BASINWIDE ASSESSMENT REPORT
SAVANNAH RIVER BASIN

NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Division of Water Quality
Environmental Sciences Section

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SAVANNAH RIVER BASIN

OVERVIEW

The Division of Water Quality uses a basinwide approach to water quality management. Activities within the Division, including permitting, monitoring, modeling, nonpoint source assessments, and planning are coordinated and integrated for each of the 17 major river basins within the state. All basins are reassessed every five years, and the Savannah River basin was sampled by the Environmental Sciences Section in 1994 and 1999, prior to this assessment in 2004.

The Environmental Sciences Section collects a variety of biological, chemical, and physical data that can be used in a myriad of ways within the basinwide planning program. The primary program areas from which data were drawn for this assessment of the Savannah River basin were benthic macroinvertebrates for the period 2000-2004. Details of biological sampling methods (including habitat evaluation) and rating criteria can be found in the appendices to this report. Technical terms are defined in the Glossary. Studies conducted prior to 2000 were previously summarized in NCDENR (2000).

The portion of the Savannah River Basin located in North Carolina lies entirely within The Southern Crystalline Ridges and Mountains ecoregion (Griffith *et al* 2002) and occupies 151 square miles. Most of the land is contained within the Nantahala National Forest and Gorges State Park. The largest towns are Highlands and Cashiers. Additional areas of commercial, residential, and golf course development can be found scattered throughout the US 64 corridor between Lake Toxaway and Highlands. Outstanding Resource Waters located in the Savannah River Basin include the Chattooga River and many of its tributaries, Big Creek, and Overflow Creek. In addition, a portion of the Horsepasture River downstream from the NC 281 benthos basinsite is included in the National Wild and Scenic River System. There are only two subbasins in this subbasin, and only eight benthos sites sampled in 2004. Six of those sites received an Excellent bioclassification, while the other two were rated Good.

SAVANNAH RIVER SUBBASIN 01

Description

This subbasin, and all the streams assessed within, is contained within the level IV ecoregion of the Southern Crystalline Ridges and Mountains. This ecoregion is characterized by elevations ranging between 1,200 and 4,500 feet, high precipitation rates, abundant forest cover, and acidic, loamy, well-drained soils (Griffith *et al* 2002). As would be expected for an area with rugged topography, land cover is mostly undisturbed forest associated with the Nantahala National Forest. The only area of anthropogenic land use is residential which occurs near the towns of Cashiers and Highlands.

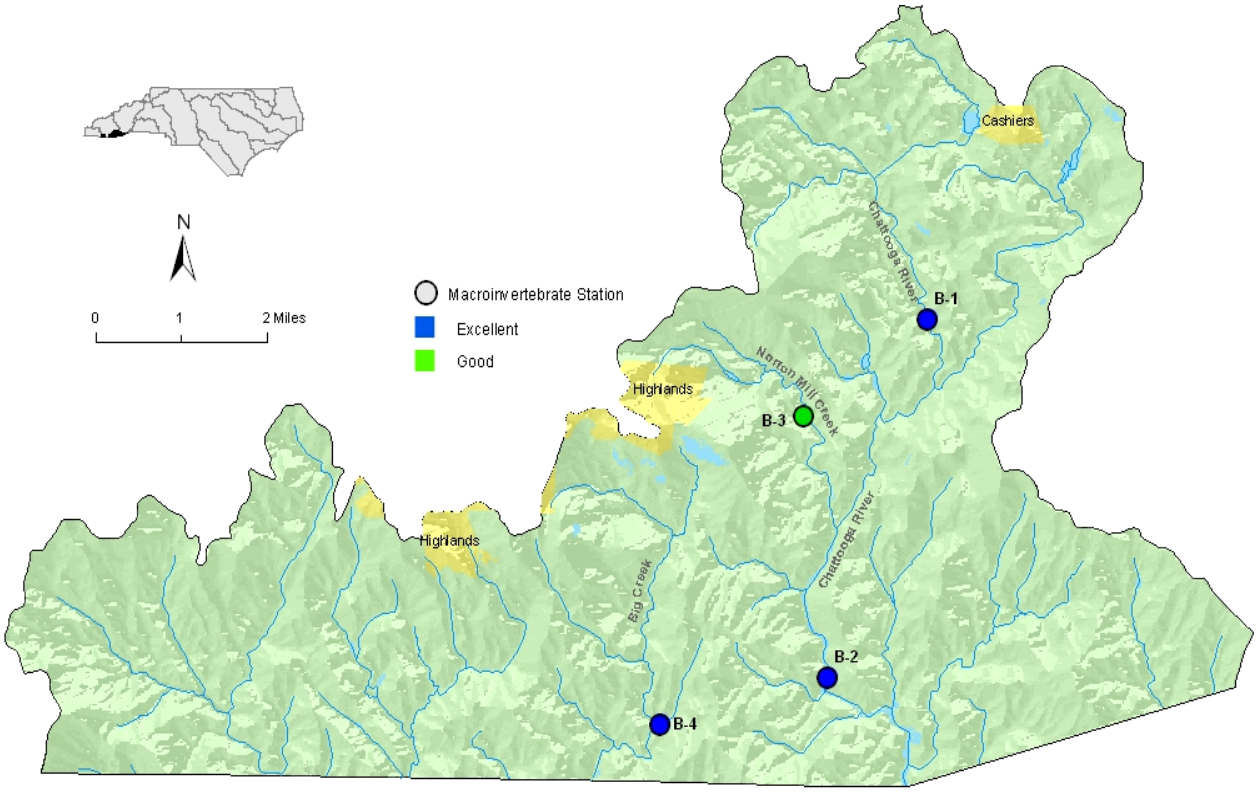

Figure 1. Sampling sites in Subbasin 01 of the Savannah River basin.

Overview of Water Quality

All streams sampled for benthic macroinvertebrates in subbasin 01 (Figure 1) were classified using mountain criteria. Based on benthic macroinvertebrate data, two sites on the Chattooga River were Excellent and Big Creek maintained the Excellent bioclassifications generated from the 1999 basinwide sampling period. Norton Mill Creek declined in bioclassification from Excellent in 1999, to Good in 2004 (Table SAV-01). There are two NPDES dischargers in this subbasin that are required to perform whole effluent toxicity testing. The Cashiers WWTP (NC0063321, 0.1 MGD) discharges to a UT of the Chattooga River and has had three toxicity violations since 2001. The Mountain (formerly Highlands Camp and Conference Center) facility (NC0061123, MGD .006) that discharges to Abes Creek has had seven toxicity violations since 2000.

There are no ambient monitoring locations in this subbasin.

Table SAV-01. Waterbodies monitored in Subbasin 01 in the Savannah River basin for basinwide assessment, 1999 - 2004.

Map #	Waterbody	County	Location	1999 Bioclassification	2004 Bioclassification
B-1	Chattooga R	Jackson	SR 1107	----------	Excellent
B-2	Chattooga R	Jackson	SR 1100	Excellent	Excellent
B-3	Norton Mill Cr	Jackson	SR 1107	Excellent	Good
B-4	Big Cr	Macon	SR 1608	Excellent	Excellent

Benthos Assessment

Chattooga River, SR 1107

The Chattooga River along this segment is approximately seven meters in width and has a drainage area of 7.8 square miles. Nearly all of the land cover in this catchment is forest with scattered areas of residences associated with the town of Cashiers. This site is also below the Cashiers WWTP. As can be seen in the photograph, this is a well-known local swimming area and nearly 25 people were swimming at the time of sampling. Substrate at this headwater site was comprised of a generally unembedded mix of boulder (10%), rubble (30%), gravel (20%), sand (30%) and silt (10%). The chief habitat problems were the lack of well-developed riffle and pool habitat and a large amount of sand. Conductivity was high for a mountain stream (31 μmhos/cm) and was likely the result of inputs from Cashier's WWTP and from nonpoint pollution from the town. Habitat received a score 75.

This site was sampled once in 1988 when it received an Excellent bioclassification with 48 EPT present. In 2004, this site also received an Excellent bioclassification with 45 EPT collected. While water quality appears to be stable at this location, it is recommended that this site be added to the basinwide sampling cycle in order to more directly monitor the growth of Cashiers and to monitor impacts from the Cashiers' WWTP.

Chattooga River, SR 1100

This location on the Chattooga is approximately six river miles downstream of the SR 1107 site and is nearly 25 meters wide with a drainage area of 23.2 square miles. The dominant landuse in this catchment is forest with only sparsely scattered areas of residential use. Substrate was a mostly unembedded mix of boulder (30%), rubble (20%), gravel (20%), sand (20%) and silt (10%). No major habitat problems were noted along this reach and the habitat received a score of 86. Conductivity was slightly lower (21μmhos/cm) than the upstream site and is likely due to dilution effects from the numerous tributaries that enter the Chattooga between the SR 1100 and SR 1107 locations.

This section of the Chattooga River has been sampled five times (twice in 1988, once in 1990, 1994, and 1999) with each collection resulting in an Excellent bioclassification. This site was again Excellent in 2004 with 64 EPT taxa collected. This represents one of the highest EPT diversities ever recorded by NCDWQ. Notably rare and intolerant EPT

present included the mayfly *Drunella tuberculata* and the caddisflies *Oecetis avara*, *Rhyacophila vuphipes*, and *Mayatrichia ayama*.

Norton Mill Creek, SR 1107

This segment of Norton Mill Creek is five meters wide with a drainage area of 2.8 square miles. Norton Mill Creek at this location was one of the lowest gradient streams assessed in the Savannah River basin and the substrate was a slightly embedded mix of rubble, gravel, sand and silt. This segment of Norton Mill Creek also includes in its catchment some fast growing residential areas associated with second home building near Cashiers. The most obvious habitat problem noted at this site was the infrequent riffles, prevalence of sand, and minor impacts to the riparian zone. The habitat score was 72 and the conductivity was 19 μmhos/cm.

Norton Mill Creek has been sampled at this location on two previous occasions. One EPT sample in January of 1988 resulted in a Good-Fair bioclassification with 19 EPT collected and an EPTBI of 2.96. This site was also sampled using Full-Scale methods in June of 1999 when it received an Excellent bioclassification with 44 EPT taxa, an EPTBI of 3.0, and a NCBI of 3.7. In 2004, this site declined to Good with 40 EPT taxa present, an EPTBI of 2.7, and a NCBI of 4.3. The reason for the decrease in bioclassification was the increase in NCBI (from 3.7 in 1999 to 4.3 in 2004), which in turn was largely due to the drastic increase in chironomid diversity. In 1999, only 13 chironomid taxa were collected while 35 were collected in 2004. Of these 35 taxa, only three were the result of improvements in taxonomic resolution that have occurred since 1999. The dramatic increase in chironomid diversity from 1999 to 2004 could indicate worsening water quality in the catchment (most likely enrichment). It is also possible that scouring before the 1999 sample may have displaced chironomids from this location prior to collection. However, there was no mention in the 1999 basin report of a large rainfall event in association with that year's sampling. Therefore, it is strongly recommended that this site be added to the basinwide cycle in order to better monitor second home development occurring in this catchment.

Big Creek, SR 1608

Nearly all of the catchment upstream of this site is forested. This reach of Big Creek was six meters wide and had a drainage area of 5.1 square miles. Substrate was an unembedded mix of boulder (20%), rubble (20%), gravel (20%), sand (30%), and bedrock (10%). No obvious habitat problems were noted and the stream received a habitat score of 83. Conductivity was 17 μmhos/cm.

Big Creek has been sampled at this location in 1987 (49 EPT), 1994 (45 EPT) and 1999 (45 EPT) with all three samples resulting in Excellent bioclassifications. In 2004, this site was also Excellent with 45 EPT taxa present. The remarkable consistency in EPT taxa since 1987 indicates stable water quality and reflects the undisturbed nature of this forested catchment. Rare and intolerant taxa present include the mayfly *Brachycercus* and the stonefly *Beloneuria*.

SAVANNAH RIVER SUBBASIN 02

Description

This subbasin, and all the streams assessed within it, is contained within the level four ecoregion of The Southern Crystalline Ridges and Mountains. This ecoregion is characterized by elevations ranging between 1,200 and 4,500 feet, high precipitation rates, abundant forest cover, and acidic, loamy, well-drained soils (Griffith *et al* 2002). As would be expected for an area with rugged topography, landuse is mostly undisturbed forest associated with the Nantahala National Forest. The only area of anthropogenic landuse is residential and light commercial and occurs along the US 64 corridor in association with second home subdivisions near Lake Toxaway and Lake Sapphire.

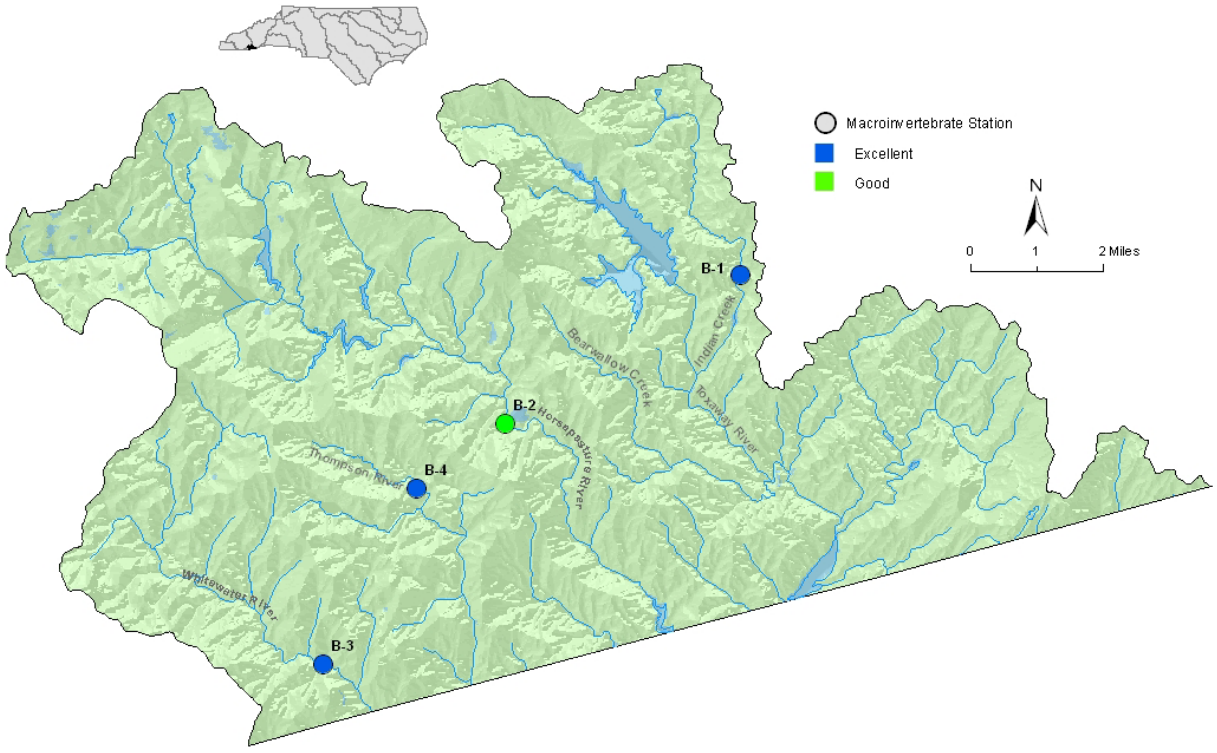

Figure SAV-02. Sampling sites in Subbasin 02 of the Savannah River basin.

Overview of Water Quality

Based on benthic macroinvertebrate data, the Whitewater River and the Thompson River maintained previous Excellent bioclassifications, Indian Creek improved from Good in 1999 to Excellent in 2004, and the Horsepasture River declined in bioclassification from Excellent in 1999 to Good in 2004.

The only ambient monitoring site in this subbasin is the Horsepasture River at NC 281. Water chemistry parameters have been stable at this site with only one measurement in five years (Iron) exceeding water quality standards or action levels.

There are two NPDES dischargers in this subbasin that are required to perform whole effluent toxicity testing. The Carolina Mountain Water WWTP (NC0067954, 0.006 MGD) discharges to a UT of the Whitewater River and has had no toxicity violations since 1997. The other NPDES facility in this subbasin

is the Wade Hampton Club WWTP (NC0062553, MGD 0.125). This facility discharges to a UT to Silver Run Creek and has had no toxicity violations since 1998.

Table SAV-02. Waterbodies monitored in Subbasin 02 in the Savannah River basin for basinwide assessment, 1999 - 2004.

Map #	Waterbody	County	Location	1999 Bioclassification	2004 Bioclassification
B-1	Indian Cr	Transylvania	US 64	Good	Excellent
B-2	Horsepasture R	Transylvania	NC 281	Excellent	Good
B-3	Whitewater R	Transylvania	NC 281	Excellent	Excellent
B-4	Thompson R	Transylvania	NC 281	----------	Excellent

Benthos Assessment

Indian Creek, US 64

At this location, Indian Creek is four meters wide and has a drainage area of 4.1 square miles. This reach of Indian Creek is very sandy and has a low gradient in most sections. Landuse in this catchment is nearly all forest and substrate was a generally unembedded mix of rubble (20%), gravel (10%), sand (40%), silt (10%) and bedrock (20%). The primary habitat deficiency at this site included the large amount of sand and the limited riparian zone associated with US 64. Conductivity was 20 μmhos/cm and the habitat received a score of 76.

This site was sampled in 1994 and 1999 receiving Good bioclassifications both times with 31 and 34 EPT taxa collected respectively. In 2004, Indian Creek received an Excellent bioclassification with the highest EPT diversity (40) recorded from this site. Intolerant EPT taxa not previously collected included the mayflies *Leucrocuta*, *Neoephemera purpurea*, the stonefly *Malirekus hastatus*, and the caddisflies *Heteroplectron americanum*, *Neophylax consimilis*, and *Rhyacophila nigrita*.

Horsepasture River, NC 281

This segment of the Horsepasture River is immediately downstream of a large quarry and is also downstream from a recently logged tract of land. However, the majority of the catchment remains forested. Width here was 16 meters and drainage area was 24.2 square miles. Substrate was a generally unembedded mix of boulder (20%), rubble (10%), gravel (20%), sand (10%), silt (10%), and bedrock (30%). The primary habitat shortcoming at this location was a lack of riffles and the habitat received a score of 81. Conductivity was 20 μmhos/cm.

This site has been sampled on six previous occasions receiving one Fair bioclassification (1985), two Good-Fair bioclassifications (1994 and 1989), three Good bioclassifications (1986, 1987, 1994) and one Excellent bioclassification in 1999. In 2004, this site declined and received a Good bioclassification. The primary reason for the decline in bioclassification was the increase in NCBI (from 3.9 in 1999 to 4.2 in 2004), which in turn was largely due to the drastic increase in chironomid diversity. In 1999, only 17 chironomid taxa were collected while 29 were collected in 2004. Of particular concern, there were no *Polypedilum* (a very pollution tolerant genus) collected in 1999. In 2004, four species of *Polypedilum* (*Polypedilum convictum*, *P. fallax*, *P.*

halterale, and *P. illinoense*) were all either common or abundant in 2004. Moreover, the chironomid *Rheosmittia* was abundant in 2004. It had previously never been collected at this location. *Rheosmittia* lives interstitially in sand and its appearance in 2004 may indicate more sand at this site relative to previous years. The increase in chironomid diversity from 1999 to 2004, coupled with the large increase in the pollution tolerant genus *Polypedilum* and the sand dwelling *Rheosmittia* could indicate worsening water quality in the catchment (most likely enrichment). Alternatively, it is possible that scouring before the 1999 sample may have displaced chironomids from this location prior to collection. However, after reviewing the 1999 basinwide assessment report no mention of a large rainfall event was mentioned in association with that year's sampling. In addition, looking at past data, it is apparent that this site fluctuates in bioclassification and this year's decline could be an extension of that pattern. The fact that ambient chemistry data do not suggest worsening water chemistry at this site supports the idea of natural variation in the benthic community. Additional monitoring at this site will be needed to determine if the variation is natural or anthropogenic.

Whitewater River, NC 281

The watershed upstream of this road crossing is completely encompassed by the Nantahala National Forest. Stream width is 10 meters and the drainage area was 12.4 square miles. Substrate was an unembedded mix of boulder (40%), rubble (30%), gravel (20%) and sand (10%). No noticeable habitat problems were observed and this reach of the Whitewater River received a habitat score of 87. The low conductivity (12 μmhos/cm) reflected the undisturbed forested catchment.

This location was sampled in 1994 and 1999 both times receiving Excellent bioclassifications with 47 and 48 EPT taxa collected respectively. In 2004, this site also received an Excellent bioclassification with 46 EPT taxa collected. The near identical EPTBI from 1999 (2.2) to 2004 (2.3) indicates stable water quality typical of a protected forested catchment.

Thompson River, NC 281

Nearly all of the catchment upstream of this site is forested and lies within the Nantahala National Forest. Stream width here was five meters and drainage area was 2.5 square miles. Substrate was an unembedded mix of boulder (10%), rubble (30%), gravel (20%), sand (20%), silt (10%), and bedrock (10%). No significant habitat deficiencies were observed and this site received a habitat score of 85. The low conductivity (9.3 μmhos/cm) reflected the undisturbed forested nature of the catchment.

This location on the Thompson River has not been sampled since August, 1989 when it received an Excellent bioclassification using Full Scale methods. One other Full Scale collection here (February, 1988) also produced an Excellent bioclassification. In 2004, an EPT sample also resulted in an Excellent bioclassification. This site should be continued for basinwide sampling in order to monitor development along the US 64 corridor near Sapphire Lake.

SPECIAL STUDIES

In the spring of 2004 Fred Tarver from the North Carolina Division of Water Resources requested a special study below Lake Toxaway (on the Toxaway River) to determine effects on the benthic macroinvertebrate community due to the hypolimnetic dam release. The bottom release from Lake

Toxaway was initiated in 2001 and is required from April through October. A sample on the Toxaway River in Gorges State Park (approximately five miles below the dam) and a comparison control site on Bearwallow Creek (near its confluence with the Toxaway River) were sampled for benthic macroinvertebrates. There are no DWQ benthological data on the Toxaway River and two previous samples on Bearwallow Creek near its confluence with the Toxaway have resulted in Excellent bioclassifications. In 2004, both the Toxaway River sample and the Bearwallow Creek sample resulted in Excellent bioclassifications with comparable benthic macroinvertebrate communities.

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GLOSSARY

7Q10	A value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. 7Q10 flow (in cfs) is used to allocate the discharge of toxic substances to streams.
Bioclass	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 (EPT) and the Biotic Index value.
cfs	Cubic feet per second, generally the unit in which stream flow is measured.
CHL *a*	Chlorophyll *a*.
Class C Waters	Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum.
Conductivity	In this report, synonymous with specific conductance and reported in the units of μmhos/cm at 25 ^{o}C. Conductivity is a measure of the resistance of a solution to electrical flow. Resistance is reduced with increasing content of ionized salts.
Division	The North Carolina Division of Water Quality.
D.O.	Dissolved Oxygen.

Ecoregion	An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, and soil type. Examples include Southern Outer Piedmont, Carolina Flatwoods, Sandhills, and Slate Belt.
EPT	The insect orders (Ephemeroptera, Plecoptera, Trichoptera); as a whole, the most intolerant insects present in the benthic community.
EPT N	The abundance of Ephemeroptera, Plecoptera, Trichoptera insects present, using values of 1 for Rare, 3 for Common and 10 for Abundant.
EPT S	Taxa richness of the insect orders Ephemeroptera, Plecoptera and Trichoptera. Higher taxa richness values are associated with better water quality.
HQW	High Quality Waters. Waters which are rated as excellent based on biological and physical/chemical characteristics through Division monitoring or special studies; primary nursery areas designated by the Marine Fisheries Commission; and all Class SA waters.
IWC	Instream Waste Concentration. The percentage of a stream comprised of an effluent calculated using permitted flow of the effluent and 7Q10 of the receiving stream.
Major Discharger	Greater than or equal to one million gallons per day discharge (≥ 1 MGD).
MGD	Million Gallons per Day, generally the unit in which effluent discharge flow is measured.
Minor Discharger	Less than one million gallons per day discharge (< 1 MGD).
NPDES	National Pollutant Discharge Elimination System.
NCBI (EPT BI)	North Carolina Biotic Index, EPT Biotic Index. A summary measure of the tolerance values of organisms found in the sample, relative to their abundance. Sometimes noted as the NCBI or EPT BI.
NCIBI	North Carolina Index of Biotic Integrity (NCIBI); a summary measure of the effects of factors influencing the fish community.
NSW	Nutrient Sensitive Waters. Waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs.
NTU	Nephelometric Turbidity Unit.
ORW	Outstanding Resource Waters. Unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.
SOC	A consent order between an NPDES permittee and the Environmental Management Commission that specifically modifies compliance responsibility of the permittee, requiring that specified actions are taken to resolve non-compliance with permit limits.
Total S (or S)	The number of different taxa present in a benthic macroinvertebrate sample.
UT	Unnamed tributary.

WWTP	Wastewater treatment plant.

Appendix B-1. Summary of Benthic Macroinvertebrate Data, Sampling Methods and Criteria

Based on benthic macroinvertebrate data, water quality in the Savannah River basin is Excellent to Good. Since 1999, 14 benthic macroinvertebrate basinwide samples have been collected with three (21%) receiving Good bioclassifications and 11 (79%) resulting in Excellent bioclassifications. Comparisons of benthos data from 1999 to 2004 between repeat sites show that one site (Indian Creek at US 64) improved from Good to Excellent while two sites (Horsepasture River at NC 281 and Norton Mill Creek at SR 1107) declined in bioclassification from Excellent to Good. Overall, water quality in this basin is unchanged since 1999. The decline in the Horsepasture River may be the result of natural variation. This site has received four different bioclassifications from eight samples since 1985. This site also supports an ambient chemistry site and analysis of that data show no significant adverse trends in water quality. The decline at Norton Mill Creek is possibly related to upstream development associated with the town of Cashiers. Additional monitoring at both sites will help discern whether the changes in bioclassification from 1999 to 2004 were anthropogenic or natural.

Several rare invertebrate taxa were collected in the Savannah River basin in 2004 including the mayflies *Drunella longicornis* (Thompson and Whitewater Rivers), *Danella lita* (Thompson River), *Litobrancha recurvata* (Thompson River), *Serratella spiculosa* (Thompson and Chattooga Rivers), *Rhithrogena fuscifrons* (Big Creek and Whitewater River), the caddisflies *Mayatrichia ayama* (Horsepasture and Chattooga River), *Oecetis avara* (Chattooga River), and the stonefly *Beloneuria* (Thompson River, Big Creek, Norton Mill Creek). In addition, the Chattooga River at SR 1100 had among the highest total taxa (124) and EPT taxa (64) ever collected in North Carolina and were the highest ever recorded in the Savannah River basin.

Sampling Methods

Standard Qualitative (Full Scale) or EPT Methods

Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using two sampling procedures. The Biological Assessment Unit's standard qualitative (Full Scale) sampling procedure includes 10 composite samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leafpack sample, and visual collections from large rocks and logs (NCDENR 2003). The samples are picked on-site. The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1 - 2 specimens), Common (3 - 9 specimens), or Abundant (≥ 10 specimens).

Benthic macroinvertebrates can also be collected using the EPT sampling procedure. Four rather than 10 composite qualitative samples are taken at each site: 1 kick, 1 sweep, 1 leafpack and visual collections. Only EPT taxa are collected and identified and only EPT criteria are used to assign a bioclassification.

Habitat Evaluation

An assessment form has been developed by the Biological Assessment Unit to better evaluate the physical habitat of a stream . The habitat score, which ranges between 1 and 100, is based on the evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration, and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings.

Data Analysis

Criteria for bioclassifications for standard qualitative samples in mountain ecoregions are given below and are based on EPT S and the NCBI.

Tolerance values for individual species and biotic index values have a range of 0 - 10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality scores (5 = Excellent, 4 = Good, 3 = Good-Fair, 2 = Fair and 1 = Poor) assigned with the biotic index numbers are averaged with EPT taxa richness scores to produce a final bioclassification. Criteria for piedmont and coastal plain streams are used for the Cape Fear River basin. EPT abundance and Total taxa richness calculations also are used to help examine between-site differences in water quality.

EPT S and BI values can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling: June - September. For samples collected outside summer, EPT S can be adjusted by subtracting out winter/spring Plecoptera or other adjustment based on resampling of summer site. The BI values also are seasonally adjusted for samples outside the summer season.

Criteria for Standard Qualitative (Full Scale) Samples.

	BI Values	EPT Values
Score	Mountain	Mountain
5	<4.00	> 43
4.6	4.00 – 4.04	42-43
4.4	4.05 – 4.09	40-41
4	4.10 – 4.83	34-39
3.6	4.84 – 4.88	32-33
3.4	4.89 – 4.93	30-31
3	4.94 – 5.69	24-29
2.6	5.70 – 5.74	22-23
2.4	5.75 – 5.79	20-21
2	5.80 – 6.95	14-19
1.6	6.96 – 7.00	12-13
1.4	7.01 – 7.05	10-11
1	> 7.05	0-9

Criteria for bioclassifications for EPT samples in mountain ecoregions are given below and are based on EPT S.

Criteria for EPT Samples.

	EPT Values
Score	Mountain
Excellent	>35
Good	28-35
Good-Fair	19-27
Fair	11-18
Poor	0-10

Table B-1. Benthic macroinvertebrate basinwide monitoring data collected in the Savannah River basin, 1999-2004. Basin sites are in bold.

Waterbody	Location	County	Index No.	Date	ST	EPT	BI	EPT BI	Rating
)1									
Chattooga R	SR 1107	Jackson	3	8/04	-----	48	-----	2.2	Excellent
Chattooga R	SR 1100	Jackson	3	8/04	124	64	3.5	2.8	Excellent
				7/99	-----	48	-----	1.5	Excellent
Norton Mill Cr	SR 1107	Jackson	3-3	8/04	108	40	4.2	2.7	Good
				6/99	119	51	4.0	2.7	Excellent
Big Cr	SR 1608	Macon	3-10-3	8/04	-----	45	-----	2.4	Excellent
				7/99	118	53	3.7	2.6	Excellent
02									
Toxaway R	At Auger Hole Trail (Gorges State Park)	Transylvania	4-(4)	8/04	-----	36	-----	2.7	Excellent
Indian Cr	US 64	Transylvania	4-5-(3)	8/04	-----	40	-----	2.4	Excellent
				7/99					
Bearwallow Cr	At Auger Hole Trail (Gorges State Park)	Transylvania	4-7-(2)	8/04	-----	41	-----	2.4	Excellent
Horsepasture R	NC 281	Transylvania	4-13-(12.5)	8/04	98	41	4.1	2.9	Good
				7/99	73	36	4.4	3.5	Good
Whitewater R	NC 281	Transylvania	4-14-(1.5)	8/04	-----	46	-----	2.3	Excellent
				7/99	-----	38	-----	2.9	Excellent
Thompson R	NC 281	Transylvania	4-14-6	8/04	-----	46	-----	1.9	Excellent

LAKE & RESERVOIR ASSESSMENTS – Savannah River Basin

Assessment Overview

Two lakes were sampled in the Savannah River Basin during the 2004 Ambient Lakes Monitoring: Cashiers Lake and Lake Toxaway. Concerns for water quality in these lakes drove these sampling efforts.

Subbasin 031301

Cashiers Lake is a small, shallow impoundment located in Jackson County. It was sampled at the request of the Asheville Regional Office. Regional staff expressed concerns related to suspended sediments. Even though sampling occurred during rainy conditions, turbidity was not above the trout waters standard of 10 mg/L. There is a trout standard for effluent total suspended solids (applies to the discharger only) of 10 mg/L. Although it cannot be used for enforcement of instream standards, a review of the instream total suspended solids indicates no concentrations above 9 mg/L. On-going wind mixing due to the shallow nature of the lake probably contributes to the perceived sediment problem. A review of all parameters sampled indicated that other standards and assessment criteria are being met. Although based on visual observations by the Asheville Regional Offices, sedimentation may be a concern.

Subbasin 031302

Lake Toxaway was sampled in conjunction with a study being conducted by the Division of Water Resources in response to odor complaints below the dam. In 2001, 2002, and 2003, the Division of Water Resources received complaints regarding the odor of bottom water released into the Toxaway River from Lake Toxaway. Bottom water is released from the reservoir in an attempt to provide colder water in the Toxaway River downstream of the dam to support a trout fishery. In response to the public complaints, a study of the river downstream of the Lake Toxaway Dam was conducted by Water Resources to determine to source of the odor problem. In support of this investigation, DWQ sampled the bottom water of Lake Toxaway near the dam to evaluate the levels of metals, particularly manganese, which is associated with taste and odor problems in drinking water. Results of this sampling indicated that both manganese and iron increased significantly in response to increased hypoxic conditions near the bottom of the lake as the summer progressed. Manganese concentrations in July and August were 1000 µg/L and 1100 µg/L, respectively. The concentration of iron in the bottom water in July was 7400 µg/L and 9600 µg/L in August. There is no surface water quality standard for manganese in B or Tr waters and the standard for water supply surface waters is 200 ug/L. The manganese concentration were also well above the maximum contaminant level (SMCL) 50 µg /L for manganese in finished drinking water. At this concentration, staining, odor and unpleasant taste in drinking water is noticeable. All other parameters sampled met the surface water quality standards.

For further background information on these lakes (including sampling data), please go to http://www.esb.enr.state.nc.us/ or call Debra Owen at 919.733.6510.

LAKES ASSESSMENT – SAVANNAH RIVER BASIN

Subbasin		*031301*	*031302*
Waterbody		***Cashiers Lake***	***Lake Toxaway***
Classification		B Tr ORW	B Tr
Trophic Status (NC TSI)		Mesotrophic	Oligotrophic
Mean Depth (meters)		5	33
Volume ($10^6 m^3$)		2.4	-
Watershed Area (mi^2)		1.1	7.8
Sampling Dates		2004	2004
Number of Samples (click here to see data)		n = 5	n = 12
Water Quality Standards			
Chlorophyll *a*	>10% above standard (N>9) = Y; exceeding 40 ug/L but not 10% of time = C	NE	N
Dissolved Oxygen	Below standard >10% of samples (N>9)	NE	N
pH	Below or above standard >10% of samples (N>9)	NE	N
Turbidity	>10% above standard (N>9)	NE	N
Temperature	Minor and infrequent excursions of temperature standards due to anthropogenic activity. No impairment of species evident. (N>9)	NE	N
Metals (excluding copper, iron & zinc)	>10% above standard (N>9)	NE	N
Other Data			
% Saturation DO	>10% above >120%	N	N
Algae	Documented blooms during 2 or more sampling events in 1 year with historic blooms	N	N
Fish	Kills related to eutrophication	N	N
Chemically/ Biologically Treated	For algal or macrophyte control - either chemicals or biologically by fish, etc.	N	N
Aesthetics complaints	Documented sheens, discoloration, etc. - written complaint and follow-up by a state	N	N
TSI	Increase of 2 trophic levels from one 5-yr period to next	N	N
Historic DWQ Data	Conclusions from other reports (link to other reports)	N	N
AGPT	Algal Growth Potential Test 5-9 mg/L = C 10 mg/L or more = P	NS	NS
Macrophytes	Limiting access to public ramps, docks, swimming areas; reducing access by fish and other aquatic life to habitat	N	N
Taste and Odor	Public complaints = P; Potential based on algal spp = C	N	**P**
Sediments	Clogging intakes – dredging program necessary = P Public/agency complaints – visual	**C**	N

Note: C = of notable Concern or productive
P= Problematic or highly productive
E = parameter is Exceeded, but in less than 10 percent of the measurements
N = Not a concern
NS = No sample taken for this parameter
NE = Not exceeded but insufficient samples to rate as N

Assessment Methodology

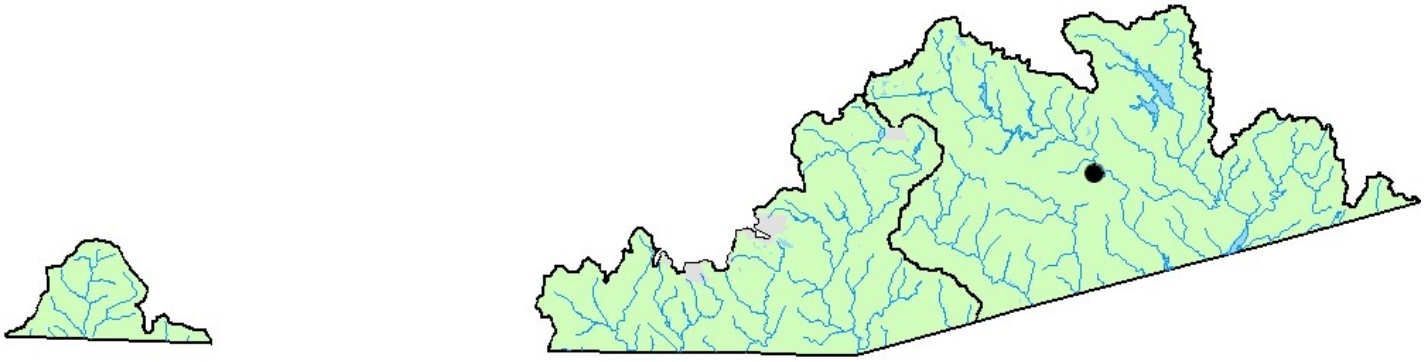
Like streams, lakes are classified for a variety of uses. Most of the lakes monitored as part of North Carolina's Ambient Lakes Monitoring Program are classified for recreation (B & SB) and water supply (WS-I through WS-V). The surface water quality numeric standard specifically associated with recreation is fecal coliform. For water supplies, there are 29 numeric standards based on consumption of water and fish. Narrative standards for B and WS classifications include aesthetics such as no odors and no untreated wastes. There are other numeric standards that also apply to lakes under protection of aquatic life and human health. These standards also apply to all other waters of the state and are listed under the Class C rules.

When possible, lake use support evaluations are made similar to free-flowing waters. Parameters with sufficient (10 or more observations), quality-assured, surface water quality data will be compared to surface water quality standards. However, for nutrient enrichment - one of the main causes of impacts to lakes and reservoirs, a more holistic or weight of evidence approach is necessary since nutrient impacts are not always reflected by the parameters sampled. For instance, some lakes have taste and odor problems associated with particular algal species, yet these lakes do not have chlorophyll *a* concentrations above 40 ug/L frequently enough to impair them based on the standard.

In addition to being moderated by biological factors, environmental factors such as climate, hydrology and morphology can impact whether nutrient loading results in lose of uses. Shorter retention times (less than 14 days) prevent excessive growth of algae even in the presence of elevated nutrients. Therefore, just measuring standard water quality parameters such as chlorophyll *a* and nutrients may not give an accurate picture of lake water quality. Where exceedances of surface water quality standards are not sufficient to impair a lake, the weight of evidence approach can take into consideration indicators and parameters not in the standards to allow a sounder determination of water quality.

The following sources of information are used in determining lake use support through the weight of evidence approach:

- Quantitative water quality parameters - dissolved oxygen, chlorophyll a, pH, etc.
- Algal bloom reports
- Fish kill reports
- Third party reports – citizens, water treatment plant operators, State agencies, etc.
    - Taste & odor
    - Sheens
    - Odd colors
    - Other aesthetic and safety considerations



Savannah River Basin
Ambient Monitoring System Report

September 1, 1999 through August 31, 2004

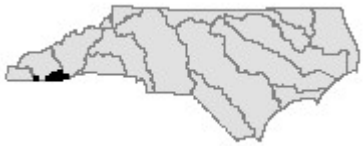


TABLE OF CONTENTS

Evaluation Levels

In order to assist the reader in developing a rapid understanding of the summary statistics provided throughout this data review, concentrations of water quality variables may be compared to an Evaluation Level (EL). Evaluation levels may be a water quality standard, an action level, an ecological threshold, or simply an arbitrary threshold that facilitates a rapid data review. Evaluation levels are further evaluated for frequency to determine if they have been exceeded in more than 10 percent of the observed samples. This summary approach facilitates a rapid and straightforward presentation of the data but may not be appropriate for making specific use support decisions necessary for constructing lists of impaired waters under the Clean Water Act's requirements for 303(d) listings. The reader is advised to review the states 303(d) listing methodology for this purpose. (see http://h2o.enr.state.nc.us/tmdl/General_303d.htm).

TABLES

FIGURES

APPENDIXES

SUMMARY

A general understanding of human activities and natural forces that affect pollution loads and their potential impacts on water quality can be obtained through routine sampling from fixed water quality monitoring stations. During this assessment period (September 1, 1999 through August 31, 2004) chemical and physical measurements were obtained by DWQ from the only active station (H6000000, Horsepasture River at NC 281 near Union) located in the basin.

In order to confidently evaluate acceptable water quality criteria at least 10 observations are desired. If at least 10 results were collected for a given site for a given parameter, the results are then compared to water quality evaluation levels. The water quality evaluation level may be an ecological evaluation level, a narrative or numeric standard, or an action level as specified in 15A NCAC 2B .0200 (Table 3). If less then 10 results were collected, then no comparison to evaluation levels was made. When more than 10 percent of the results exceeded the evaluation level, a binomial statistical test was employed to determine if there was sufficient statistical confidence (95% confidence) to conclude that the results statistically exceed the 10% criteria. When that is found to be true, it is termed a *statistically significant exceedance* (SSE). This criterion was applied to all parameters with an evaluation level, except for fecal coliform bacteria. The criteria for fecal coliform varied based on the classification of the water body. See the Parameters section for an explanation of fecal coliform methods. The results of the data analysis are displayed in tables, box plots, scatter plots, and maps. The AMS Station Summary Sheet is located in Appendix A.

All data were collected between September 1, 1999 and August 31, 2004. H6000000 had no SSEs. One 10 percent violation that was not an SSE occurred for water temperature. An increasing trend for fecal coliform was detected, but does not appear to be a concern yet.

The following table gives a summary of the concerns areas located in the basin.

Table 1. Violations and Areas of Concern in the Savannah River Basin

Subbasin/ Station ID	Location	Class	Parameter/Evaluation Level	% Exceedance	% Confidence
2	***Toxaway, Horsepasture, Thompson, and Whitewater Rivers***				
H6000000	Horsepasture River at NC 28 near Union	B Tr	Water Temperature (>20)	14.0%	89%

Blue entries indicate violations of standards. Black entries indicate violations of action levels or evaluation levels.

INTRODUCTION

The DWQ's Ambient Monitoring System is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data. The stations are located at convenient access points (e.g. bridge crossings) that are sampled on a monthly basis. These locations were chosen to characterize the effects of point source dischargers and nonpoint sources such as agriculture, animal operations, and urbanization within watersheds. Currently the DWQ does not conduct probabilistic (random) monitoring.

The data are used to identify long term trends within watersheds, to develop Total Maximum Daily Loads (TMDLs) and to compare measured values with water quality standards to identify possible areas of impairment. Parametric coverage is determined by freshwater or saltwater waterbody classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added when justified (Table 2).

Within this document, an analysis of how monitoring results compare with water quality standards and action levels is presented. A conceptual overview of water quality standards is provided at: http://www.epa.gov/waterscience/standards. Specific information on North Carolina water quality standards is provided at: http://h2o.enr.state.nc.us/csu/swstdsfaq.html.

Table 2. Parametric coverage for the Ambient Monitoring System.[1]

Parameter	All Waters	Water Supply
Dissolved oxygen (s)	✔	✔
pH (s)	✔	✔
Specific conductance	✔	✔
Temperature (s)	✔	✔
Total phosphorus[2]	✔	✔
Ammonia as N[2]	✔	✔
Total Kjeldahl as N[2]	✔	✔
Nitrate+nitrite as N[2] (s)	✔	✔
Total suspended solids	✔	✔
Turbidity (s)	✔	✔
Fecal coliform bacteria (s)	✔	✔
Aluminum	✔	✔
Arsenic (s)	✔	✔
Cadmium (s)	✔	✔
Chromium, total (s)	✔	✔
Copper, total (s)	✔	✔
Iron (s)	✔	✔
Lead (s)	✔	✔
Mercury (s)	✔	✔
Nickel (s)	✔	✔
Zinc (s)	✔	✔
Manganese (s)	---	✔
Chlorophyll *a*[2] (s)	✔	✔

[1]A check (✔) indicates the parameter is collected and an 's' indicates the parameter has a standard or action level.
[2]Chlorophyll *a* is collected in Nutrient Sensitive Waters (NSW) and some coastal areas. Since 2001, nutrient sampling likewise is only done in areas of concern, such as NSW, estuaries, and areas with known enrichment issues.

Table 3. Selected freshwater quality standards for parameters sampled as part of the ambient monitoring system.[1]

	Standards for All Freshwater			Standards to Support Additional Uses		
Parameter (µg/L, unless noted)	Aquatic Life	Human Health	Water Supply Classifications	Trout Water	HQW	Swamp Waters
Arsenic		10				
Cadmium	2.0			0.4		
Chloride	230,000[2]		250,000			
Chlorophyll *a* (corrected)	40[3]			15[3]		
Chromium, total	50					
Coliform, total (MFTCC/100 ml)[4]			50[3] (WS-I only)			
Coliform, fecal (MFFCC/100 ml)[5]		200[3]				
Copper, total	7[2]					
Dissolved oxygen (mg/L)	5.0[6,7]			6.0		[3, 7]
Hardness, total (mg/L)			100			
Iron	1,000[2]					
Lead	25[3]					
Manganese			200			
Mercury	0.012					
Nickel	88		25			
Nitrate nitrogen			10,000			
pH (units)	6.0 - 9.0[3, 7]					[3, 7]
Solids, total suspended (mg/L)					10 Trout, 20 other[8]	
Turbidity (NTU)	50, 25[3]			10[3]		
Zinc	50[2]					

[1]Standards apply to all classifications. For the protection of water supply and supplemental classifications, standards listed under Standards to Support Additional Uses should be used unless standards for aquatic life or human health are listed and are more stringent. Standards are the same for all water supply classifications (Administrative Code 15A NCAC 2B 0200, eff. April 1, 2001).
[2]Action level.
[3]Refer to 2B.0211 for narrative description of limits.
[4]Membrane filter total coliform count per 100 ml of sample.
[5]Membrane filter fecal coliform count per 100 ml of sample.
[6]An instantaneous reading may be as low as 4.0 mg/L, but the daily average must be 5.0 mg/L or more.
[7]Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3, if due to natural conditions.
[8]For effluent limits only, refer to 2B.0224(1)(b)(ii).

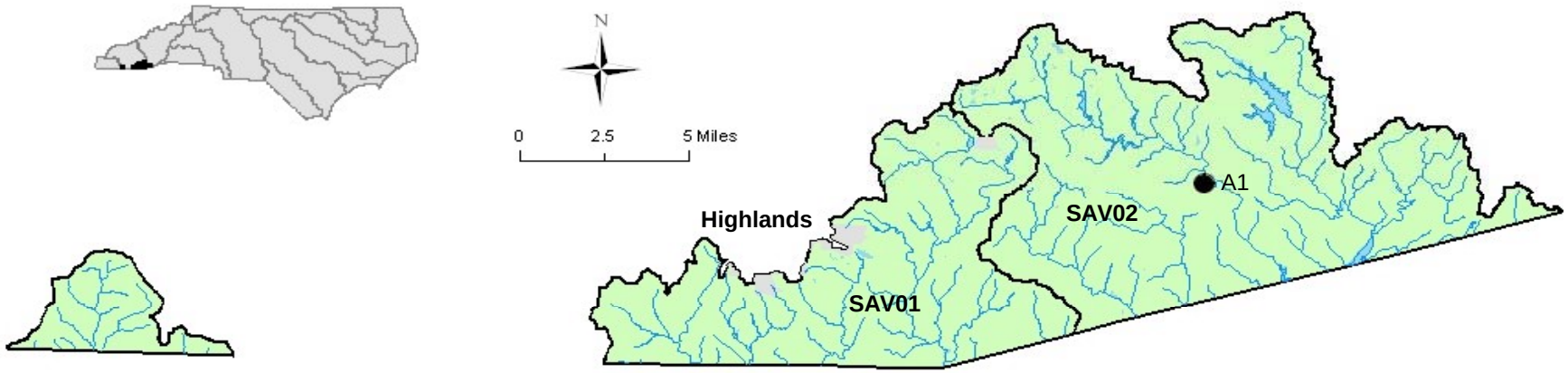


Figure 1. DWQ's ambient monitoring system within the Savannah River Basin.

Table 4. Monitoring stations in the Savannah River Basin, 1999 - 2004.

Subbasin/ Station ID	Location	Class	Lat.	Long.	County	Map ID
01	***Chattooga River***					
	No Stations					
02	***Toxaway, Horepasture, Thompson, and Whitewater Rivers***					
H6000000	Horsepasture River at NC 281 near Union	B Tr	35.0922	-82.9764	Transylvania	A1

DATA ASSESSMENT AND INTERPRETATION

Monitoring and sampling results considered in this report represent samples collected or measurements taken at less than one-meter depth.

Percentile statistics were calculated for most of the data using JMP statistical software (version 5.01; SAS Institute, Cary, NC). Values less than the minimum reporting level (non-detects) were evaluated as equal to the reporting level. Box and whisker plots (constructed using SigmaPlot version 8.02) and maps are presented for most water quality parameters collected at each monitoring station. See Figure 1 for en explanation of box plots. Significant trends in water quality parameters (constructed using Microsoft Excel) are illustrated as scatterplots. Significant trends are found by assessing the probability that the linear model explains the data no better then chance. If that chance is 5% or less (an observed significance probability of 0.05 or less) then that is considered evidence of a regression effect in this document. The strength of the regression effect is given as an r^2 value, the portion of the data that is explained by the linear model.

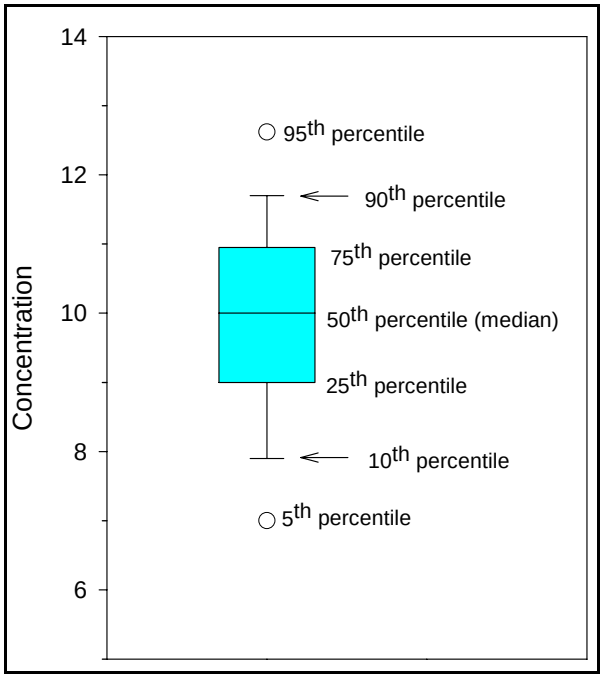


Figure 2. Explanation of box plots.

Analytical Considerations

Two issues were noted by the DWQ Laboratory Section as part of the analytical processes during this assessment period:

1) Between February and April 2001, improved analytical techniques and protocols for nutrient samples were implemented. No nutrient samples were processed during the period when the techniques and protocols were being implemented.
2) In early 2001 the Laboratory Section reviewed their internal QA/QC programs and some of the analytical methods. This effort resulted in a temporary increase in reporting levels for certain parameters. New analytical equipment and methods were subsequently acquired to establish more accurate reporting levels and rigorous quality assurance. Because of the improvements, the reporting levels quickly declined back down to or near the previous reporting levels. Nutrients were especially affected by these changes (Table 5).

Table 5. Changes in the Laboratory Section's reporting levels for nutrients.

	Reporting Level By Date (mg/l)			
Parameter	**Pre-2001**	**3/13/2001 to 3/29/2001**	**3/30/2001 to 7/24/2001**	**7/25/2001 to present**
NH_3	0.01	0.5	0.2	0.01
TKN	0.1	1.0	0.6	0.20
NO_2+NO_3	0.01	0.5	0.15	0.01
TP	0.01	0.5	0.1	0.02

Providing Confidence in the Exceedances of Water Quality Standards

NC DWQ uses guidance provided by the US EPA for determining when the number of results that exceed a water quality standard indicate potential water quality issues. Historically, the US EPA has suggested that management actions be implemented when 10 percent of the results exceeded a water quality standard. This interpretation is the same whether 1 out of 10, or 5 out of 50, or 25 out of 250 results exceed a standard. Evaluating exceedances in this manner is termed the "raw-score" approach. Although this "10 percent exceedance criterion" defines a point where potential water quality issues may be present, it does not consider uncertainty. Some results are subject to chance or other factors such as calibration errors or sample mishandling. Uncertainty levels change with sample size. The smaller the sample size, the greater the uncertainty.

This document uses a nonparametric procedure (Lin *et al.* 2000) to identify when a sufficient number of exceedances have occurred that indicate a true exceedance probability of 10 percent. Calculating the minimum number of exceedances needed for a particular sample size was done using the BINOMDIST function in Microsoft Excel®. This statistical function suggests that at least three exceedances need to be observed in a sample of 10 in order to be [about] 95 percent confident that the results statistically exceed the water quality standard more than 10% of the time. For example, there is less statistical confidence associated with a 1 exceedance out of 10 (73 percent) than when there are 3 exceedances out of 10 (93 percent confidence (Table 6).

Table 6. Exceedance Confidence

Number of Samples	Number of Exceedances																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	74%	93%	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**							
12	66%	89%	**97%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**					
14	58%	84%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**			
16	51%	79%	93%	**98%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	
18	45%	73%	90%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
20	39%	68%	87%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
22	34%	62%	83%	94%	**98%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
24	29%	56%	79%	91%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
26	25%	51%	74%	89%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
28	22%	46%	69%	86%	94%	**98%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
30	18%	41%	65%	82%	93%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
32	16%	37%	60%	79%	91%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
34	13%	33%	55%	75%	88%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
36	11%	29%	51%	71%	85%	94%	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
38	10%	25%	46%	67%	83%	92%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
40	8%	22%	42%	63%	79%	90%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
42	7%	20%	38%	59%	76%	88%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
44	6%	17%	35%	55%	73%	85%	93%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
46	5%	15%	31%	51%	69%	83%	92%	**96%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
48	4%	13%	28%	47%	65%	80%	90%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
50	3%	11%	25%	43%	62%	77%	88%	94%	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
52	3%	10%	22%	40%	58%	74%	86%	93%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
54	2%	8%	20%	36%	54%	71%	83%	91%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
56	2%	7%	18%	33%	51%	67%	81%	90%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
58	2%	6%	16%	30%	47%	64%	78%	88%	94%	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
60	1%	5%	14%	27%	44%	61%	75%	86%	93%	**97%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**
62	1%	5%	12%	24%	40%	57%	72%	84%	91%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**
64	1%	4%	11%	22%	37%	54%	69%	81%	90%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**
66	1%	3%	9%	20%	34%	51%	66%	79%	88%	94%	**97%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**
68	1%	3%	8%	18%	31%	47%	63%	76%	86%	93%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**
70	1%	2%	7%	16%	29%	44%	60%	74%	84%	91%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**	**100%**
72	0%	2%	6%	14%	26%	41%	57%	71%	82%	90%	**95%**	**97%**	**99%**	**100%**	**100%**	**100%**	**100%**
74	0%	2%	5%	13%	24%	38%	54%	68%	80%	88%	94%	**97%**	**99%**	**99%**	**100%**	**100%**	**100%**
76	0%	1%	5%	11%	22%	35%	51%	65%	77%	86%	93%	**96%**	**98%**	**99%**	**100%**	**100%**	**100%**
78	0%	1%	4%	10%	20%	33%	48%	62%	75%	85%	91%	**95%**	**98%**	**99%**	**100%**	**100%**	**100%**
80	0%	1%	4%	9%	18%	30%	45%	59%	72%	83%	90%	**95%**	**97%**	**99%**	**99%**	**100%**	**100%**

Note: Bold entries indicate that there is at least 95% confidence that at least 10% of the possible samples exceed the standard/action level.

Methods Used to Summarize Results

Methods used to summarize the results in this report encompass both tabular and graphical formats. Individual summary sheets for each station provide details on station location, stream classification, along with specifics on what parameters were measured, the number of samples taken (i.e. sample size), the number of results below reporting levels, the number of results exceeding a water quality standard or action level (evaluation level), statistical confidence that 10% of results exceeded the evaluation level, and a general overview of the distribution of the results using percentiles. These station summary sheets provide the most details on a station-by-station basis. They are included as an appendix to this report.

Use Support Assessment Considerations

1) The dissolved freshwater oxygen concentrations of 5.0 and 4.0 mg/L are presented as evaluation levels. Instantaneous concentrations of 4.0 mg/L or less are in violation of the standard unless caused by natural (e.g. swampy) conditions. The 5.0 mg/L evaluation level is based upon a freshwater standard which specifies "not less than a daily average of 5.0" (15A NCAC 2B.0200).
2) Action levels (copper, iron, and zinc) are used primarily as evaluation guidelines because results include fractions that may have little effect on aquatic life. Where appropriate, follow-up toxicological work will need to be conducted before use support determination can be made for these parameters.

Specific information on water quality standards and action levels can be found in 15A NCAC 2B.0200 (August 1, 2004).

PARAMETERS

Dissolved Oxygen

Dissolved oxygen is one of the most important of all the chemical measurements. Dissolved oxygen provides valuable information about the ability of the water to support aquatic life and the capacity of water to assimilate point and nonpoint discharges. Water quality standards for dissolved oxygen vary depending on the classification of the body of water [see, for example: 15A NCAC 02B.0211(1)(b) and 15A NCAC 02B.0220 (1)(b)] but generally results less than 4.0 mg/L can be problematic. Consistent patterns of low concentrations of dissolved oxygen can be subject to intense management review and corrective actions, although patterns of low dissolved oxygen can occur naturally in and near swamp waters. Trout waters are held to a more stringent standard of 6.0 mg/L.

pH

The pH of natural waters can vary throughout the state. Low values (<< 7.0 s.u.) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values (>> 7.0 s.u.) may be found during algal blooms. Point source dischargers can also influence the pH of a stream. The measurement of pH is relatively easy; however the accuracy of field measurements is limited by the abilities of the field equipment, which is accurate to within 0.2 S.U. This is due, in part, because the scale for measuring pH is logarithmic (i.e. a pH of 8 is ten times less concentrated in hydrogen ions than a pH of 7).

The water quality standards for pH in freshwaters consider values less than 6.0 s.u. or greater than 9.0 s.u. to warrant attention; whereas in salt waters pH values less than 6.8 or greater than 8.5 warrant attention.

Conductivity

In this report, conductivity is synonymous with specific conductance. It is reported in micromhos per centimeter (µmhos/cm) at 25°C. Conductivity is a measure of the ability of water to conduct an electric current. The presence of ions and temperature are major factors in the ability of water to conduct a current. Clean freshwater has a low conductivity, whereas high conductivities may indicate polluted water or saline conditions. Measurements reported are corrected for temperature, thus the range of values

reported over a period of time indicate the relative presence of ions in water. Conductivities in US fresh waters commonly vary between 50 to 1,500 µmhos/cm (APHA 1998). According to a USGS study completed in 1992, North Carolina freshwater streams have a natural conductance range of 17-65 µmhos/cm.

Conductivity can be used to evaluate variations in dissolved mineral concentrations (ions) among sites with varying degrees of impact resulting from point source discharges. Generally, impacted sites show elevated and widely ranging values for conductivity. However, water bodies that contain saltwater will also have high conductivities. Therefore those wishing to use conductivity as an indicator for problems must first account for salinity.

Turbidity

Turbidity data may denote episodic high values on particular dates or within narrow time periods. These can often be the result of intense or sustained rainfall events; however elevated values can occur at other times. Tidal surges can also disturb shallow estuarine sediments and naturally increase turbidity.

Metals

A number of metals are essential micronutrients for the support of aquatic life. However, there are threshold concentrations over which metals can be toxic. Currently the DWQ monitors total (not dissolved) concentrations for aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, manganese (Water Supply waters only), nickel, and zinc. Aluminum and iron are commonly found in soils.

Nutrients

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as "nutrients." Nitrogen compounds include ammonia-nitrogen (NH_3-N), total Kjeldahl nitrogen (TKN) and nitrite+nitrate nitrogen (NO_2+NO_3-N). Phosphorus is measured as total phosphorus. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes, or runoff from urban or agricultural land, the growth of algae (algal blooms) and other plants may be accelerated.

In addition to the possibility of causing algal blooms, ammonia-nitrogen may combine with high pH water to form NH_4OH, a form toxic to fish and other aquatic organisms.

Fecal Coliform Bacteria

Concentrations of fecal coliform bacteria can vary greatly. The descriptive statistics used to evaluate fecal coliform bacteria data include the geometric mean and the median depending on the classification of the waterbody. For all sites in the Savannah River Basin, the standard specified in Administrative Code 15A NCAC 02B.0211 (3)(e) (August 1, 2004) is applicable:

"Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method."

The strict application of the standard is often hindered because the monthly (*circa* 30 day) sampling frequency employed for water quality monitoring usually does not provide more than one sample per 30-day period. However, water quality problems can be discerned using monthly sampling.

Only fresh waters are present in the Savannah River basin. Sites where the geometric mean was greater that 200 colonies/100ml, or where greater than 20 percent of the results exceed 400 colonies/100ml are indicated on the respective station summary sheets.

WATER QUALITY PATTERNS IN THE SAVANNAH RIVER BASIN

Table 7. Summary of Evaluation Level Exceedances

Subbasin	Station	Class	Percentage Of Results That Exceeded The Evaluation Level Parameters With Less Than 10 Measurements Were Not Evaluated		
			Water Temperature	**Iron**	**Fecal Coliform**
1	Chattooga River				
No Stations					
2	Toxaway, Horsepasture, Thompson, and Whitewater Rivers				
	H6000000	B Tr	**14%**	5%	2%

Notes:

Bold entries indicate 10% (20% for fecal coliform) of results exceeded the evaluation level.

Box and whisker plots, scatterplots, and maps were used to depict differences in a variety of water quality parameters. While graphs portray information visually, specific and accurate details can only be conveyed in tables. Individual station summary sheets should be consulted when exact information is needed. For the box plots, stations with fewer then 10 data points for a given parameter were not included.

Regional Patterns

Box and whisker plots were generated for station H6000000 for each water quality parameter that has an evaluation level, plus specific conductance, total nitrate/nitrite, total kjeldahl nitrogen, total ammonia, and total phosphorus.

The ambient data (one station) is nearly free of issues. The only standard exceeded more then once is the water temperature standard. H6000000 is classified as trout waters, which are held to a temperature standard of 20 degrees Celsius. The standard was violated eight times out of 57 samples. Each violation occurred during the summer months.

Trends over Time

One significant trend ($p < 0.05$) of interest was identified. Fecal coliform counts appear to be on the rise. However, there was only one exceedance of the 400 colonies per 100mL standard, so this does not appear to be an issue at the moment.

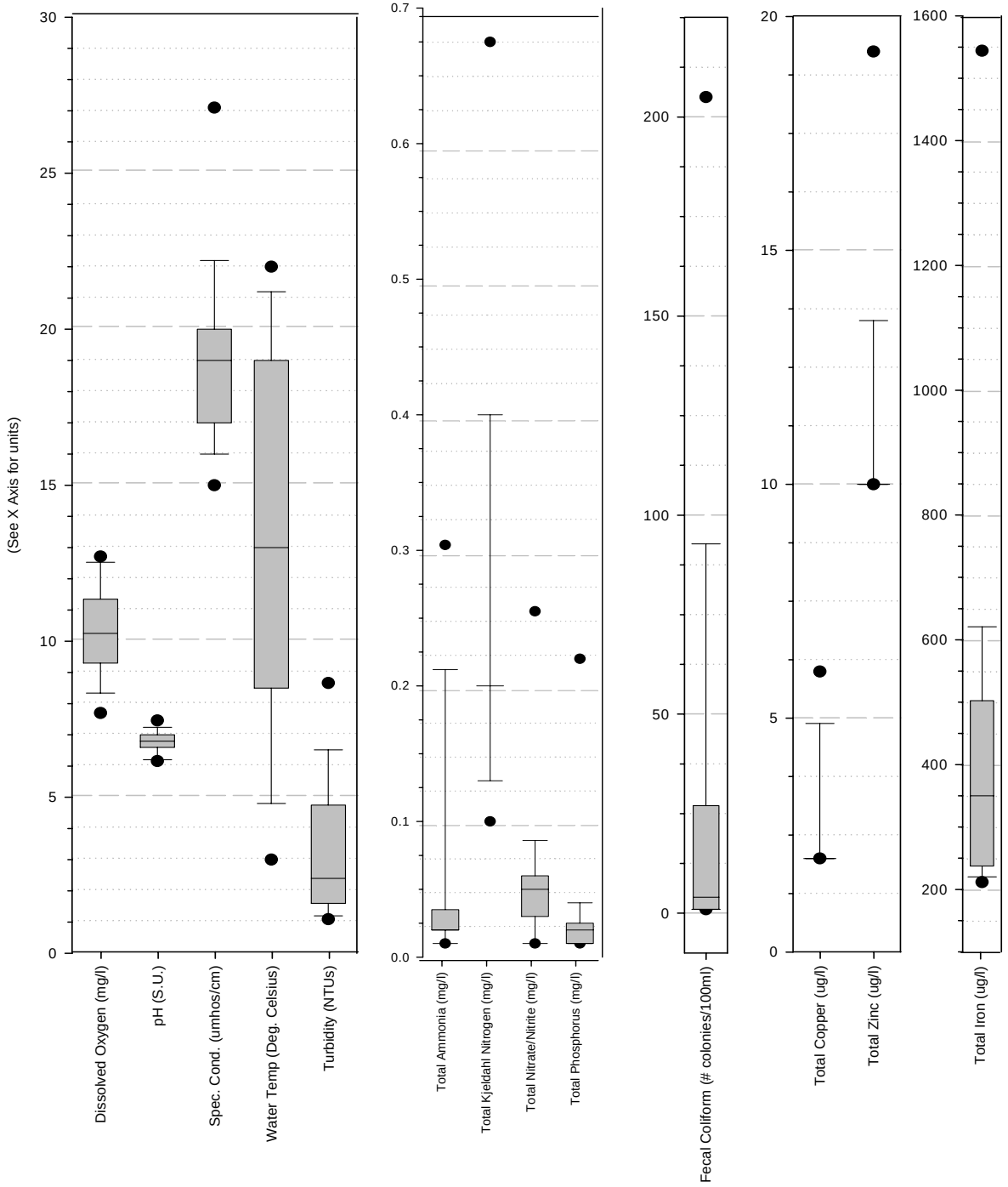


Figure 3. Box Plots for Various Water Quality Parameters at Station H6000000: Horsepasture River at NC 281 near Union in the Savannah River Basin

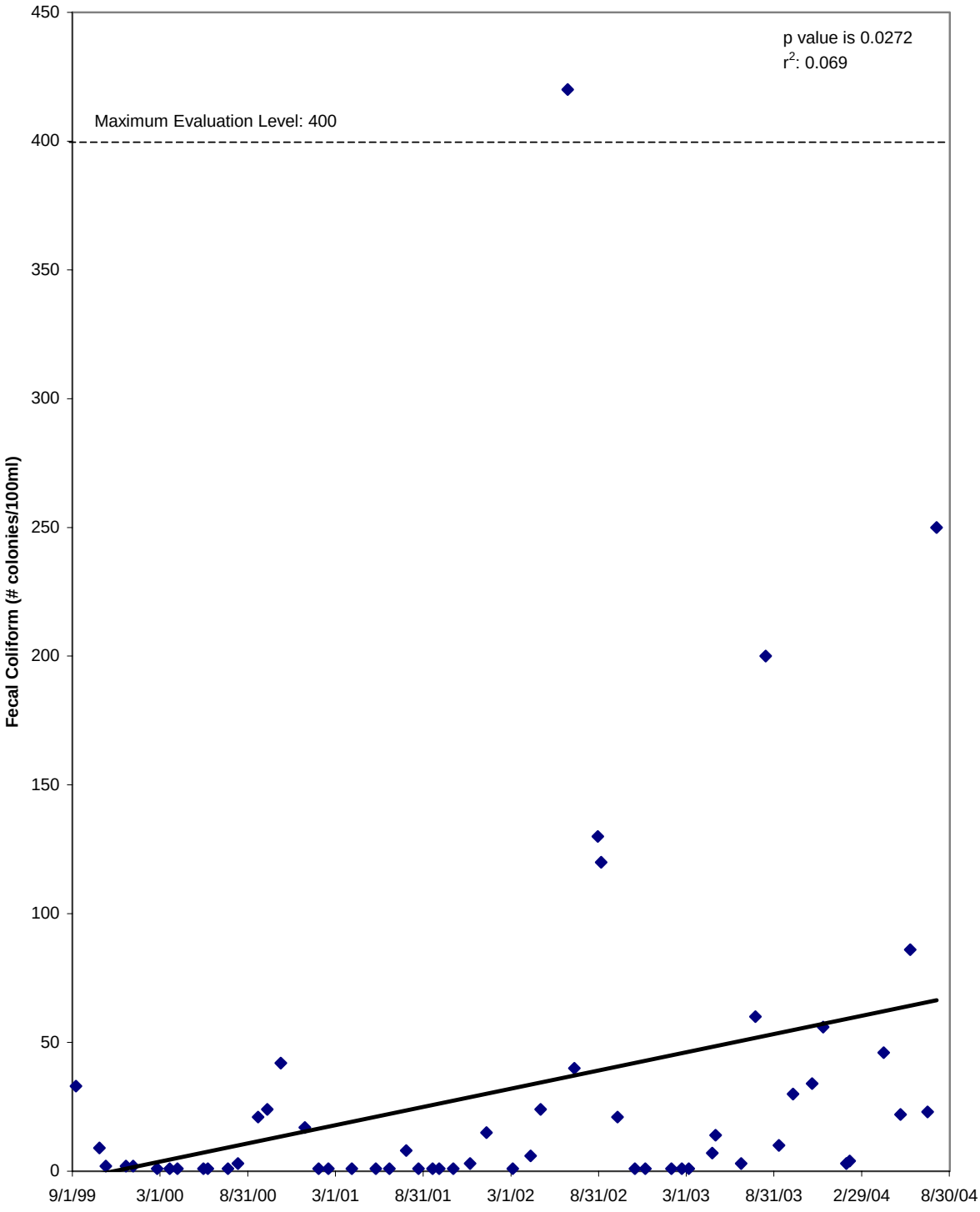


Figure 4. Fecal Coliform at Station H6000000: Horsepasture River at NC 28 near Union in the Savannah River Basin

Appendix A: AMS Station Summary Sheet

Location: HORSEPASTURE RIV AT NC 281 NR UNION
Station #: H6000000 **Subbasin:** SAV02
Latitude: 35.09222 **Longitude:** -82.97642 **Stream class:** B Tr
Agency: NCAMBNT **NC stream index:** 4-13-(12.5)

Time period: 09/08/1999 to 08/03/2004

	# result	# ND	Results not meeting EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	56	0	<6	0	0		7.6	8.3	9.3	10.2	11.3	12.5	13.8
pH (SU)	55	0	<6	0	0		6	6.2	6.6	6.8	7	7.2	7.8
	55	0	>9	0	0		6	6.2	6.6	6.8	7	7.2	7.8
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				14	16	17	19	20	22	31
Water Temperature (°C)	57	0	>20	8	14	No	2	4.8	8.5	13	19	21.2	23
Other													
Chlorophyll A (ug/L)	1	0	>15	0	0		2	2	2	2	2	2	2
TSS (mg/L)	23	11	N/A				1	1	1	2	3	6	7
Turbidity (NTU)	57	0	>10	0	0		1	1	2	2	5	7	9
Nutrients (mg/L)													
NH3 as N	33	17	N/A				0.01	0.01	0.02	0.02	0.03	0.21	0.5
NO2 + NO3 as N	33	2	N/A				0.01	0.01	0.03	0.05	0.06	0.09	0.5
TKN as N	32	15	N/A				0.1	0.13	0.2	0.2	0.2	0.4	1
Total Phosphorus	33	10	N/A				0.01	0.01	0.01	0.02	0.02	0.04	0.5
Metals (ug/L)													
Aluminum, total (Al)	22	1	N/A				50	60	66	101	175	288	500
Arsenic, total (As)	22	22	>10	0	0		10	10	10	10	10	10	10
Cadmium, total (Cd)	22	22	>0.4	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	22	22	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	22	18	>7	0	0		2	2	2	2	2	5	6
Iron, total (Fe)	22	0	>1000	1	4.5		210	220	238	350	502	621	1700
Lead, total (Pb)	22	22	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	22	22	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	22	22	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	22	20	>50	0	0		10	10	10	10	10	13	20

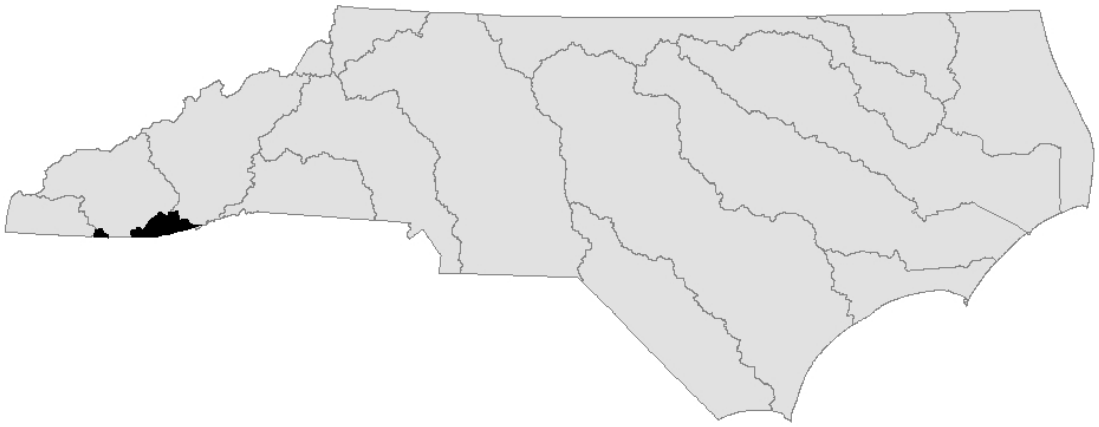
Fecal coliform (#/100mL)

# results:	Geomean	# > 400:	% > 400:	95%:
57	6	1	2	

Key:
result: number of observations
ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Savannah River Basin
Basinwide Assessment Report
Whole Effluent Toxicity Program

2000-2004



The Division of Water Quality's Whole Effluent Toxicity Monitoring Program

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 researchers to be predictive of discharge effects to receiving stream populations.

Many facilities are required to monitor whole effluent toxicity (WET) by their NPDES permit. Facilities without monitoring requirements may have their effluents evaluated for toxicity by DWQ's Aquatic Toxicology Laboratory. If toxicity is detected, DWQ may include aquatic toxicity testing upon permit renewal.

DWQ's Aquatic 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 WQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

WET Monitoring in the Savannah River Basin – 2000-2004

Four facility permits in the Savannah River basin currently require whole effluent toxicity (WET) monitoring (Figure 1 and Table 1). All four facility permits have a WET limit.

Figure 1. Savannah River basin facilities required to conduct whole effluent toxicity testing

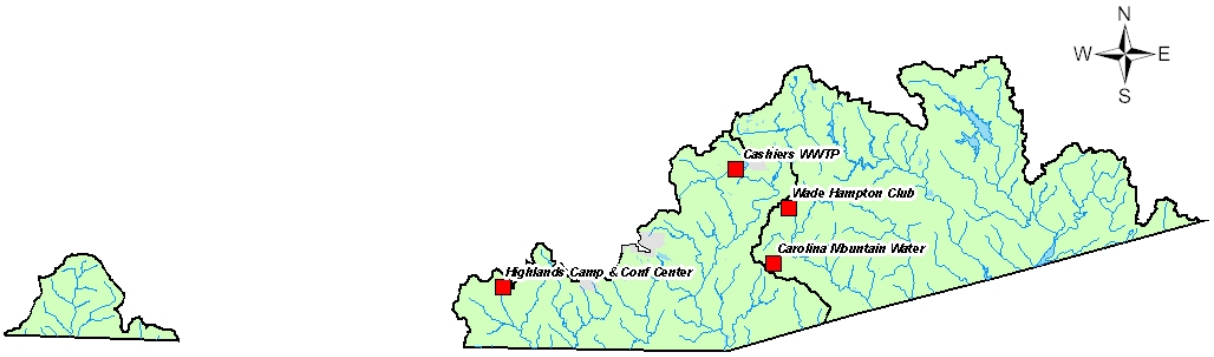


Table 1. Savannah River basin facilities required to conduct whole effluent toxicity testing

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	7Q10 (cfs)
03-13-01						
Cashiers WWTP	NC0063321/001	UT Chattooga R.	Jackson	0.1	24.0	0.5
Highlands Camp & Conf Center	NC0061123/001	Abes Cr.	Macon	0.006	100	0.0
03-13-02						
Carolina Mountain Water	NC0067954/001	UT Whitewater R.	Jackson	0.006	11.03	0.075
Wade Hampton Club	NC0062553/001	UT Silver Run Cr.	Jackson	0.125	34	0.37

The relatively small number of facilities in this basin monitoring whole effluent toxicity increased slightly since 1987, the first year that monitoring was required. The compliance rate of those facilities has generally risen since the inception of the program. Since 1998 the compliance rate has stabilized at approximately 95-100% (Figure 1 and Table 2).

The Highland Camp & Conference Center (Subbasin 01) has experienced problems meeting its whole effluent toxicity limit since it began monitoring in 1993. Failures have been associated with the facility's chlorination/de-chlorination unit processes, cleaning chemicals, and ineffective treatment of ammonia by the facility's sand filter. The facility faces several impediments to addressing the toxicity issue, including intermittent occurrence of toxicity, difficulties operating the sand filter due to a variable wastewater load, and the inability to connect to a municipality. The facility's administrators are currently investigating non discharge system options.

Figure 2. NPDES facility whole effluent toxicity compliance in the Savannah River basin, 1990-2004. The compliance values were calculated by determining whether facilities with WET limits were meeting their ultimate permit limits during the given time period, regardless of any SOCs in force.

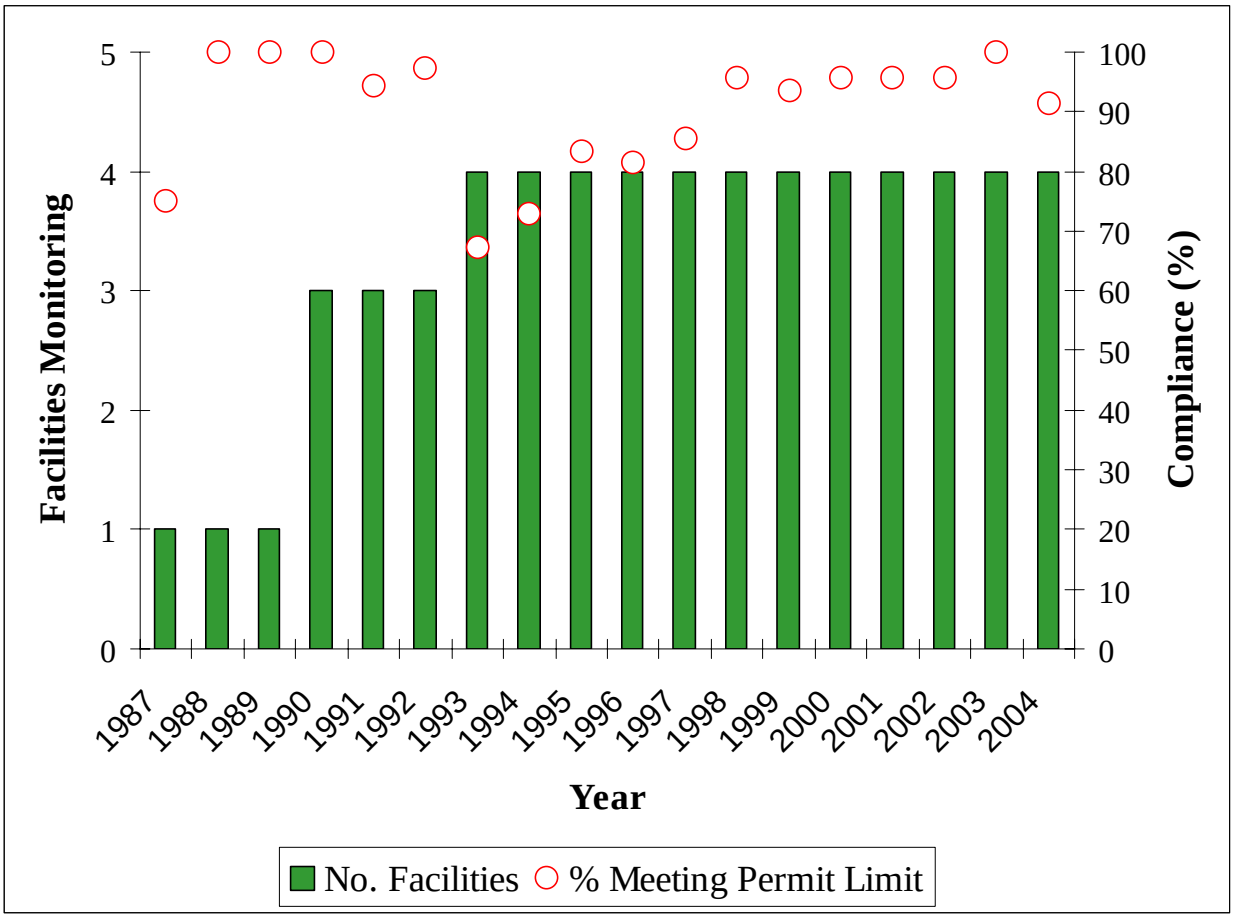


Table 2. Recent compliance record of facilities performing whole effluent toxicity testing in the Savannah River basin

Subbasin/Facility	NPDES Permit No.	2000- 2003 Passes	2000- 2003 Fails	2004 Passes	2004 Fails
03-05-02					
Cashiers WWTP	NC0063321/001	16	2	6	1
Highlands Camp & Conf Center	NC0061123/001	16	4	5	3
03-05-03					
Carolina Mountain Water	NC0067954/001	16	0	5	0
Wade Hampton Club	NC0062553/001	16	0	4	0

Note that "pass" denotes meeting a permit limit or, for those facilities with a monitoring requirement, meeting a target value. The actual test result may be a "pass" (from a pass/fail acute or chronic test), LC_{50}, or chronic value. Conversely, "fail" means failing to meet a permit limit or target value.