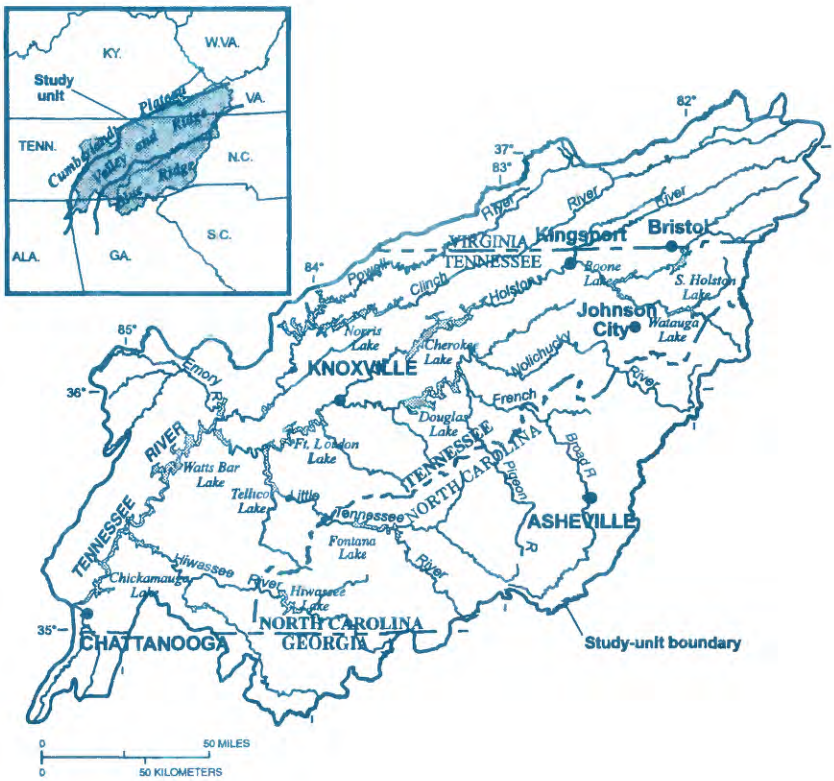
# National Water-Quality Assessment Program—The Upper Tennessee River Basin Study Unit



In 1991, the U.S. Geological Survey (USGS), U.S. Department of the Interior, began implementation of the National Water-Quality Assessment (NAWQA) Program. The long-term goals of the NAWQA Program are to describe, in a nationally consistent manner, the status of and trends in the quality of a large representative part of the Nation's surface- and ground-water resources and to provide a sound scientific understanding of the principal natural and human-related factors that affect the quality of these resources. In addressing these goals, the NAWQA Program will provide water-quality information that is useful to policymakers and managers at Federal, State, and local levels.

Studies of 60 hydrologic systems that include parts of most major river basins and aquifer systems in the country are the building blocks of the national assessment. The 60 study units range in size from 1,000 to more than 60,000 square miles and represent about 65 percent of the Nation's water use and the population served by public water supplies. Investigations of 20 study units began in 1991, 20 additional investigations began in 1994, and 20 more are planned to begin in 1997. Assessment activities in the upper Tennessee River Basin study unit began in 1994.




Location of the upper Tennessee River Basin NAWQA study unit.

## Description of the Upper Tennessee River Basin Study Unit

The upper Tennessee River Basin study unit encompasses about 21,390 square miles and includes the entire drainage of the Tennessee River and its tributaries upstream of the USGS gaging station on the Tennessee River at Chattanooga, Tennessee. The study area includes parts of four states; Tennessee (11,500 square miles), North Carolina (5,480 square miles), Virginia (3,130 square miles), and Georgia (1,280 square miles). In 1990, the total population of the study area was about 2.4 million of which about 1.6 million resided in the four metropolitan statistical areas of Chattanooga and Knoxville, Tennessee, Asheville, North Carolina, and the Tri-Cities area of Kingsport and Johnson City, Tennessee, and Bristol, Tennessee and Virginia.

Three physiographic provinces—the Cumberland Plateau, the Valley and Ridge, and the Blue Ridge—are included in the upper Tennessee River Basin. Altitudes in the study area range from 621 feet above sea level at the USGS gaging station at Chattanooga to 6,684 feet at Mt. Mitchell, which is the highest point in the Eastern United States and is located just northeast of Asheville. The study area contains some of the most rugged terrain in the Eastern United States, including the Great Smoky Mountains range, which crests along the Tennessee–North Carolina border between the Little Tennessee and the Pigeon Rivers. The Smokies crest exceeds 5,000 feet for 34 miles along the State line, has 16 peaks that exceed 6,000 feet, and caps the highest and most massive mountain range east of the Mississippi River.

Forest covers more than 64 percent of the study area. Much of the forest land is contained within the National Forests—Jefferson, Pisgah, Cherokee, Nantahala, and Chattahoochee. Agricultural land, which is mostly pastureland, is the second most common land use and accounts for more than 27 percent of the study area. Most agricultural land is located in the stream valleys and the more gently rolling areas of the Valley and Ridge Province. Other land uses are urban, 6 percent; open water, 2 percent; and barren land, 1 percent, most of which is related to mining activities.

The region generally has a temperate climate; temperatures and annual precipitation totals largely are, for the most part, related to land-surface elevations. Average annual temperatures in the area generally decrease by about 3° Fahrenheit for every 1,000-foot increase in elevation. At Knoxville, which has an elevation of about 1,000 feet, the average annual temperature is about 59° Fahrenheit. Annual precipitation ranges from about 40 inches in some low-lying, sheltered areas to more than 90 inches at elevations of more than 6,000 feet.

Five major tributaries account for about 86 percent of the annual mean discharge of 35,450 cubic feet per second at the Tennessee River at Chattanooga and over 87 percent of the total area of the upper Tennessee River Basin. The Clinch (4,413 square miles), the Holston (3,776 square miles), the French Broad (5,124 square miles), the Little Tennessee (2,627 square miles), and the Hiwassee (2,700 square miles) River Basins each exhibit distinctive climatic and runoff characteristics. Average annual precipitation ranges from about 45 inches for the Holston River to almost 60 inches for the Little Tennessee River, which is the heaviest rainfall in the continental United States outside of the Pacific Northwest. Average annual runoff totals show similar variation and range from about 18 inches for the Holston River to more than 34 inches for the Little Tennessee River.

The most prominent surface-water features of the upper Tennessee River Basin are the tributary and main-stem reservoirs constructed and maintained by the Tennessee Valley Authority (TVA). The four main-stem reservoirs are primarily flow-through systems that provide power generation but little flood storage and that have a combined total capacity of about 3.1 million acre-feet. A total of 17 TVA reservoirs that provide flood storage and power generation are located on the tributaries and have a combined total storage of about 10.0 million acre-feet. An additional 17 private reservoirs also are located in the study area and have a combined storage capacity of about 0.6 million acre-feet.

Ground water in the study area occurs almost entirely under water-table conditions and with no regional flow system. Ground-water systems are usually less than 10 square miles in area and are controlled principally by the bedrock geology. Pennsylvanian sandstones and conglomerates form the principal aquifer of the Cumberland Plateau Province where yields generally range from 5 to 50 gallons per minute from fractures, faults, and bedding-plane openings. The Valley and Ridge Province is underlain by folded and extensively faulted limestone, dolomite, shale, and sandstone in long subparallel belts that trend southwest to northeast. The principal water-bearing units are the carbonates, which provide water for some cities and industries. Yields generally range from 5 to 200 gallons per minute, but wells that penetrate extensive solution features may yield as much as 2,000 gallons per minute. The Blue Ridge Province is characterized by fractured crystalline igneous and metamorphic rocks that have low porosity and little storage capacity. Yields depend upon interception of water-bearing fracture systems and usually range from 10 to 25 gallons per minute.

In 1990, withdrawals of surface and ground waters in the upper Tennessee River Basin totaled about 5.0 billion gallons per day. Surface-water withdrawals for once-through cooling at thermoelectric plants accounted for 72 percent (3.59 billion gallons per day) of this total; industrial use, 805 million gallons per day; municipal use, 317 million gallons per day, and mining and agricultural use, 243 million gallons per day. About 530 facilities discharged wastewater to streams in the Basin in 1990. Although ground water represents only 3.2 percent of the total water use in the Basin, about 42 percent of the population in the Basin relies upon ground-water sources for drinking water.

## Major Water-Quality Issues

The major water-quality issues in the upper Tennessee River Basin study unit include the following:

- Sedimentation results from logging and the use of steeply sloping lands. The clearing of riparian zones for planting has adversely affected bank stability, as well as sensitive aquatic ecosystems. Most of the water-quality constituents of greatest concern in the Basin are sediment related.
- Nutrient enrichment from agricultural activities affects not only the streams of the Basin, but also the health of the major reservoirs. The relative contributions of point and nonpoint sources of nutrients are of major importance to environmental agencies.
- Industrial organic chemicals and trace elements are major concerns in parts of the study unit. PCB's, dioxins, and mercury are of great concern because of bioaccumulation which has led to fish-consumption advisories in several streams and reservoirs. Radionuclides are a concern in the area around the U.S. Department of Energy's Oak Ridge Reservation just west of Knoxville.
- The upper Tennessee River Basin is probably the most biodiverse of the 60 NAWQA Program study units. For example, the upper Clinch and the Powell River Basins are home to more than 300 globally rare species, including perhaps the most diverse freshwater mussel fauna in the world. In addition, most (68 percent) of the fish fauna of the Southeastern United States, the richest segment of the most diverse temperate freshwater fish fauna in the world (North America), resides within the Basin.

## Communication and Coordination

Communication and coordination between the USGS and other public and private agencies are critical components of the NAWQA Program. Study-unit liaison committees, which consist of representatives from Federal, State, and local agencies; universities; and the private sector who have water-resources responsibilities or interests, have proved to be highly effective. Specific activities of the liaison committees include the following:

- Exchange of information on and prioritization of water-quality issues of regional and local interest
- Identification of sources of water-quality data and other information
- Assistance in the design and scope of project elements
- Review of project-planning activities, findings, and interpretations, including reports

*—by Paul S. Hampson*

**Information on technical reports and hydrologic data related to NAWQA can be obtained from:**

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