels were twice as high as in previous years, presumably due to heavy rainfall events and subsequent runoff carrying nutrients. Algae levels rated fair. Benthic macroinvertebrate life rated poor due to low numbers and diversity. Sediment quality in the lake improved in 1994 and rated good. Previous toxicity problems to test animals improved also. The fish rating improved (good and fair determinations) as a result of improvements in TVA's evaluation method.

Chatuge Lake

In 1994, Chatuge lake rated fair by TVA's determinations, with conditions about the same as the previous year. However, because of changes in TVA's evaluations of algae, the lake rated higher than the previous year (good and fair). Oxygen (good and fair), sediment (fair) and fish community (fair) all improved in rating from 1993. Elevated levels of copper and chromium were detected in sediment samples from the Shooting Creek arm of the lake. Benthic macroinvertebrate samplings showed a decrease in rating (to fair) due to lower numbers and diversity of animals.

DWQ biologists have not established sampling sites at these same location, so no comparison of these data can be made at this time. It is important to note that there are differences in sampling methodology used by DWQ and TVA. For example; 1) TVA does not have an Excellent rating for their EPT methodology, and 2) DWQ biologists identify macroinvertebrate samples to a lower level of taxonomy (to genus and species level). With proper training, it is realistic for volunteers to achieve family level taxonomy. However, it appears that family level identification and the use of a national list of tolerance values may not be sensitive enough to detect subtle water quality changes. It has been further suggested that the use of regionalized data for family tolerance values would improve the quality of volunteer generated data (Penrose and Call 1995) and allow for better comparison between datasets.

In the future, it may be possible for the DWQ biologists to work with TVA to coordinate sampling locations on sites within the Little Tennessee River basin. It may also be possible for DWQ to conduct follow-up field work or QA/QC investigations on those TVA stream sites that do not correspond with DWQ findings.

Duke Power

Duke Power has an ongoing erosion control assessment program designed to document baseline conditions, quickly detect sedimentation impacts and to assess the effectiveness of erosion control measures in protecting water quality. This program is used particularly for transmission line construction activities conducted by Duke Power (see Section 5.6.4 for additional information). The focus of this program is to monitor Total Suspended Solids (TSS) and Total Phosphorous (TP) as key parameters relating to the effects of erosion and sedimentation. Samples are collected using vertical series of depth-integrated single-stage samplers to document before, during and after construction impacts to a waterbody. Information is used to quickly alert field crews where stabilization efforts need to be undertaken. Duke Power has over 100 monitoring sites in western North Carolina and northern South Carolina (Braatz 1996).

In the Hiwassee River basin, Duke Power has eight sampling stations (three stations on the Valley River at Rhodo, Andrews and Marble; one onWebb Creek near the mouth; one on Gipp Creek near the mouth and three sites on Britton Creek). Raw TSS and TP data is available on these sites from Duke Power. Summary information is yet to be compiled.

4.3 NARRATIVE WATER QUALITY SUMMARIES BY SUBBASIN

4.3.1 Chatuge Lake and Hiwassee River (Subbasin 04-05-01)

Description

Hiwassee subbasin 04-05-01 lies primarily within Clay County (Figure 4.2). The Hiwassee River originates in Towns County in north Georgia and flows northward into North Carolina, where it is dammed to form Chatuge Lake. Major tributaries to the Hiwassee River in this subbasin include Shooting Creek, Tusquitee Creek, Fires Creek and Brasstown Creek (which also originates in Georgia). The largest town in this subbasin is Hayesville. Land use within this subbasin is mainly forest and agricultural. The Fires Creek Wildlife Management Area is part of the Nantahala National Forest.

Overview Of Water Quality

Overall water quality in this subbasin is Excellent as most of the streams drain undisturbed, undeveloped and protected mountain areas. The entire Fires Creek catchment has been designated ORW and most of the Tusquitee Creek watershed is classified HQW.

A total of 20 benthos sites (46 collections) have been sampled in this subbasin since 1985. Four of the basin assessment sites in 1994 have long term data for analysis of changes in water quality. Sampling locations are shown in Figure 4.2. Benthos collections from Shooting Creek, a large tributary stream to Chatuge Lake, were part of a special study in 1994 conducted to determine the effects of an illegal discharge from a poultry operation. The water quality declined downstream of the discharge from Excellent to Good, but it was not determined that the poultry operation was the only source of impact to the stream. Shooting Creek may be affected by US 64, which follows the creek for most of its length.

There are four permitted dischargers in this subbasin, however the few water quality problems encountered in this subbasin are primarily due to nonpoint source runoff. In fact, the only site sampled in this subbasin that did not receive an Excellent or Good rating was Brasstown Creek at SR 1104 (Fair). This creek originates in north Georgia and is impacted by nonpoint source runoff, as it flows along NC 66 for most of its length. It also receives effluent from the Young Harris Water Pollution Control Plant in Georgia.

Chatuge Lake, a large reservoir straddling the North Carolina-Georgia state line, lies within this subbasin. Data indicates that Chatuge Lake fully supports its designated uses.

Benthic Macroinvertebrates

Six sites were sampled for benthic macroinvertebrates as part of the basinwide assessment program in 1994 (Table 4.5). Twenty sites have been sampled in this subbasin since 1985, including two special studies.

Table 4.5 Basin Assessment Sites in Hiwassee Subbasin 04-05-01, 1994, Taxa Richness Values and Bioclassification.

Site#	Creek	Date	County	Road	S/SEPT	Rating
B-3	Shooting Cr	940713	Clay	SR 1347	-/32	Good
B-6	Tusquitee Cr	940728	Clay	SR 1330	69/34	Excellent
B-8	Big Tuni Cr	940713	Clay	SR 1311	63/38	Excellent
B-15	Fires Cr	940713	Clay	SR 1330 Bristol Camp	80/43	Excellent
B-16	Fires Cr	940713	Clay	SR 1330 Picnic Area	-/35	Excellent
	Fires Cr	940829	Clay	SR 1330 Picnic Area	81/38	Excellent
B-20	Brasstown Cr	940728	Clay	SR 1104	-/18	Fair

Shooting Creek is a large tributary stream to Chatuge Lake, and had no prior data. It follows US 64 for most of its length. The bottom substrate shows evidence of sedimentation (pools filled in with sand and silt). The Good rating found at SR 1347 is lower than an Excellent rating found further upstream during a special study in August 1994.

Brasstown Creek, received a bioclassification of Fair. This creek originates in north Georgia and is impacted by nonpoint source run-off, as it flows along NC 66 for most of its length. A water quality investigation of Brasstown Creek by the Georgia Department of Natural Resources determined that the effluent from the Young Harris Water Pollution Control Plant exceeded its permit limitation for fecal coliform bacteria. Biological and chemical data, with the exception of fecal coliform bacteria, indicated good water quality in Brasstown Creek (GDNR 1993).

Hiwassee River Basin
040501

Legend

- (A) Ambient Monitoring Station
- (L) Lake Assessment
- (F) Fish Community
- (T) Fish Tissue
- (B) Benthic Macroinvertebrate Ambient Station

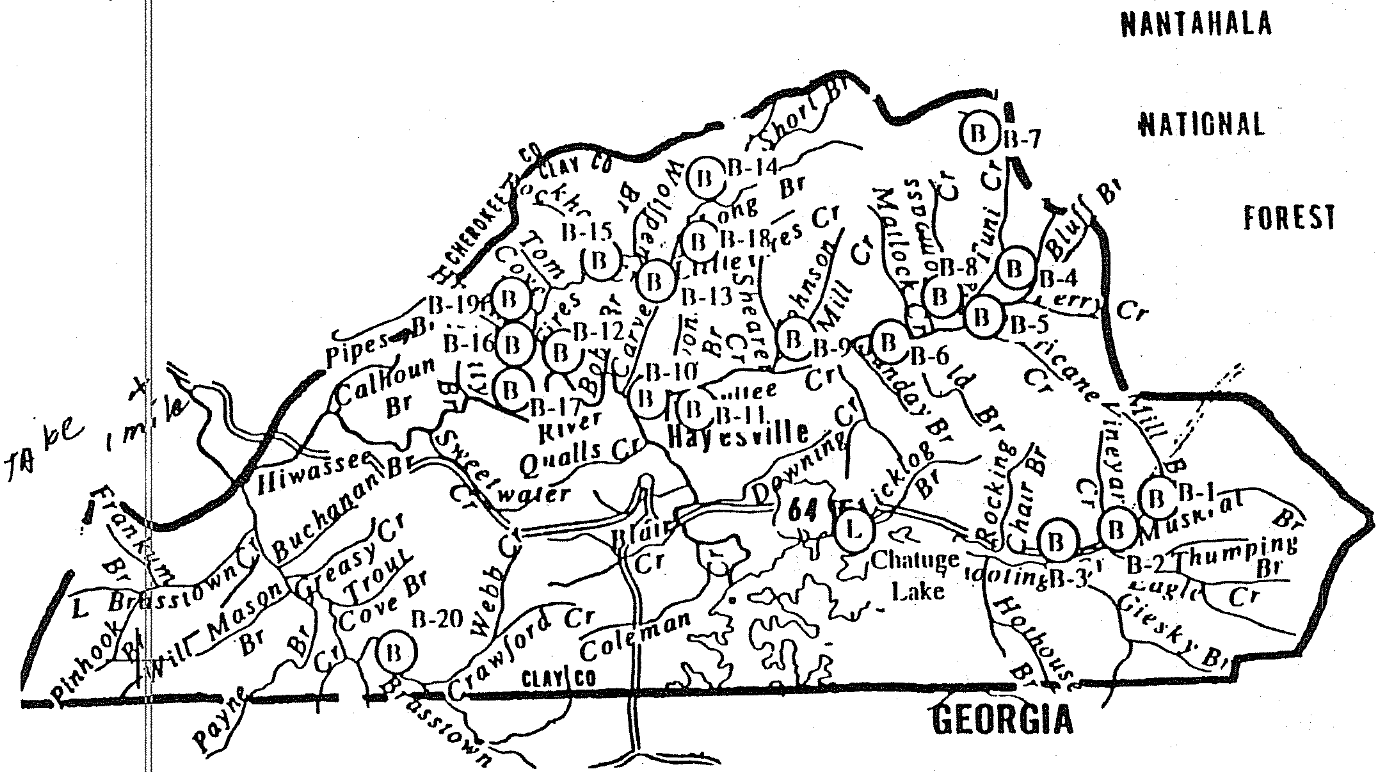


Figure 4.2 Sampling Locations in Chatuge Lake and Hiwassee River (Subbasin 04-05-01)

Long Term Benthic Macroinvertebrate Sites

Tusquitee Creek (and its tributary, Big Tuni Creek), and Fires Creek, major tributaries to the Hiwassee River, remain in Excellent biological condition. The Tusquitee Creek site has consistently rated Excellent since 1987.

A downstream site on Big Tuni Creek at SR 1311 was sampled in 1994, resulting in an Excellent bioclassification. Total taxa richness and intolerant EPT taxa richness decreased from 1989, but the Biotic Index was lower in 1994. This may be due to the effects of heavy rains. This site has also consistently supported a diverse population of pollution intolerant species.
Fires Creek at Bristol Camp is located upstream of the Fires Creek Picnic Area site in a more remote area of the watershed. Fires Creek is a pristine mountain stream which supports populations of several unusual animal species, such as the water shrew, the blackbelly salamander, and the Hellbender (NCDEM Report B-880906). This site has consistently rated Excellent. Fires Creek is classified as an Outstanding Resource Water.

A downstream Fires Creek site at the Picnic Area is subject to more recreational use (swimming) than the Bristol Camp site. This site has consistently been given an Excellent bioclassification.

Special Benthic Macroinvertebrate Studies

Data from all special studies since 1983 are presented in Table 4.6, with a reference to the Biological Assessment Group report file number if more detailed information is needed.

Table 4.6 Benthic Macroinvertebrate Special Studies, Hiwassee Subbasin 040501, 1983-1994.

Site#	Creek	Date	Study	County	Road	S:Rating
B-1	Shooting Cr	940829	Poultry Farm	Clay	SR 1349	68/37:Excellent
B-2	Shooting Cr	940829	Poultry Farm	Clay	SR 1168	59/28:Good

This study was conducted to determine the effects of an illegal discharge from a poultry operation. The water quality did decline downstream of the discharge, but it could not be determined that the poultry operation was the only source impacting the stream. Farther downstream Shooting Creek shows a decline in water quality, probably due to agricultural nonpoint runoff.

A number of streams or stream reaches that were classified as WS-I were not being used as water supply sources. It was proposed by the Planning Branch of DWQ that these streams be reclassified to C-HQW. Little Fires Creek was used as a seasonal reference site in this study. Little Fires Creek was given an Excellent bioclassification rating.

Eight sites in the Tusquitee Creek watershed were investigated for possible HQW reclassification (Table 4.7). Most of Tusquitee Creek and all tributaries except Greasy Creek were reclassified as HQW.

In 1987 and 1988, DEM worked in conjunction with the US Forest Service and the North Carolina Department of Agriculture to assess any effects on stream water quality from the eradication of Gypsy moths in the Fires Creek watershed. Before and after samples were collected. Results suggested that there were no significant changes in the benthic macroinvertebrate community structure between collection periods.

Table 4.7 High Quality Waters Investigation Results for the Hiwassee River Basin

Site#	Creek	Date	Study	County	Road	S:Rating
B-4	Tusquitee Cr	890331	Hiwassee Basin HQW	Clay	ab hatchery	-/35:Good
B-5	Tusquitee Cr	890330	Hiwassee Basin HQW	Clay	SR 1307	-/49:Excellent
B-6	Tusquitee Cr	890330	Hiwassee Basin HQW	Clay	SR 1330	-/45:Excellent
B-7	Big Tuni Cr	890331	Hiwassee Basin HQW	Clay	SR 1311 up	-/46:Excellent
B-8	Big Tuni Cr	890331	Hiwassee Basin HQW	Clay	SR 1311 dn	83/45:Excellent
B-9	Johnson (Mill) Cr	890330	Hiwassee Basin HQW	Clay	SR 1307	-/42:Excellent
B-10	Tusquitee Cr	890330	Hiwassee Basin HQW	Clay	SR 1300	90/47:Excellent
B-11	Greasy Cr	890330	Hiwassee Basin HQW	Clay	SR 1318	-/38:Good

Aquatic Toxicity Monitoring

One facility in this subbasin currently monitors effluent toxicity as per a permit requirement. That facility is:

Facility	NPDES#	Receiving Stream	County	Flow(MGD)	IWC(%)
Hayesville WWTP	NC0026697/001	Town Cr	Clay	0.072	18.90

Whole effluent toxicity monitoring results for all dischargers in the Hiwassee Basin are presented in Appendix III. This facility has not obtained regulatory relief for its toxicity limit through a special or judicial order. Recently Clay County took over operation of the facility.

Lakes Assessment Program

Chatuge Lake

Chatuge Lake is a large reservoir which straddles the North Carolina-Georgia state line in the southwest portion of North Carolina. The lake is adjacent to the Nantahala National Forest and is an impounded section of the Hiwassee River upstream of Hiwassee Lake and Apalachia Lake. Chatuge Lake is owned by the Tennessee Valley Authority (TVA) and was constructed to provide hydroelectric power, flood control, and recreation. Construction on the Chatuge Dam was completed in 1942. The reservoir has a maximum depth of 144 feet (44 meters), and a mean depth of 36 feet (11 meters). Chatuge Lake is 13 miles (21 kilometers) long with a surface area of 6950 acres (2812 hectares) and 132 miles (212 kilometers) of shoreline. The drainage area covers 187 mi^2 (484 km^2) and is mostly forested with a few residences, campgrounds and small boat docks. Major tributaries include the Hiwassee River and Shooting Creek.

The elevated turbidity observed in 1994, as well as the elevated total phosphorus value, near the Shooting Creek arm may have been the result of sampling the lake during a rainfall event. In 1994, the NCTSI score was -1.3, indicating mesotrophic conditions. Chatuge Lake is classified B waters and fully supports its designated uses.

Chatuge Lake was previously sampled by DEM in 1981 and 1987. In 1981, Chatuge Lake was oligotrophic with a NCTSI score of -3.1. In 1987, the NCTSI value of -4.6 indicated oligotrophic conditions. These results indicate that Chatuge Lake, while still meeting its use-support designation, has declined in water quality.

4.3.2 Hiwassee River, Hiwassee Lake and Apalachia Lake (Subbasin 04-05-02)

Description

Hiwassee River subbasin 04-05-02 lies entirely within Cherokee County (Figure 4.3), where it is impounded to form Hiwassee Lake and Apalachia Lake. The Tennessee Valley Authority (TVA) regulates water releases from these lakes for the production of hydroelectric power.

The Valley River is the largest tributary to the Hiwassee River. The Valley River, flows in a southwesterly direction from Topton through Andrews, Marble, and Tomatla to converge with the Hiwassee River near Murphy. Land use is primarily agricultural and forest, with some urban areas in the Valley River watershed between Andrews and Murphy, along US 19/129. Most of the Hiwassee River drainage is located within the Nantahala National Forest. There are eleven permitted dischargers in this subbasin, the largest of which is the Andrews WWTP with a design flow of 1.5 MGD.

Overview Of Water Quality

A total of 17 benthos sites (27 collections) have been sampled in this subbasin since 1983. Subbasin sampling in 1994 resulted in Excellent bioclassifications for Peachtree Creek, Hanging Dog Creek, Nottely River, Persimmon Creek, and Beaverdam Creek. South Shoal Creek and Shuler Creek received Good ratings.

One site, the Valley River near Tomatla, has long term data and has remained relatively stable with a Good-Fair rating. A special study of the Valley River in 1994 revealed unexpected water quality problems in the Valley River near Andrews. The headwater areas (including Junaluska Creek) were rated Good-Fair, with evidence of some sediment problems. The Valley River between Stewart Road and a site about 3 miles below Andrews, however, was rated Fair with evidence of toxicity problems. There was no evidence that the Andrews WWTP contributed to these problems. The site above the WWTP showed the most severe water quality problems. There are no permitted dischargers in the area where the problem originates.

There are two small watersheds in this subbasin that are classified as High Quality Waters (HQW) or Outstanding Resource Waters (ORW). These watersheds are Britton Creek and Gipp Creek, both tributaries to the Valley River.

There are two ambient monitoring sites in this subbasin, one located on the Hiwassee River near Murphy and the other on the Valley River near Tomatla. There are very few excursions from the water quality criterion in this drainage. Four of the five total excursions were from the fecal coliform criterion and this parameter is addressed later in this section.

Hiwassee Lake and Apalachia Lake are impoundments of the Hiwassee River that lie within this subbasin. Hiwassee Lake is one of sixteen lakes selected throughout the state as representative of minimally impacted lakes. Apalachia Lake is a run-of-the-river reservoir located within the Nantahala National Forest. Located immediately downstream of Hiwassee Lake, this reservoir is owned by the Tennessee Valley Authority (TVA) and was built for hydroelectric power generation, flood control and recreation. These lakes were found to be fully supporting of their designated uses.

Benthic Macroinvertebrates

Thirteen sites were sampled for benthic macroinvertebrates as part of the basin assessment program in 1994. Biological ratings obtained for these stream sites can be found in Table 4.8. With the exception of the Valley River, Junaluska Creek, South Shoal Creek and Shuler Creek, all streams

Hiwassee River Basin
040502

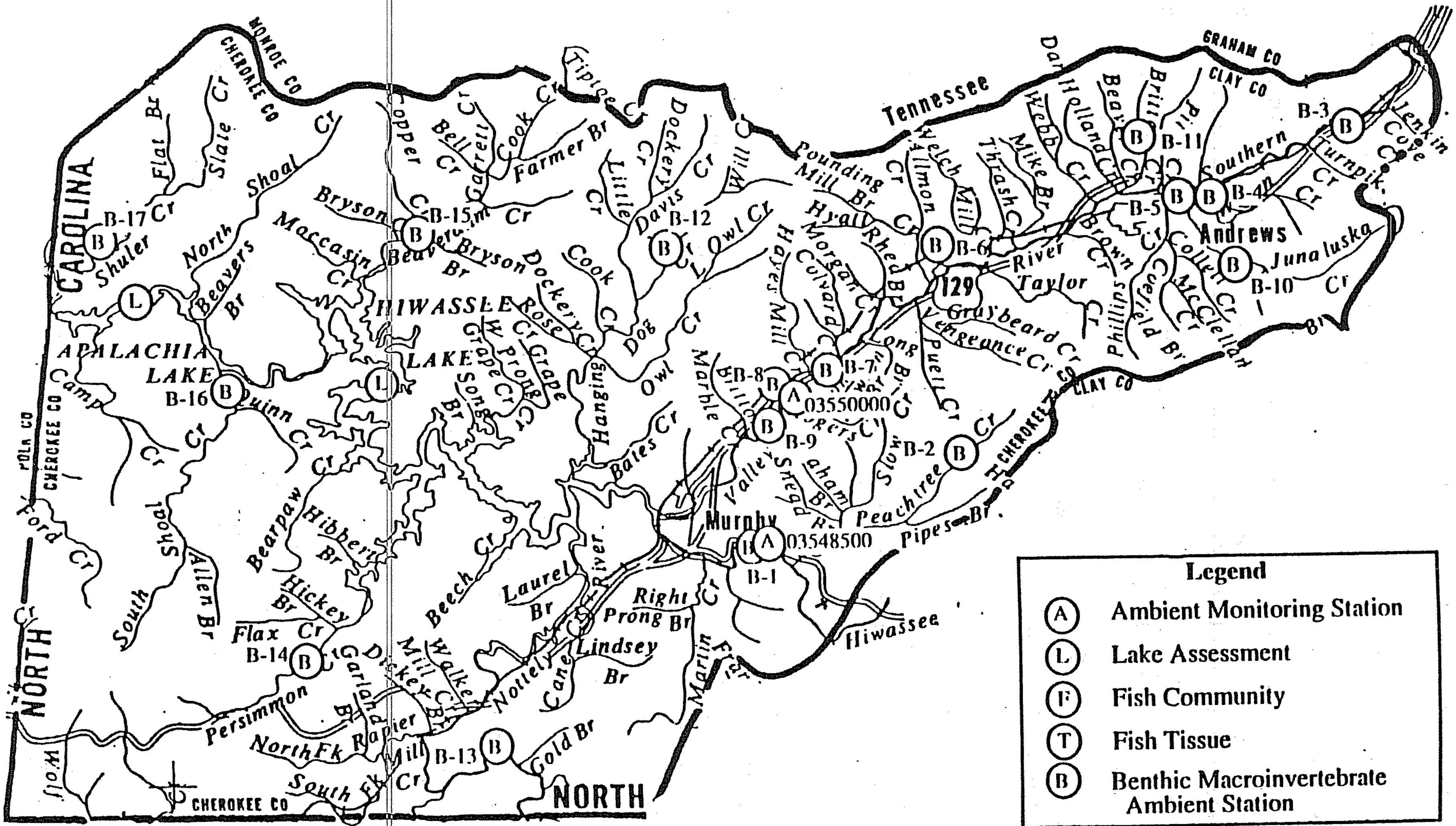


Figure 4.3 Sampling Locations in the Hiwassee River, Hiwassee Lake and Apalachia Lake (Subbasin 04-05-02)

received an Excellent rating. Valley River and Junaluska Creek are discussed further under Long Term Benthos sites and Special Studies. South Shoal Creek, a high gradient rocky stream and Shuler Creek flow into Appalachia Lake. Both creeks are embedded and Shuler Creek has areas of severe bank erosion.

Long Term Benthos Sites

The Valley River is the largest (20 meters wide) tributary of the Hiwassee River. The downstream site near Tomatla is an active ambient sampling location with historical data since 1984. Total and EPT taxa richness at the Valley River site near Tomatla (SR 1554) has remained relatively stable, with a Good-Fair bioclassification. In 1990, this site received a Good rating. There was a decrease in taxa richness in 1994 due to high flow conditions and difficulty in sampling. The biotic index increased slightly in 1994, resulting in a bioclassification of Good-Fair, indicating that the Valley River may be affected by run-off and point sources from the Andrews area. High flows could also cause the biotic index to increase due to flushing out of some of the tolerant species such as midges.

Table 4.8 Basin Assessment Sites in Hiwassee Subbasin 04-05-02, 1994, Taxa Richness Values and Bioclassification.

Site#	Creek	Date	County	Road	S/SEPT	Rating
B-2	Peachtree Cr	940712	Cherokee	SR 1537	-/37	Excellent
B-9	Valley R	940711	Cherokee	SR 1554	77/29	Good-Fair
B-10	Junaluska Cr	940711	Cherokee	SR 1505	-/25	Good-Fair
B-12	Hanging Dog Cr	940712	Cherokee	SR 1331	-/46	Excellent
B-13	Nottely R	940712	Cherokee	SR 1596	-/36	Excellent
B-14	Persimmon Cr	940712	Cherokee	SR 1127	-/42	Excellent
B-15	Beaverdam Cr	940830	Cherokee	SR 1326	-/39	Excellent
B-16	South Shoal Cr	940830	Cherokee	SR 1314	-/30	Good
B-17	Shuler Cr	940830	Cherokee	SR 1323	-/35	Good

Special Studies

Data from all special studies since 1983 are presented in Table 4.9. This portion of the Hiwassee River may be stressed by flow fluctuation due to upstream hydroelectric power dams (Chatuge and Mission) and sedimentation from nonpoint runoff. The biological rating of this stream has increased since the initial survey in 1983 (Good-Fair to Good). This site was not sampled in 1994 due to very high flow conditions. The Hiwassee River at Murphy also is an ambient monitoring location.

Table 4.9 Benthic Macroinvertebrate Special Studies, Hiwassee Subbasin 04-05-02, 1983-1994.

Site#	Creek	Date	Study	County	Road	S:Rating
B-1	Hiwassee R	900808	BMAN	Cherokee	US 64 nr Murphy	38/78:Good
		870806				35/78:Good
		860722				32/65:Good-Fair
		850708				26/56:Good
		840820				29/67:Good
		830815				23/62:Good-Fair

The DWQ Biological Assessment Group received a request from the DWQ Instream Assessment Unit for additional information on the effects of the Andrews WWTP on the Valley River (Table 4.10). This survey revealed unexpected water quality problems in the Valley River near Andrews. The headwater areas (including Junaluska Creek) were rated as Good-Fair with evidence of some sediment problems. The Valley River between Stewart Road and a site about 3 miles below Andrews, however, was rated Fair with evidence of toxicity problems. There was no evidence that the Andrews WWTP contributed to these problems. The site above the WWTP showed the most severe water quality problems. There are no permitted dischargers in the area where the problem originates.

Junaluska Creek is a small tributary stream of the Valley River. It was initially chosen as a basin assessment site because there was no prior data from this region of the subbasin. Junaluska Creek is bordered by SR 1505 from its headwaters to the Town of Andrews. This could be a factor contributing to its Good-Fair bioclassification. Intolerant EPT species numbers were low at this site and the rocks were "clean", indicating impact by scour.

Table 4.10 Valley River above and below the Town of Andrews WWTP, 1985 - 1994.

Site#	Creek	Date	Study	County	Road	S:Rating
B-3	Valley R	940831	Andrews WWTP	Cherokee	near Rhodo off NC19	-/23:Good-Fair
B-4	Valley R	940831	Andrews WWTP	Cherokee	Stewart Rd, SR 1389	-/15:Fair
B-5	Valley R	940830	Andrews WWTP	Cherokee	Main St, Andrews	40/6:Fair
B-6	Valley R	940830	Andrews WWTP	Cherokee	SR 1515 ab Marble	57/16:Fair
B-7	Valley R	850808	Andrews WWTP	Cherokee	ab Andrews WWTP	76/33:Good-Fair
B-8	Valley R	850808	Andrews WWTP	Cherokee	be Andrews WWTP	75/30:Good-Fair
B-10	Junaluska Cr	940831	Andrews WWTP	Cherokee	SR 1505, first bridge	-/25:Good-Fair

Potential HQW/ORW Streams

A number of streams or stream reaches that were classified as WS-I were identified as not being utilized as water supply sources. It was proposed that these areas be reclassified to C-HQW. Based on benthic macroinvertebrate and physical/chemical data, Britton Creek was recommended for reclassification and was reclassified in August 1992.

Based on data collected from summer 1994 surveys, Peachtree Creek, Hanging Dog Creek, Persimmon Creek and Beaverdam Creek may qualify for ORW/HQW reclassification.

Fisheries

Fish tissue samples were collected at 2 sites within the Hiwassee 04-05-02 subbasin, and are summarized below and in Appendix III.

Station	Years Sampled	# Samples	# Samples exceeding criteria	Criteria exceeded
Hiwassee R at Hiwassee	1981	2	0	NA
Lake Hiwassee	1985 and 1986	11	0	NA

Aquatic Toxicity Monitoring

Three facilities in this subbasin currently monitor effluent toxicity per permit requirements. These facilities are:

Facility	NPDES#	Receiving Stream	County	Flow(MGD)	IWC(%)
Andrews WWTP	NC0020800/001	Valley R	Cherokee	1.500	13.00
Clifton Precision South Division	NC0080683/001	Slow Cr	Cherokee	0.300	46.00
Murphy WWTP	NC0020940/001	Hiwassee R	Cherokee	0.925	1.50

Whole effluent toxicity monitoring results for all dischargers in the Hiwassee basin are presented in Appendix III. None of these facilities has obtained regulatory relief for toxicity limits through a special or judicial order.

Lakes Assessment Program

Hiwassee Lake

Hiwassee Lake is located on the Hiwassee River near the North Carolina-Tennessee state border. Chatuge Lake is located upstream of Hiwassee Lake and Apalachia Lake is immediately downstream. Hiwassee Lake, which is owned by the Tennessee Valley Authority (TVA) was built between 1936 and 1940 to provide hydroelectric power, flood control and recreation. The maximum depth of the reservoir is 308 feet (94 meters) and the surface area is 6275 acres (2539 hectares). The length of the reservoir is 22 miles (35 kilometers) with 163 miles (262 kilometers) of shoreline at full pool elevation. The major tributaries are the Hiwassee River, Nottely River, Persimmon Creek, Valley River, Hanging Dog Creek, and Bearpaw Creek. The steeply sloped, forested watershed measures 968 mi^2 (2507 km^2). Hiwassee Lake is classified B.

The reservoir was most recently sampled by DWQ on August 30, 1994. There were three violations of the state water quality standard for dissolved gasses near the Grape Creek Arm in the vicinity of the Bearpaw Creek Arm and the Chambers Creek Arm. Ammonia ranged from 0.02 to 0.06 mg/l and nitrite plus nitrate ranged from 0.005 to 0.04 mg/l. The higher values of these two nutrients was observed at the sampling site near the Nottely Creek Arm (for ammonia) and near the Chambers Creek arm (for nitrite plus nitrate). The NCTSI score for 1994 was -3.5, indicating oligotrophic conditions. Hiwassee Lake is fully supported its designated uses.
Hiwassee Lake was one of sixteen lakes selected throughout the state as representative of minimally impacted lakes. This lake was sampled three times per summer from 1991 through 1993. Hiwassee Lake had a consistently low NCTSI score and was oligotrophic during the three years of the monitoring program.

Phytoplankton samples were collected during the summer months from 1991-1993. Algal biovolume and density estimates were generally low during most of the collecting period. However, some samples in 1991 showed moderate to high algal numbers. The predominance of particular species in these samples is usually indicative of soft, relatively unpolluted waters with a slightly acidic pH. Normally unpolluted waters are characterized by a diversity of species. The ecological significance of the dominance of these species is unclear. Overall the algal community during 1991-1993 was indicative of a deep oligotrophic lake.

Hiwassee Lake was previously sampled by DWQ in 1981, 1982 and 1988. In all years the NCTSI score indicated oligotrophic conditions.

Apalachia Lake

Apalachia Lake is a run-of-the-river reservoir located within the Nantahala National Forest. Located immediately downstream of Hiwassee Lake, this reservoir is owned by the Tennessee Valley Authority (TVA) and was built for hydroelectric power generation, flood control and recreation. Construction of the dam began in 1941 and was completed in 1943. Apalachia Lake has a maximum depth of 118 feet (36 meters), a length of 10 miles (16 kilometers), and 31 miles (50 kilometers) of shoreline at full pool elevation. The surface area is 1100 acres (445 hectares). Major tributaries to the lake include the Hiwassee River, Camp Creek, and North and South Shoal Creeks. The drainage area covers 1006 mi^2 (2605 km^2) of forested and mountainous terrain. This lake is classified B.

Apalachia Lake was most recently sampled by DWQ on August 30, 1994. At the time of sampling, water was being released from the Lake Hiwassee dam. The stretch of river between

Lake Hiwassee and Apalachia Lake is approximately one mile in length, therefore, the water released from Hiwassee Lake greatly affected the upstream portion of Apalachia Lake. The NCTSI score for Apalachia Lake in 1994 was -4.5, indicating oligotrophic conditions. The lake fully supported its designated uses.

Apalachia Lake was previously sampled in 1981 and 1987. In both years, the NCTSI score in indicated that the lake was oligotrophic.

4.4 USE-SUPPORT: DEFINITIONS AND METHODOLOGY

4.4.1 Introduction to Use Support

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

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

Streams rated as either partially supporting or nonsupporting are considered *impaired.* A waterbody is fully supporting but threatened (ST) for a particular designated use when it fully supports that use now, but may not in the future unless pollution prevention or control action is taken. This rating describes waters for which actual monitored or evaluated data indicate an apparent declining trend (i.e., water quality conditions have deteriorated, compared to earlier assessments, but the waters still support uses). Although these waters are currently supporting uses, they are treated as a separate category from waters fully supporting uses. Streams which had no data to determine their use support were listed as non-evaluated (NE).

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

4.4.2 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 impaired waters. Data used in the use support assessments include biological data, chemical physical data, lakes assessment data, DEH shellfish sanitation surveys, and monitoring data. Although there is a general procedure for analyzing the data and determining a waterbody's use support rating, each stream segment is reviewed individually, and best professional judgment is applied during these determinations.

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

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

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

4.4.3 Assessment Methodology - Freshwater Bodies

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

A. Biological Data

Benthic Macroinvertebrate Bioclassification

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

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

Fish Community Structure

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

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

Phytoplankton and Algal Bloom Data

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

B. Chemical/Physical Data

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

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

C. Fish Consumption Advisory

Fish consumption advisories are issued by the Environmental Epidemiology Section. The advisories correspond to the use support ratings as follows:

Advisory	Rating
No Restriction	Fully Supporting
Restricted Consumption	Partially Supporting
No Consumption	Partially Supporting

D. Lakes Program Data

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

E. Sources and Cause Data

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

F. Point Source Data

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

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

G. Nonpoint Source Data

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

H. Problem Parameters

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

I. Monitored vs. Evaluated

Assessments were made on either monitored (M) or evaluated (E) basis depending on the level of information that was used. A monitored basis represents monitored data which are less that five years old. An evaluated basis refers to monitored data older than five years, and/or the use of best professional judgment.

4.4.4 Assigning Use Support Ratings

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

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

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

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

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

4.5 USE SUPPORT RATINGS FOR THE HIWASSEE RIVER BASIN

Use support ratings and background information for all monitored stream segments are presented in Table 4.11. Ratings for all monitored and evaluated surface waters are presented on color-coded maps in Figure 4.4.

4.5.1 Streams and Rivers

Of the 989 miles of streams and rivers in the Hiwassee River basin, use support ratings were determined for 81% or 797 miles with the following breakdown:

SUPPORTING	78%	
Fully supporting:		64%
Support-threatened:		14%
IMPAIRED	3%	
Partially supporting:		3%
Not supporting:		0%
NOT EVALUATED:	19%	

These use support values are different from the values in the 1992-1993 305(b) Report. The total waters supporting their uses appear to have increased, while those that are impaired appear to have decreased. While the water quality may have improved since the 1992-1993 305(b) report, the changes in values may also be due to the following:

- Methodology for determining use support has been altered. In the 1992-1993 305(b) Report, evaluated information from older reports and workshops were included in the use support process. Streams rated using this information were considered to be rated on an evaluated basis. In the current use support process, this older, evaluated information has been discarded, and streams are now rated using only monitored information (including current and older monitoring data), or evaluated based on being a tributary to a stream that is monitored.

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

Although the majority of the streams have good to excellent bioclassifications and very few standards were violated at the ambient stations, nonpoint source effects such as increased sedimentation, were evident at many of the sampling sites. Table 4.11 provides information on streams and stream segments that were monitored. This includes bioclassification and collection date for macroinvertebrate samples, ambient monitoring station information, problem parameters such as sediment, potential sources of pollution (point or nonpoint), and the overall use support rating. Table 4.12 and Figure 4.5 present the use support determinations by subbasin.

Impaired Waters

Only two streams were given an impaired rating of partially supporting. In Subbasin 04-05-01, 8.5 miles of Brasstown Creek received a bioclassification of Fair which resulted in a partially supporting rating. This creek originates in north Georgia and is impacted by nonpoint source run-off, as it flows along NC 66 for most of its length. All tributaries to Brasstown Creek which were not monitored were given a Not Evaluated (NE) rating.

In Subbasin 04-05-02, the Valley River between Stewart Road and a site about 3 miles below Andrews received a bioclassification of Fair, which resulted in a partially supporting rating. This 19.6 mile stretch of the river showed evidence of toxicity problems although there are no permitted dischargers in the area where the problem originates. All tributaries to this section of the Valley River which were not monitored were given a Not Evaluated (NE) rating.

Lakes

Chatuge Lake, Hiwassee Lake and Apalachia Lake were all sampled in August 1994 and found to be supporting their designated uses (Table 4.13).

Table 4.11 Monitored Stream Sites in the Hiwassee River Basin.

Station Number	Station Location	Classification	Index Number	Miles	Chem. Rating 90-94	<---Biological Rating---> 1990	1991	1992	1993	1994	OVERALL [illegible] RAT Prob. Param.	Use Support	Major Source
40501													
	Shooting Cr, SR 1349, SR 1168, SR 1347, Clay	C Tr	1-5	5.0						Excellent	Sed	S	NP
	Tusquitee Cr, SR 1330, Clay	C Tr HQW	1-21-(4.5)	5.8						Excellent		S	
	Big Tuni Creek at FS Rd 440 & SR 1311, Clay	C Tr HQW	1-21-5	6.4						Excellent		S	
	Fires Cr,Bristol Camp, Picnic Area, & SR 1300, Clay	WS-IV Tr ORW	1-27-(5.5)	8.8						Excellent		S	
	Little Fires Cr, FS Rd nr mouth, Clay	WS-IV Tr ORW	1-27-7	2.9			Excellent				Sed	S	NP
	Brasstown Cr, SR 1104, Clay	WS-IV	1-42	8.5						Fair		PS	
40502													
03548500	Hiwassee River US 64, nr Murphy, Cherokee	WS-V	1-(43.7)	3.1	S	Good						S	
	Peachtree Cr, SR 1537, Cherokee	C	1-44	8.3						Excellent		S	
	Valley River, off US 19, nr Rhodo, Cherokee	C Tr	1-52a	4.6						Good-Fair		ST	
	Valley R. above Andrews, Main St Andrews ab WWTP,	C Tr	1-52b	19.6						Fair		PS	
	ab landfill off US 19, Cherokee												
3550000	Valley R. SR 1554 nr Tomatla, Cherokee	C Tr	1-52c	4.7	S	Good				Good-Fair		ST	
	Junaluska Cr. SR 1505, Cherokee	C Tr	1-52-25	7.4						Good-Fair		ST	
	Britton Cr, off FS Rd nr SR 1339, Cherokee	C HQW	1-52-29-(1)	0.9			Excellent					S	
	Hanging Dog Cr, SR 1331, Cherokee	C	1-57	12.8						Excellent		S	
	Nottely River, SR 1596, Cherokee	C	1-58	18.7						Excellent		S	NP
	Persimmon Cr, SR 1127, Cherokee	C	1-63	9.1						Excellent		S	
	Beaverdam Creek, SR 1326, Cherokee	C Tr	1-72	6.4						Excellent		S	
	South Shoal Cr, SR 1314, Cherokee	C Tr	1-77	11.9						Good		S	
	Shuler Creek, SR 1323, Cherokee	C	1-86	12.2						Good		S	NP

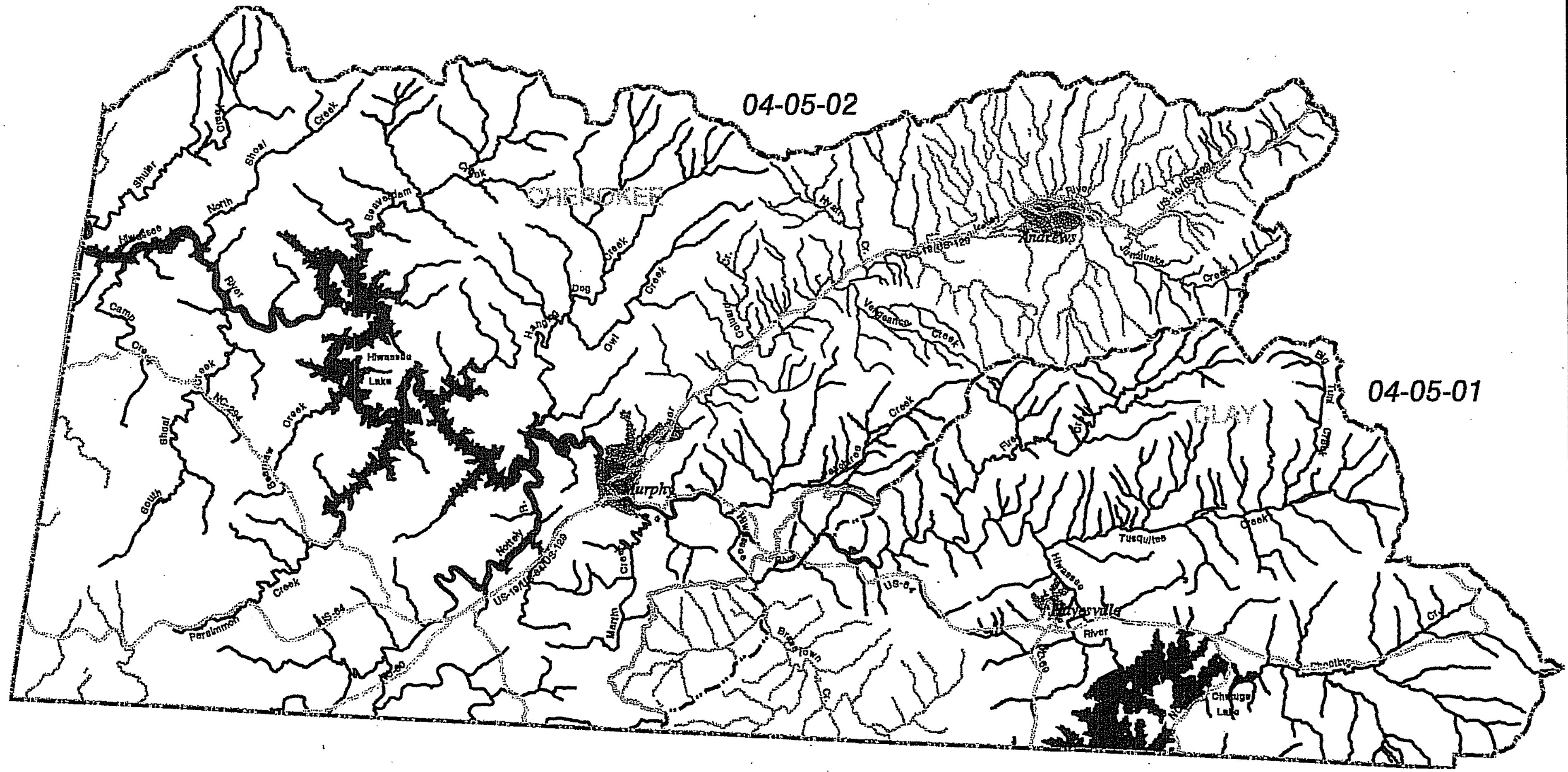
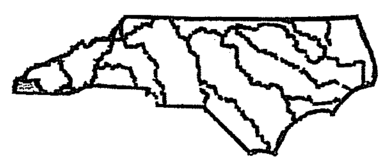


Figure 4.4 Use Support Map for the Hiwassee River Basin

LEGEND

- Supporting
- Support Threatened
- Partially Supporting
- Not Evaluated
- County Boundary
- Primary Roads
- Basin / Subbasin Boundary

VICINITY MAP



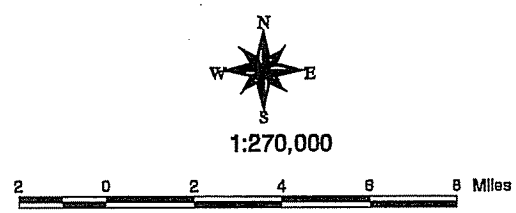


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Table 4.12 Overall Use Support Status for Streams (Miles) by Subbasin for Hiwassee River Basin (1990 - 1994)

Subbasin	Support	Support Threatened	Partially Supporting	Not Supporting	Not Evaluated	Total Miles
04-05-01	288.8	0.0	8.5	0.0	49.5	346.8
04-05-02	340.9	139.4	19.6	0.0	142.8	642.7
Total	629.7	139.4	28.1	0.0	192.3	989.5
Percentage	64%	14%	3%	0%	19%	

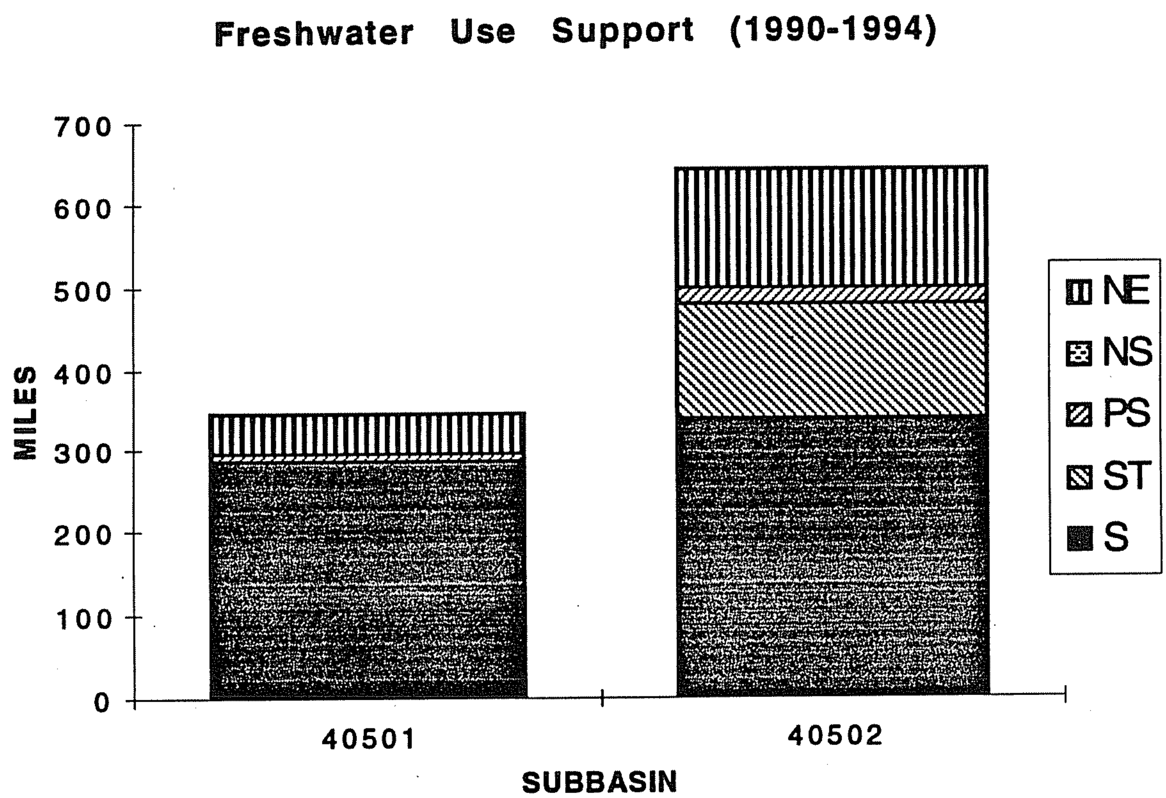

Figure 4.5 Use Support for Hiwassee River Basin

Table 4.13 Monitored Lakes in the Hiwassee River Basin

LAKE NAME	COUNTY NAME	Subbasin	SIZE (acres)	CLASS	OVERALL USE	FISH CONSUMP.	AQ. LIFE & SECONDARY CONTACT	SWIMMING	DRINKING WATER	TROPH STATUS
CHATUGE LAKE (NC portion)	CLAY	40501	6950	B	FULL	FULL	FULL	FULL	n/a	MESOTROPHIC
HIWASSEE RESERVOIR	CHEROKEE	40502	6275	B,C	FULL	FULL	FULL	FULL	n/a	OLIGOTROPHIC
APALACHIA LAKE	CHEROKEE	40502	1100	B	FULL	FULL	FULL	FULL	n/a	OLIGOTROPHIC

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