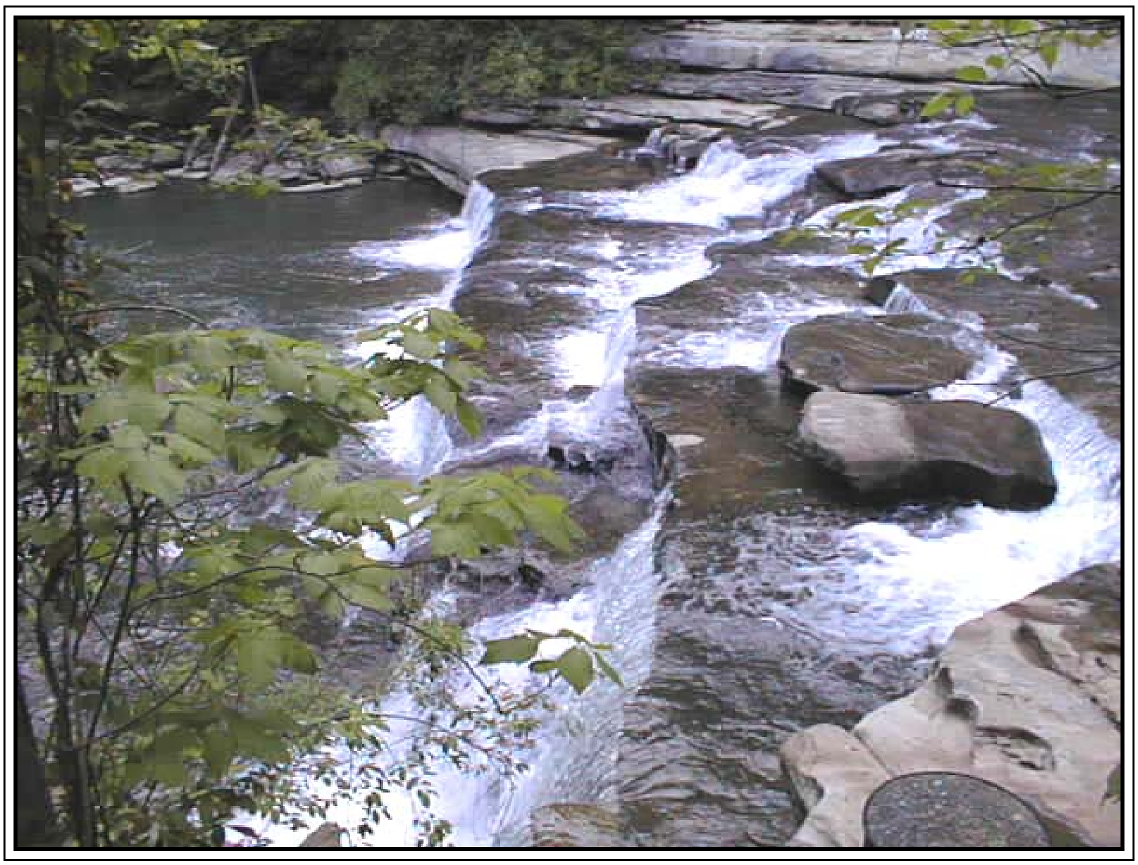
2006 305(b) Report
The Status of Water Quality in Tennessee



Division of Water Pollution Control
Tennessee Department of Environment and Conservation

2006 305(b) Report
The Status of Water Quality in Tennessee

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Cover Photo: Roaring River in Overton County. Photo provided by Annie Goodhue, NEFO.

Section I – 2006 305(b) Report
Status of Water Quality in Tennessee

Introduction to Tennessee's Water Quality

This report was prepared by the Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control, to fulfill the requirements of both federal and state laws. Section 305(b) of the federal Clean Water Act requires a biennial analysis of water quality in the state. The Tennessee Water Quality Control Act also requires that the division produce a report on the status of water quality.

TDEC's goals for the 305(b) Report are:

- Describe the water quality assessment process (Chapter 1).
- Categorize waters in the State by placing them in the assessment categories suggested by federal guidance (Chapter 2).
- Identify waterbodies that pose eminent human-health risks due to elevated bacteria levels or contamination of fish (Chapter 5).
- Provide detailed information on each watershed (Section II).

Acknowledgements

The Director of the Division of Water Pollution Control (WPC) is Paul E. Davis and the Deputy Director is Garland P. Wiggins. The Planning and Standards Section of WPC produced this report in cooperation with regional field office staff.

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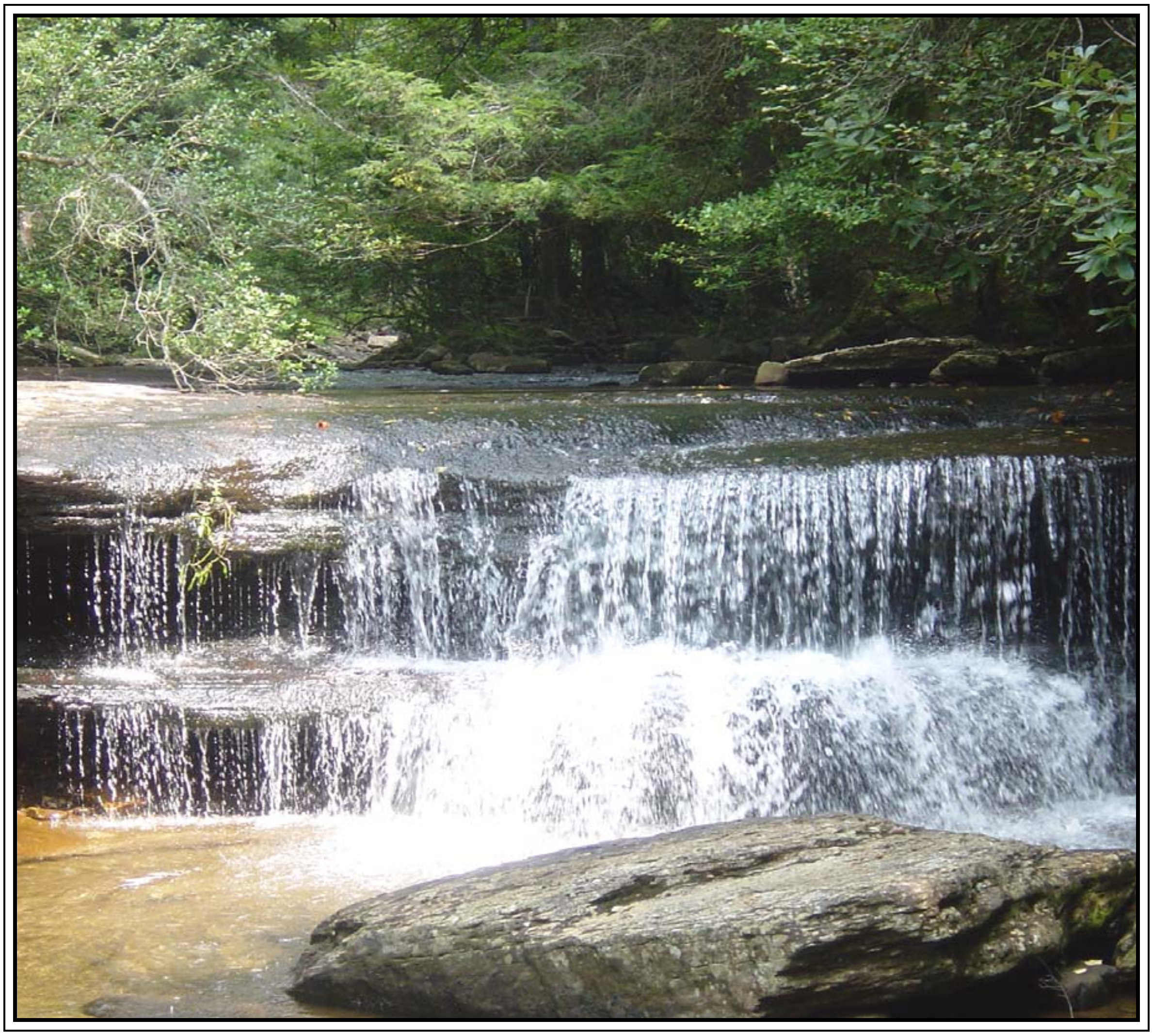
The information compiled in this 2006 water quality assessment document included data provided by many state and federal agencies. These agencies include Tennessee Department of Health (TDH), Tennessee Valley Authority (TVA), U. S. Environmental Protection Agency (EPA), Tennessee Wildlife Resources Agency (TWRA), U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), and U.S. Department of Interior Office of Surface Mining (DIOSM). The division is grateful for their assistance and cooperation.

In addition to the agencies that provided water quality data, the Division of Water Pollution Control acknowledges the assistance provided by the U. S. Environmental Protection Agency's Region 4 staff.



Cain Creek in Sequatchie County. Photo provided by Terry Whalen, Chattanooga Environmental Field Office

Executive Summary

A primary mandate of Water Pollution Control (WPC) is to preserve and protect the right of the people of Tennessee to unpolluted water. To safeguard this valuable resource, the goals of WPC are to assist in the establishment of clean water objectives, implement a surface water monitoring program, and determine if waters support their intended uses.

The *Federal Water Pollution Control Act*, Section 305(b) (US Congress, 2002) requires a biennial accounting to congress of the water quality of each state. The *Tennessee Water Quality Control Act* (Tennessee Secretary of State, 1999) also requires a report on water quality. The Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control (WPC) has primary responsibility for assessment and reporting of the quality of surface waters.

Water Quality Standards

The specific water quality standards are established in *Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control*, Chapter 1200-4-3, General Water Quality Criteria and Chapter 1200-4-4, Use Classifications for Surface Water (Tennessee Department of Environment and Conservation, Water Quality Control Board, 2004). Tennessee's water quality standards have three sections. The first establishes seven designated uses for Tennessee waterways. The second identifies numeric or narrative water quality criteria to protect each of the designated uses. The final section is an antidegradation policy designated to protect existing water uses and prevent future damage to water quality.

Monitoring Programs

Tennessee has an abundance of water resources with over 60,000 miles of rivers and streams and nearly 538,000 lake and reservoir acres. However, this vast system of streams, rivers, reservoirs and wetlands requires efficient use of Tennessee's monitoring resources.

TDEC's watershed approach serves as an organizational framework for systematic assessment of the state's water quality problems. By viewing the entire drainage area or watershed as a whole, the department is better able to address water quality monitoring, assessment, permitting, and stream restoration efforts. This unified approach affords a more in-depth study of each watershed and encourages coordination of public and governmental organizations. The watersheds are addressed on a five-year cycle that coincides with permit issuance.

In addition to systematic watershed monitoring, waterbodies are sampled to fulfill other information needs within the division. Some of these other needs include continuation of the ecoregion reference stream monitoring, Total Maximum Daily Load (TMDL) generation, complaint investigation, antidegradation tier evaluations, trend investigations, compliance monitoring, and special studies.

Assessment Process

Using a standardized assessment methodology, monitoring data from individual streams are compared to water quality standards. Violations of water quality standards are identified and the degree to which each individual waterbody meets its designated uses is determined. Assessment categories recommended by EPA are used to characterize water quality.

Assessment results are compiled and reported to the public periodically. The principal vehicles for this water quality assessment reporting are the 305(b) Report and the 303(d) List.

Water Quality

Approximately half of the stream miles and almost all the large reservoirs have recently been monitored and assessed. Waters without data collected within the last five years are usually identified as not assessed. About 64 percent of assessed streams and over 78 percent of assessed reservoir acres are found to be fully supporting of designated uses. The remainder of the assessed waterbodies are impaired to some degree and therefore, not supporting of all designated uses.

Causes and Source of Pollution

Once it is determined that a stream, river, or reservoir is not fully supporting of its designated uses, it is necessary to determine what the pollutant is (cause) and where it is coming from (source). The most common causes of pollution in rivers and streams are sediment/silt, habitat alteration, pathogens, and nutrients. The main sources of these pollutants are agriculture, hydrologic modification, municipal dischargers, and construction. The leading causes of pollution in reservoirs and lakes are organic substances, like PCBs, dioxins, and chlordane, plus nutrients, sediment/silt, and low dissolved oxygen. The principal source of problems in reservoirs and lakes is the historical discharge of pollutants that have accumulated in sediment and fish flesh. Other sources include agriculture, hydrologic modifications, municipal dischargers, and construction.

Advisories

When streams or reservoirs are found to have significantly elevated bacteria levels or when fish tissue contaminant levels exceed risk-based criteria, it is the responsibility of the Department of Environment and Conservation to post warning signs so that people will be aware of the potential threat to their health. In Tennessee, the most common reasons for a stream or river to be posted is the presence of high levels of bacteria. In lakes and reservoirs, the most common reason is accumulated PCBs, chlordane, dioxins, or mercury in fish tissue.

Statutory Requirements

Tennessee first created a water pollution regulatory organization in 1927. In 1929, the scope of that agency was expanded to include stream pollution studies to protect potential water supplies. A Stream Pollution Study Board charged with evaluating all available water quality data in Tennessee and locating the sources of pollution was appointed in 1943. The stream pollution study was completed and submitted to the General Assembly in 1945. Subsequently, the General Assembly enacted Chapter 128, Public Acts of 1945.

The 1945 law was in effect until the Water Pollution Control Act of 1971 was passed. In 1972, the Federal Clean Water Act was enacted into law. According to the Act, states are required to assess water quality and report the results to EPA and the public biennially. The Tennessee General Assembly revised the Water Quality Control Act in 1977 and the Department began statewide stream monitoring that same year.

In addition to the federal requirements, the Tennessee Water Quality Control Act of 1977 requires the Division of Water Pollution Control to produce a report to the governor and the general assembly on the status of water quality in the state. The report includes a description of the water quality plan, regulations in effect, and recommendations for improving water quality. This report serves the requirements of both the federal and state laws. Both laws require that emphasis be placed on identifying and restoring impaired waters.

> *Recognizing that the waters of Tennessee are the property of the state and are held in public trust for the use of the people of the state, it is declared to be the public policy of Tennessee that the people of Tennessee, as beneficiaries of this trust, have a right to unpolluted waters. In the exercise of its public trust over the waters of the state, the government of Tennessee has an obligation to take all prudent steps to secure, protect, and preserve this right.* (The Tennessee Water Quality Control Act, 1999)

In 1985, the Division of Water Quality Control was divided into the Divisions of Water Pollution Control and Water Supply. The Division of Water Pollution Control continues to monitor surface water for 305(b) and 303(d) assessments. The Division of Water Supply works to ensure that public drinking water supplies are safe.

This report covers only surface waters in Tennessee. The department's Division of Water Supply prepared a report on ground water quality entitled *Tennessee Ground Water 305(b) Water Quality Report* (TDEC, 2004). The ground water report can be viewed on line at www.tdec.net.

Tennessee at a Glance

Tennessee is one of the most biodiverse inland states in the nation. Geography ranges from the Appalachian Mountains in the eastern part of the state to the Mississippi River floodplains in the west. Elevations vary from over 6,600 feet at Clingman's Dome in the Great Smoky Mountains National Park, to less than 200 feet near Memphis.

The average statewide precipitation is over 50 inches annually (NOAA, 2003). Most of this rainfall is received between November and May. Historically the driest month is October. The average summer high temperature is 91 degrees Fahrenheit, while the average winter low temperature is 28 degrees Fahrenheit.

Tennessee's population is growing fairly rapidly. According to the 2000 Census, Tennessee's population is over 5,689,000, which is a 14 percent increase in population from the 1990 Census (Secretary of State, 2005). This puts a burden on the state's waterways. Tennessee has over 60,000 stream miles and more than 538,000 lake acres. The Mississippi River forms the western border of the state. Several large reservoirs are shared with bordering states including Pickwick Lake, Kentucky Lake, Lake Barkley, and Dale Hollow Lake.

Kelso Lake is an oxbow of the Hatchie River. Photo provided by Alless Wiess with Nature Conservancy.

Tennessee Facts

State population (2000 Census)	5,689,283
Largest Cities (2000 Census)	
Memphis	650,100
Nashville	545,524
Knoxville	173,890
Chattanooga	155,554
Clarksville	103,455
Murfreesboro	68,816
Jackson	59,643
Johnson City	55,469
Number of Counties	95
State Surface Area (square miles)	42,244
Number of Major Basins	13
Number of Level III Ecoregions	8
Number of Level IV Ecoregions	25
Number of Watersheds (HUC8)	55
Number of Stream Miles Forming State Border	213
(The Mississippi River forms most of the stream miles shared by another state.)	
Stream Miles Statewide (NHD)	60,507
Largest Rivers at Low Flow (7Q10 in ft^3/sec.)	
Mississippi River at Memphis	109,000
Tennessee River at South Pittsburg	12,500
Cumberland River at Dover	2,280
Hiwassee River above Charleston	1,220
Little Tennessee River at Calderwood	1,200
Holston River at Surgoinsville	762
French Broad River near Knoxville	722
South Fork Holston River at Kingsport	550
Duck River above Hurricane Mills	477
Obion River at Megelwood	357
Publicly-owned Lake Acres Statewide	538,257
Largest Lakes (size in acres)	
Kentucky Reservoir (Tennessee portion)	117,500
Watts Bar Reservoir	39,000
Barkley Reservoir (Tennessee portion)	37,000
Chickamauga Reservoir	35,400
Estimated Acres of Wetlands	787,000

Cost of Water Pollution

Everyone benefits from clean water.

Everyone is affected by water pollution and has a vested interest in improving water quality. The average American uses 140 to 160 gallons of water per day. Water is used for sanitation, drinking, and many other human needs, such as recreation, transportation, and irrigation. When a water source is grossly polluted, it can no longer be used for drinking water.

On average, tap water costs slightly more than $2 per 1,000 gallons. The cost of tap water increases as the amount of water pollution increases. There are many other costs associated with polluted waters other than treating water for public consumption.

When the water is no longer safe for recreational activities, the community loses an important resource. Two of the most obvious costs of water pollution are the expenses of health care and loss of productivity while people are ill. The biggest health risks people encounter in polluted waters are from pathogens and contaminated fish. People who swim in waters polluted by pathogens can become sick. People, especially children and pregnant women, who eat contaminated fish are at a higher risk for cancer and other health problems than those who do not eat contaminated fish. Subsistence fishermen are faced with the loss of their primary protein source.

When people can no longer eat fish from rivers, streams, and lakes, there is a potential for economic loss in the community. Commercial fishermen lose income when it is no longer legal to sell the fish they catch. As the fishermen move out of the community to find another place to fish, local business can decline.

Another cost of water pollution is the expense associated with keeping waters navigable. Commercial navigation as a means to move goods and services around the country is one of the most economical methods of transportation. As channels fill with sediment from upland erosion, commercial navigation becomes less practical. Silt deposits also reduces the useful lifespan of lakes and reservoirs. They become filled with silt, which decreases the depth of the water until dredging is required or the lake or reservoir is completely filled.

Chapter 1
Water Quality Assessment Process

Using a standardized assessment methodology, existing monitoring data from individual streams are compared to water quality standards in order to categorize the degree of use support (Chapter 2). Violations of water quality standards are identified. Individual assessments are stored in an electronic format, assessment information is compiled into reports such as the 305(b), and geographic referencing tools are used to prepare interactive maps that can be accessed by the public.

Since the 2004 305(b) report was published, Group 3 watersheds have been assessed. Chemical data analyzed for the Group 4 watersheds have also been assessed. However, due to the time constraints of biological analyses, Group 4 watershed biological samples are not included in this report.

A. Water Quality Standards

The *Tennessee Water Quality Control Act* (Tennessee Secretary of State, 1999) identifies the Water Quality Control Board as the entity responsible for the promulgation of clean water goals. Federal law requires that the water quality standards be revisited at least every three years. Division staff provide technical assistance to the board in the development of criteria and the identification of appropriate use-classifications. Public participation is a vital part of the goal-setting process.

The specific water quality standards are established in *Rules of Tennessee Department of Environment and Conservation Division of Water Pollution Control*, Chapter 1200-4-3, General Water Quality Criteria and Chapter 1200-4-4, Use Classifications for Surface Water (Tennessee Department of Environment and Conservation, Water Quality Control Board, 2004). The Tennessee water quality standards have three sections. The first section establishes seven designated uses for Tennessee waterways. The second section identifies numeric or narrative water quality criteria to protect each of the designated uses. The final section is an antidegradation policy designated to protect existing water uses and prevent future damage to water quality.

All waterbodies are classified for multiple uses and may have several criteria for each substance or condition (pollutants). When multiple criteria are assigned for different uses on a stream, the regulation states that the most stringent criterion must be met. The combination of classified uses, the most stringent criterion for those uses, and the requirements of the antidegradation policy create the water quality standard for each waterbody segment.

1. Stream Use Classifications

> **Tennessee's Current Stream-Use Classifications:**
>
> 1. Fish and aquatic life
> 2. Recreation
> 3. Irrigation
> 4. Livestock watering and wildlife
> 5. Drinking water supply
> 6. Navigation
> 7. Industrial water supply

The Tennessee Water Quality Control Board (TWQCB) is responsible for the designation of beneficial uses of waterbodies. All streams, rivers, lakes, and reservoirs in Tennessee are classified for at least two public uses: protection of fish and aquatic life and recreation. These minimum use classifications comply with the goals of the federal act, which requires that all waters provide for the "protection and propagation of a balanced population of …fish and wildlife, and allow recreational activities in and on the water" (U.S. Congress, 2000).

Most waterbodies are also classified for irrigation and livestock watering and wildlife. Three additional classifications apply to certain waterbodies. The drinking water supply designation is assigned to waterbodies currently or likely to be used as domestic water sources in the future. The navigation and industrial water supply classifications are usually limited to waters currently being used for those purposes, but can be expanded to other waters as needed.

a. **Fish and Aquatic Life (FAL)** – This use classification is assigned to all waterbodies for the protection of fish and other aquatic life such as aquatic insects, snails, clams, and crayfish. While Tennessee does not currently have a system that creates tiers of aquatic life protection (e.g., warm water vs. cold water fisheries), the state has developed regional interpretations of some criteria such as nutrients and biological integrity. Additionally, trout waters have more stringent criteria for dissolved oxygen and temperature.

b. **Recreation** – All waterbodies in Tennessee are classified for the protection of the public's ability to swim, wade, and fish. Threats to recreational uses of streams include the loss of aesthetic values due to algae or turbidity, elevated pathogen levels, and the accumulation of dangerous levels of metals or organic compounds in fish tissue.

c. **Irrigation** - This use classification is assigned to most waterways to protect the ability of farmers to use streams or reservoirs as a source of water to irrigate crops.

d. **Livestock Watering and Wildlife** – This use classification protects waters to be used as an untreated drinking water source for livestock and wildlife.

e. **Drinking Water Supply** –This use classification is assigned to waterbodies that are currently or are likely to be used for domestic water supply.

f. **Navigation** – This use classification is designated to protect navigational rivers and reservoirs from any alterations that would adversely affect commercial uses.

g. **Industrial Water Supply** - This classification is assigned to waters currently used for industrial purposes. If needed, additional waters may be designated as industrial water supplies.

Designated uses are goals, not necessarily a documentation of the current use of that waterbody. Even if a stream or reservoir is not currently used for a given activity, it should be protected for that use in the future.

All streams that are not specifically listed in Use Classifications for Surface Waters are classified for fish and aquatic life, recreation, irrigation, livestock watering and wildlife. These regulations can be viewed or downloaded at the Tennessee Secretary of State's homepage. There is a link to this site from the department's home page:

http://www.tdec.net/wpc/publications

1. Water Quality Criteria

The Tennessee Water Quality Control Board has assigned specific water quality criteria to each of the designated uses. These criteria establish the level of water quality needed to support each of the designated uses. Since every waterbody has multiple classified uses, it may have multiple applicable criteria. The standard for each stream is based on the most stringent criterion for the uses assigned to it. The most stringent criteria are associated with the protection of fish and aquatic life, recreational uses, or drinking water.

a. **Fish and Aquatic Life (FAL)** – FAL criteria are designed to protect aquatic life from the two types of toxicity: acute and chronic. Acute toxicity refers to the level of contaminant that causes death in an organism in a relatively short period of time. Chronic toxicity refers to a lower level of contamination that causes death or other ill effects (such as reproductive failure) over a longer period of time. Since Tennessee does not perform primary research into the toxic effects of pollutants, reliance is placed on EPA's published national criteria, which are based on the following types of research:

- Toxicity tests performed on lab animals.
- The number of cancer incidences in animals after exposure to a substance.
- A substance's tendency to concentrate in the food chain.

FAL have the most protective numeric criteria for many parameters including; dissolved oxygen (DO), pH, turbidity, temperature, some toxic substances, nutrients, biological integrity, habitat and flow. The criteria for FAL also have narrative criteria for turbidity, nutrients, biological integrity, habitat, and flow. The department has developed guidance documents to assist in the interpretation of narrative criteria for nutrients, biological integrity, and habitat. Additionally, dissolved oxygen and temperature criteria for trout waters are found in this section.

b. Recreation – These criteria are established to protect the public's ability to swim and wade in Tennessee waters and to safely eat fish they catch. If fish tissue have dangerous levels of metals or organic substances, or if streams are found to have elevated bacteria levels, warning signs are posted to inform the public concerning the potential health risk. See Chapter 5 for additional information on advisories.

For two parameter categories, pathogens and carcinogens, recreational criteria are the most protective. *E. coli* is used as the primary indicator of risk due to pathogens. Criteria for carcinogens are designed to prevent the accumulation of dangerous levels of metals or organic compounds in the water or sediment that may ultimately accumulate in fish tissue. The criteria also identify the procedure to be used when evaluating fish tissue contamination and for the decision process for stream posting.

c. Irrigation – These criteria protect waters to be used for agricultural irrigation purposes. Most of the irrigation criteria are narrative.

d. Livestock Watering and Wildlife – These criteria protect waters to be used as untreated drinking water sources for livestock and wildlife. Most of the livestock watering and wildlife criteria are narrative.

e. Drinking Water Supply – These criteria protect waters used as domestic water supplies from substances that might cause a public health threat, if not removed by conventional water treatment. Since many contaminants are difficult and expensive to remove, it is more cost effective to keep pollutants from entering the water supply in the first place. For this purpose, the surface water criteria adopt the Maximum Contaminant Levels (MCLs) suggested by EPA for finished water as goals for surface waters used for source waters.

f. Navigation – These criteria protect waterways used for commercial navigation. Navigation criteria are narrative.

g. Industrial Water Supply- These criteria protect waters used as water supplies for industrial purposes. Criteria for pH, total dissolved solids, and temperature are numerical. The remaining industrial water supply criteria are narrative.

General Water Quality Criteria for surface waters in Tennessee are listed in Rules of TDEC, Chapter 1200-4-3 (TDEC-WQCB, 2004). A copy of these regulations can be viewed or downloaded at the Tennessee Secretary of State's home page at

http://www.state.tn.us/sos/rules/1200/1200-04/1200-04-03.pdf.

3. Antidegradation Policy

The third section of Tennessee water quality standards contains the antidegradation policy, which protects existing uses of all surface waters and prevents degradation in waters identified as high quality. In high quality waters, degradation can only be allowed if it is in the public interest and there are no other options. Degradation in impaired waters cannot be authorized for parameters of concern.

In the regulation, high quality waters are those identified as having good water quality, important ecological significance, or outstanding scenic or recreational characteristics. The waters with the highest degree of protection are identified as Outstanding National Resource Waters (ONRW) (Table 1). These waters are specifically designated by the Water Quality Control Board and are listed in the regulation. No new discharges, expansions of existing discharges, or other regulated activities that would cause degradation may be permitted in these waters.

The second highest level of protection is afforded to Tier II waters. No degradation can be allowed in Tier II waters, unless it can be determined that the social and/or economic benefits justify it and the degradation will not impair any of the waterway's classified uses.

Table 1: Outstanding National Resource Waters

Waterbody	Portion Designated as ONRW
Little River	Portion within Great Smoky Mountains National Park
Abrams Creek	Portion within Great Smoky Mountains National Park
West Prong Little Pigeon River	Portion within Great Smoky Mountains National Park
Little Pigeon River	From headwaters within Great Smoky Mountains National Park to the downstream boundary of Pittman Center
Big South Fork Cumberland River	Portion within Big South Fork National River and Recreation Area
Reelfoot Lake	Tennessee portion of the lake and its associated wetlands
Obed River	Portions of the Obed and Emory Rivers and Clear and Daddy's Creeks in Morgan and Cumberland Counties

A current list of known high quality waters, which includes both Tier II and ONRWs is available on the state's website at http://www.state.tn.us/environment/wpc/. Additional high quality waters will be added to the list as they are identified. The number of known high quality waters in each watershed is provided in Section II. This information is updated regularly on the website.

Waters not identified as either ONRW or Tier II are evaluated on a parameter-by-parameter basis (Table 2). If water quality fails to meet the criterion for one or more parameter, no additional discharges of those substances can be allowed. Where water quality is better than the applicable criterion for a given substance, additional degradation for that parameter will only be allowed if the applicant has demonstrated to the division that reasonable alternatives are not feasible and that it is in the public interest for the activity to take place.

Table 2: Antidegradation Categories

Category	Protections
Tier I	Existing uses will be maintained by application of the general water quality criteria. Additional loadings of specific pollutants cannot be allowed if the water quality standard for those substances is currently being violated. Degradation can be allowed if the water has assimilative capacity, but only if non-degrading alternatives are unavailable. The degradation must be in the public's interests.
Tier II	No degradation will be allowed unless and until it is demonstrated that a change is justifiable as a result of necessary economic or social development and will not interfere with or become injurious to any classified uses existing in such waters.
Tier III (Outstanding National Resource Waters)	These constitute an outstanding national resource, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. No degradation will be allowed in these waters (Table 1).

B. Water Quality Resource Management

The watershed approach serves as an organizational framework for systematic assessment of the state's water quality problems. By viewing the entire drainage area or watershed as a whole, the department is better able to address water quality problems in a comprehensive manner. This unified approach affords a more in-depth study of each watershed and encourages coordination of public and governmental organizations. The watersheds are addressed on a five-year cycle that coincides with permit issuance.

It is important that watersheds are not confused with ecoregions. The watershed approach is an organizational monitoring framework. Ecoregions serve as a geographical framework for establishing water quality expectations. In addition to systematic watershed monitoring, waterbodies are sampled to fulfill other information needs within the division. Some of these other needs include continuation of ecoregion reference stream monitoring, TMDL generation, complaint investigation, antidegradation tier evaluations, trend investigations, compliance monitoring, and special studies.

1. Watershed Approach

In the early 1970's, the USGS delineated 55 hydrologic watershed boundaries within Tennessee. In 1996, the division adopted a watershed approach that reorganized existing programs based on management and focused on place-based water quality management. The state's 55 watersheds have been divided into five monitoring groups for scheduling assessments (Figure 1 and Table 3). Each group contains between 9 and 16 watersheds. One group is monitored each year and assessed the following year. This allows intense monitoring of one watershed group each year, with all watersheds monitored every five years. Since the 2004 305(b) report was published, Group 3 and 4 watersheds have been monitored. However, due to the volume of biological analyses, Group 4 watershed biological samples were not processed in time to be included in this report.

The watershed approach is a five-year cycle that has the following features:

- Commits to a monitoring strategy that addresses all watersheds
- Synchronizes discharge permit issuance with the development of TMDLs
- Establishes TMDLs by integrating point and non-point source pollution
- Commits to two public meetings per watershed within the five-year cycle
- Partners with other agencies to obtain the most current water quality and quantity data

The five-year watershed cycle provides for a logical progression of water quality management. The cycle includes planning, monitoring, assessment, TMDL development, and permit issuance (Figure 2). The watershed cycle coincides with the discharge permits that are issued to point source dischargers. The key activities involved in each five-year watershed cycle are as follows:

Year 1. Planning, Data Review, and Public Outreach - Existing data and reports from appropriate agencies and organizations are compiled and used to describe the quality of the state's rivers and streams. Watershed planning meetings are held with interested stakeholders including citizen and environmental groups, other governmental agencies, and permit holders. Monitoring plans are developed.

Year 2. Monitoring - Field data are collected for key waterbodies in the watershed to supplement existing data. Two standard operating procedures (SOPs) have been developed to guide sampling techniques and quality control for macroinvertebrate surveys (TDEC, 2003) and chemical and bacteriological sampling (TDEC, 2004).

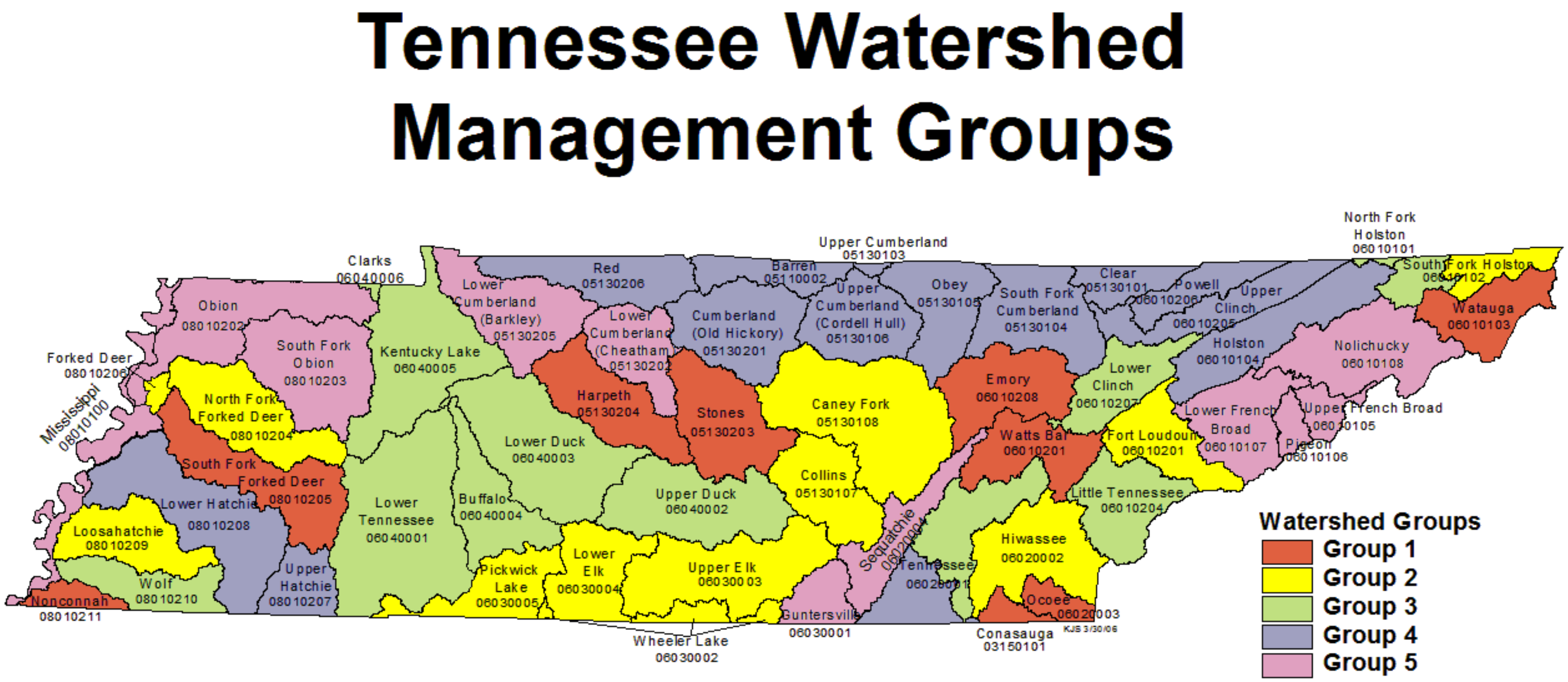


Figure 1: Watershed Monitoring Groups

Table 3: Watershed Groups and Monitoring Schedule

	Monitoring Years	West Tennessee	Middle Tennessee	East Tennessee
Group 1	1996 2001 2006 2011 2016	• Nonconnah • South Fork of the Forked Deer	• Stones • Harpeth	• Upper Tennessee (Watts Bar Res.*)† • Ocoee • Emory* • Watauga • Conasauga
Group 2	1997 2002 2007 2012 2017	• Loosahatchie • North Fork Forked Deer • Forked Deer	• Collins • Caney Fork • Wheeler Res. • Upper Elk • Lower Elk • Pickwick Res.	• Hiwassee • Upper Tennessee (Fort Loudoun Res.*)† • South Fork Holston (part)†
Group 3	1998 2003 2008 2013 2018	• Wolf • TN Western Valley (KY Lake) • TN Western Valley (Beech) • Clarks	• Upper Duck • Lower Duck • Buffalo	• Lower Tennessee (Chickamauga Res.)† • Little Tennessee* • Lower Clinch* • North Fork Holston • South Fork Holston (part)†
Group 4	1999 2004 2009 2014 2019	• Hatchie • Little Hatchie	• Red • Barren • Cumberland (Old Hickory) • Upper Cumberland (Cordell Hull) • Obey	• South Fork Cumberland* • Upper Cumberland* • Powell* • Upper Clinch* • Holston* • Clear Fork • Lower Tennessee (Nickajack Res.)†
Group 5	2000 2005 2010 2015 2020	• Mississippi • Obion • South Fork Obion	• Barkley Reservoir • Cheatham Reservoir • Guntersville Reservoir	• Sequatchie • Upper French Broad* • Lower French Broad* • Pigeon* • Nolichucky

*These watersheds are monitored the following year.
†These watersheds have been split into 2 watershed groups.

Year 3. **Assessment** – Monitoring data are used to determine if the streams, rivers, lakes, reservoirs, and wetlands support their designated uses and to place the waterbodies in the appropriate use support category. Causes and sources of impairment are identified for waterbodies that do not meet their designated uses.

Year 4. **Wasteload Allocation/Total Maximum Daily Load (TMDL)** - Monitoring data are used to determine pollutant effluent limits for permittees releasing wastewater to watersheds. Limits are set to assure that water quality is protected. The TMDL program locates, quantifies and identifies continuing pollution problems in the state and then proposes solutions for the problem. TMDL documents may recommend regulatory or other actions required to resolve pollution problems. Tennessee's prioritization schedule is based on a 1998 agreement between EPA and TDEC. Under this schedule, TDEC is committed to the development of TMDLs for all waterbodies listed in 1998 by 2011. EPA committed to provide better guidance and new tools for developing TMDLs.

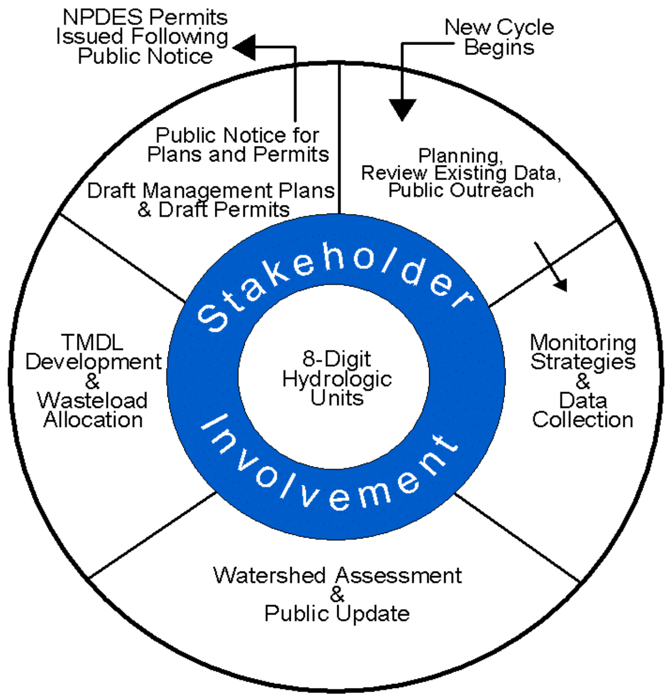


Figure 2: Watershed Cycle

The five steps of the TMDL process are:

1. Identify water quality problems in a waterbody
2. Prioritize water quality problems
3. Develop TMDL plan to control sources
4. Implement water quality improvement actions
5. Assess water quality improvement efforts

Year 5. **Draft Permits and Public Updates** - Issuance and expiration of all discharge permits are synchronized based on watersheds. Draft National Pollutant Discharge Elimination System (NPDES) permits are issued, then following public participation the permits are issued. Draft watershed management plans are also developed. In 2005, Group 3 Watershed meetings were held throughout the state, to update the public on watershed issues and encourage public involvement.

Year 6/Year 1. Permits and Watershed Management Plans - NPDES permits are issued. Final watershed management plans, including information for each watershed, consist of a general watershed description, water quality goals, major concerns, issues and management strategies. This year the cycle begins again with planning and data collection.

More details may be found on the WPC home page http://www.tdec.net/wpc/watershed/.

C. Types of Monitoring

The Division of Water Pollution Control has developed a monitoring strategy based on the desire to collect data for various program needs. Biological, chemical, bacteriological, and physical data are collected to supply information for the activities listed below. Additional information concerning the division's monitoring strategy can be found in *Quality Assurance Project Plan (QAPP) for 106 Monitoring in the Division of Water Pollution Control* (2006). This document is posted on the department's webpage.

1. Watershed Monitoring

Consistent with the division's watershed approach, as many additional stations as possible are monitored in order to collect information on waterbody segments that have not previously been assessed. If possible, sampling locations are located near the mouth of each tributary. Minimally, macroinvertebrate biorecons, habitat assessments, and field measurements of DO, conductivity, pH, and temperature are conducted at these sites.

If impairment is observed, and time and priorities allow, additional sites are located upstream of the impaired water reach to define the impairment length. Chemical samples are collected as needed to determine potential pollutant causes. Bacteriological samples are collected to determine recreational use support.

2. 303(d) Monitoring

During each watershed cycle, at least one station in every waterbody segment included on the 303(d) List within the targeted watersheds is monitored. Minimally, 303(d) stations are sampled three times for the pollutants for which they are included on the 303(d) list and a macroinvertebrate biological sample is collected. Additional monitoring is required if water quality appears to have improved.

3. Long Term Trend Station Monitoring

Approximately 60 long-term trend stations are monitored quarterly for chemical and bacteriological quality. These data are used to check for changes in water quality over time.

4. Antidegradation Monitoring

Before activities that degrade water quality can be authorized, a stream's proper status under the antidegradation policy must be determined. The division uses a standardized evaluation procedure for this purpose. These activities are difficult to plan , because waterbodies are evaluated as needed - generally in response to requests for new or expanded NPDES and Aquatic Resource Alteration Permit (ARAP) permits.

The type monitoring utilized for this purpose is the more intensive biological survey since the biological integrity of a stream is an important consideration.

5. Ecoregional Reference Stream Monitoring

Established reference stations are monitored in conjunction with the watershed cycle. Each station is sampled quarterly for chemistry and pathogens as well as in the spring and fall for macroinvertebrates. Both semi-quantitative single habitat and biorecon samples are collected in the spring and fall to provide data to establish biocriteria and biorecon guidelines. If watershed screening results indicate a potential new reference site, more intensive reference stream monitoring protocols are used at that station to evaluate potential inclusion in the reference database.

6. Permit Compliance/Complaint Investigation

Monitoring is undertaken each year to insure that facilities or other entities are in compliance with permit conditions. These monitoring efforts typically have one of the following designs:

- Above/Below Surveys – Samples are collected above and below an activity to determine the immediate effect the activity is having on the stream.

- Trend Determination – Samples are collected over time downstream of an activity to document whether conditions are getting better or worse.

- Reference Approach - Data collected below an activity are compared to a suitable reference stream. This technique is particularly helpful when the activity is in a headwater reach or where the stream is also impacted upstream of the activity.

Additionally, the department receives numerous water quality complaints each year from citizens. These are handled as a priority activity and any data collected at these streams can be used to assess the waterbody.

D. Water Quality Data

1. Data Sources

The division used all reliable data that were readily available for the assessment of Tennessee's waterways. This included data from TDEC, other state and federal agencies, universities, citizens, and the private sector (Table 4). In November 2005, the division issued a public notice requesting water quality data for use in the statewide water quality assessment. Additionally, the national water quality storage and retrieval (STORET) database was queried for other recent information, including data collected by other state agencies at stations near the state line. State and federal agencies were contacted directly to request any information not available on STORET.

Agency information regarding Tennessee's water quality was received from TVA, USGS, OSM, TWRA, and USACE. Biological data submitted by NPDES dischargers as part of permit requirements were also used.

In addition to agency data, universities and watershed groups also supplied data. All submitted data were considered in the assessment process. If data reliability could not be established, submitted data were used to screen waters for future studies. In situations where data from the division and another source did not agree, more weight was given to the division's data unless the other data were significantly more recent.

Table 4: Data Submitted to the Division for Consideration in the 2006 Assessment Process

Agency	Physical Data	Biological Data	Chemical Data	Bact. Data
US Army Corp of Engineers		X	X	
US Office of Surface Mining	X		X	
Tennessee Valley Authority	X	X	X	X
US Geological Survey	X	X	X	X
Tennessee Wildlife Resources Agency	X	X		
Phase II MS4 permittees	X	X	X	X
NPDES permittees	X	X	X	X
Universities	X	X	X	X

2. Data Quality Objectives

To assure the highest confidence in the assessment results, all data must be of reliable quality. As part of this goal, a *Quality Assurance Project Plan for 106 Monitoring* has been compiled by the division. This document defines monitoring, analyses, quality control, and assessment procedures.

In order to specify collection techniques within the state, standard procedures have been developed for collection of water quality samples. The procedures also identify appropriate quality control measures. The *QSSOP for Macroinvertebrate Stream Surveys* (TDEC, 2003) was first published in March of 2002 and revised in November 2003. The *QSSOP for Chemical and Bacteriological Sampling of Surface Waters* (TDEC, 2004) was published in March 2004. Both documents are reviewed annually and revised as needed. Staff are trained annually on proper collection techniques.

3. Data Management

The division has several tools that have increased the efficiency, accuracy, and accessibility of assessments. Software programs, combined with increased computer capabilities have greatly expanded the ability to organize, store, and retrieve water quality monitoring and assessment information. These improvements have helped not only with the organization of large quantities of information, but also analysis of specific waterbodies.

a. STORET

Due to the large amount of data collected in monitoring activities, it was paramount that the division utilize an electronic database to store and easily retrieve data for analyses and assessment. In the early 1990s, EPA developed the national water quality STOrage and RETrieval database called **STORET**. This recently updated database allows for easy access to bacteriological and chemical information collected throughout the state and nation. TDEC WPC station locations and chemical and bacteriological data are uploaded into the database quarterly. Both current and historical TDEC water quality data are available on STORET at http://www.epa.gov/STORET.

Historical data from the early 1970s through 1999 are stored in the STORET Legacy Data Center. Data uploaded since 1999 are stored in the Modernized STORET database. Both of these databases are accessed through the STORET logo on the first page of the EPA website. Under the heading is a link to an ABOUT STORET webpage, which provides instructions on downloading data from these databases. Data can be retrieved by station name, county, watershed code, or organization name.

b. Water Quality Database

Tennessee's Water Quality Database (WQDB) has been designed as an interim storage database for water quality data prior to upload to STORET. Additionally, other types of data including macroinvertebrate,, habitat, periphyton, and other data are also stored in this database. This database is updated and made available to WPC employees quarterly.

c. Assessment Database

The **Assessment Database (ADB**) used by the division was developed by EPA to store assessment information on streams, rivers, and reservoirs. A revised third version of the ADB was used to assist in the assessments included in this report. The ADB allows for specific analysis of small stream segments, as well as overall assessments of total watersheds. Comments place in this database are critical to the later understanding of the basis for assessments.

All waters are assigned a unique identification number called a waterbody ID. Unique identification numbers are assigned to each segment using the National Hydrology Database (NHD) and the Assessment Database (ADB). All waterbody IDs begin with Tennessee's abbreviation (TN). The next 8-digits represent the numerical Hydrological Unit Code (HUC) assigned to each watershed by the U.S. Geological Survey (USGS). The next 3-digits represent a specific reach or subdivision of the waterbody. The final 4-digits specify a unique segment number. The resulting 15-digit waterbody ID is a unique identification number specific to a precise portion of a waterbody.

d. Geographic Information Systems

The ADB system is linked to the division's **Geographic Information System (GIS)**. The combination of these technologies allow for easy access to information on specific waterbodies by locating them on GIS maps.

e. Reach Indexing Tool and National Hydrography Dataset

EPA also developed the **Reach Indexing Tool (RIT)** and **National Hydrography Dataset (NHD)**. These software are linked to the ADB and GIS allowing quick georeferencing of assessment information. RIT and NHD can produce maps with specific waterbody information.

f. Online Water Quality Assessment

An interactive map called Tennessee's Online Water Quality Assessment that links the ADB and GIS through the RIT is available on the division's home page at: http://www.tdec.net/water.php.

This site is an interactive map that allows the user to select a specific waterbody and read the available water quality assessment information. To use the website, it is helpful to be familiar with the toolbar used to navigate the map. On the first page of the website, there is a help file available for first time users that explains how to use the toolbar. Upon entering the Tennessee Streams Assessment Website, a county map of Tennessee will be displayed. By zooming in closely to the selected area of the state, waterbody and road details will be made available. Once the selected waterbody is located, the reviewer can make the stream assessment layer active to view stream or river assessments or make the lake assessment layer active to view lake or reservoir information.

E. Water Quality Assessment Methodology

Water quality assessments are completed by comparing water quality data to the appropriate criteria to determine if waters are supportive of designated uses. To facilitate this process, several provisions have been made:

- Criteria have been refined to help evaluate data. The ecoregion project has dramatically reduced the uncertainty associated with the application of statewide narrative and numerical criteria. Guidance documents have been developed to assist in the interpretation of biological, nutrient, and habitat data.

- Critical periods have been determined for various criteria. Certain collection seasons and types of data have proven more important for the protection of specific water uses. For instance, the critical period for parameters like toxic metals or organics is the low flow season of late summer and early fall. Likewise, most water contact, like swimming and wading, occurs in the summer. Therefore, that is the season when pathogen results are considered most significant.

- To make defensible assessments, data quality objectives have been set. For some parameters, a minimum number of observations are needed to assure confidence in the accuracy of the assessment.

- Provisions in the water quality criteria instruct staff to determine whether violations are caused by man-induced or natural conditions. Natural conditions are not considered pollution.

- The magnitude, frequency, and duration of violations are considered in the assessment process.

- Streams in some ecoregions naturally go dry or historically have only subsurface flow during prolonged periods of low flow. Evaluations of biological integrity attempt to differentiate whether waters have been recently dry or have been affected by man-induced conditions.

- Ecoregion reference sites are re-evaluated and statistically tested annually. New sites are added whenever possible. Existing sites are dropped if data show the water quality has degraded, the site is not typical of the region, or does not reflect the best attainable conditions. Data from bordering states that share the same ecoregions are used to test suitability of reference sites and augment the dataset. Currently the state is reviewing river, lake and reservoir data to identify reference conditions in these systems.

1. Application Methodology for Specific Criteria

There are two types of criteria: numeric and narrative. Both types offer different challenges when applied to monitoring data. Numeric criteria have the advantage of providing a specific level that should not be exceeded. However, the number of exceedances required for a stream to be considered impaired is open for interpretation. As an additional complication, the regulation instructs staff to consider the frequency, magnitude, and duration of numeric criteria violations and to determine whether the appearance of pollution might be due to natural causes.

Narrative criteria are written descriptions of water quality. These descriptions generally state that the waters should be "free from" particular types or effects of pollution. The division's long standing position is that narrative criteria should have a regional basis for interpretation. To help provide regional information for narrative criteria, guidance documents based on reference stream data have been developed for biological integrity (Arnwine and Denton, 2001), habitat (Arnwine and Denton, 2001), and nutrients (Denton et al., 2001).

a. Toxic Substances (Numeric)

- Metals data are appropriately "translated" according to the water quality standards before comparison to criteria. For example, toxicity of metals can be altered by the waterbody's hardness and the amount of total suspended solids in the water. Widely accepted methodologies are used to translate toxicity data.

- If more than ten percent of the observations of a specific metal is above chronic criteria, the stream is assessed as impaired by that metal.

b. Pathogen Criteria (Numeric)

- Waterbodies are not assessed as impaired due to high bacteria levels with less than four water samples. The only waters assessed with one or two observations are waterbodies previously listed due to elevated bacteria levels or streams with obviously gross conditions, such as failing animal waste lagoons.

- *E. coli* since this group is generally considered more reflective of true risk than are fecal coliform data.

- If flow data are available, low flow, dry season data are considered more meaningful than high flow, wet season data. In the absence of flow data, samples collected in late summer and fall are considered low flow or dry season samples. It is important to note that wet season pathogen samples are not disregarded.

c. Dissolved Oxygen (Numeric)

- TDEC's SOP for chemical monitoring calls for dissolved oxygen levels to be measured in flowing water. Data collected at extreme low flows must be interpreted with caution as any violations may be due to natural stagnation rather than pollution.

- If the source of the low DO is a natural condition such as ground water, spring, or wetland, then the low DO is considered a natural condition and not pollution.

d. Nutrient Criteria (Narrative)

- The only designated uses that have nutrient criteria are fish and aquatic life and recreation. A regional guidance document that provides a regional nutrient criteria translator has been developed for fish and aquatic life use support. A specific nutrient response criterion based on chlorophyll *a* has been proposed for Pickwick Lake.

- Regional nutrient goals (Denton et al., 2001) were used as guidance during this assessment cycle.

- Waters are not assessed as impaired by nutrients unless biological or aesthetic impacts are also documented.

- At least four nutrient observations are needed for a valid assessment, unless biological impairment is also observed. For example, if the biology of a stream is very poor and the amount of algae present indicates organic enrichment, then fewer than four nutrient samples could be used to identify a suspected cause of pollution.

e. Turbidity/Suspended Solids Criteria (Narrative)

- Historically, silt has been one of the primary pollutants in Tennessee waterways. The division has experimented with multiple ways to determine if a stream, river, or reservoir is impaired due to silt. These methods include visual observations, chemical analysis (total suspended solids), and macroinvertebrate/ habitat surveys. The most satisfactory method for identification of impairment due to silt has been biological surveys that include habitat assessments.

- Ecoregions vary in the amount of silt that can be tolerated before aquatic life is impaired. Through work at reference streams, staff found that the appearance of sediment/silt in the water is often, but not always, associated with loss of biological integrity. Thus, for water quality assessment purposes, it is important to establish whether or not aquatic life is being impaired. For those streams where loss of biological integrity can be documented, the habitat assessment can determine if this loss is due to excessive silt deposits.

f. Biological Integrity Criteria (Narrative)

- Biological integrity criteria are designed to protect fish and aquatic life.

- Biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing use support. Two standardized biological methods, biorecons and semi-quantitative samples, are used to produce a biological index score. These methods are described in *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys* (TDEC, 2003) and are referenced in the water quality standards.

- The most commonly utilized biological survey method is the biorecon. Biological scores are compared to the metric values obtained in ecoregion reference streams. The principal metrics used are the total macroinvertebrate families (or genera), the number of families (or genera) of mayflies, stoneflies, and caddisflies (EPT), and the number of pollution intolerant families (or genera) found in a stream. The biorecon index is scored on a scale from 1 – 15. A score less than 5 is regarded as very poor. A score over 10 is considered good.

Kim Sparks and Debbie Arnwine (WPC) collect a semi-quantitative single habitat sample. Photo provided by Planning and Standards (PAS) section of WPC.

- If a more definitive assessment is needed, a single habitat, semi-quantitative sample is collected. Organisms are identified to genus, and an index based on seven biological metrics is used for comparison to reference streams. Streams are considered impaired if the biological integrity falls below the expected range of conditions found at reference streams.

- If both biorecon and single habitat semi-quantitative data are available and the results do not agree, more weight is given to the single habitat semi-quantitative samples. If data from the division and another agency do not agree, more weight is given to the state's data unless the other agency's data are considerably more recent.

- To be comparable to ecoregions guidance, streams must be the same size (order) and drainage as the reference streams in the ecoregion and must have at least 80 percent of the upstream drainage within that ecoregion.

g. pH (Numeric)

- The pH criterion for wadeable streams is 6.0 - 9.0. For nonwadeable rivers, streams, reservoirs, and wetlands, pH criteria is 6.5 – 9.0.

- A complicating factor is that increased acidity causes some metals to become more toxic. In many waterbodies assessed as impaired by acidity, it is difficult to discern whether the harm was caused by the reduced pH or the resulting metal toxicity, especially in areas with historical or active mining present.

h. Habitat Data (Narrative)

- Division staff use a standardized scoring system developed by EPA to rate the habitat in a stream (Barbour, et. al., 1999). The *QSSOP for Macroinvertebrate Stream Surveys* (TDEC, 2003) provides guidance for completing a habitat assessment and how to evaluate the results.

- Habitat scores calculated by division biologists are compared to the ecoregion reference stream database. Streams with habitat scores less than 75 percent of the median reference score for the ecoregion are considered impaired, unless biological integrity meets expectations. If biological integrity meets ecoregional expectations, then poor habitat is not considered an impairment.

- Guidance on interpretation of the narrative habitat criterion has been developed and was used during this assessment cycle (Arnwine and Denton, 2001). The habitat goals are referenced in the 2004 General Water Quality Criteria, (TDEC-WQCB, 2004).

2. Assessment Rates for 2006

The division maintains a statewide monitoring system of approximately 5,700 stations. In addition, new stations are created every year to increase the number of assessed waterbodies. Over 700 stations were monitored in Group 3 watersheds in 2004. Another 700 stations were monitored in Group 5 in 2005.

Chapter 3 of this report summarizes water quality in Tennessee's streams, rivers, reservoirs, and lakes. In order to determine use support, it must be decided if the waterbody meets the most protective water quality criterion for its assigned uses. Generally, the most stringent criteria are associated with recreational use and support of fish and aquatic life.

> Waterbodies were assessed using current (less than five years old) data, including biological and chemical results, field observations, and any other available information.

With available resources, it is not possible to monitor all of Tennessee's waterbodies during the two year window covered by this report. A strategy based on watershed cycles has been designed and implemented to systematically sample and monitor as many waterbodies as possible. Some waterbodies are difficult to access or are very small. Other streams have intermittent flows. During periods of low flow, some of these streams go dry or flow under ground.

For this report, about half (30,252 miles) of the stream miles (Figure 3) and almost all (531,042 acres) of the reservoir and lake acres (Figure 4) in the state were monitored and assessed. Fifty percent (30,255 miles) of Tennessee's streams and rivers were not assessed during this cycle. However, it should be noted that most of the larger rivers and streams have been assessed. Only one percent (7,215 acres) of Tennessee's reservoir and lake acres were not assessed during this cycle.

The division continues to increase its reliance on rapid biological assessments. These assessments provide a quick and accurate evaluation of the general water quality and aquatic life use support in a stream or wadeable river. However, biological assessments do not provide information to pinpoint specific toxic pollutants or bacterial levels in water. The challenge in the next few years will be to combine biological assessments with chemical and bacteriological data so that use support status, plus accurate cause and source information, can be generated.

3. Data Application – Categorization of Use Support

Waterbodies are assessed by comparing monitored water conditions to water quality standards for the stream, river, or reservoir's designated uses. Data that meet state quality control standards and collection techniques are used to generate assessments. After use support is determined, waterbodies are placed in one of the following five categories recommended by EPA. A description of categories appears below.

Use Support Categories

Category 1 waters are **fully supporting** of all designated uses. These streams, rivers, and reservoirs have been monitored and meet the most stringent water quality criteria for all designated uses for which they are classified. The biological integrity of Category 1 waters is comparable with reference streams in the same subecoregion and pathogen concentrations are at acceptable levels.

Category 2 waters are **fully supporting** of some designated uses, but have not been assessed for all uses. In many cases, these waterbodies have been monitored and are fully supporting of fish and aquatic life, but have not been assessed for recreational use.

Category 3 waters are **not assessed** due to insufficient or outdated data.

Category 4 waters are **impaired**, but a TMDL is not required. Category 4 has been further subdivided into three subcategories.

Category 4a impaired waters that have already had all necessary TMDLs approved by EPA.

Category 4b impaired waters do not require TMDL development since "other pollution control requirements required by local, State or Federal authority are expected to address all water-quality pollutants" (EPA, 2003). An example of a 4b stream might be where a discharge point will be moved in the near future to another waterbody with more assimilative capacity.

Category 4c impaired waters in which the impacts are not caused by a pollutant (e.g., certain habitat or flow alterations).

Category 5 waters have been monitored and found to not meet one or more water quality standards. These waters have been identified as **not supporting** their designated uses. Category 5 waterbodies are moderately to highly impaired by pollution and need to have TMDLs developed for the known impairments. These waters are included in the 303(d) List of impaired waters in Tennessee.

The current 303(d) List may be viewed at

http://www.tdec.net/wpc/.

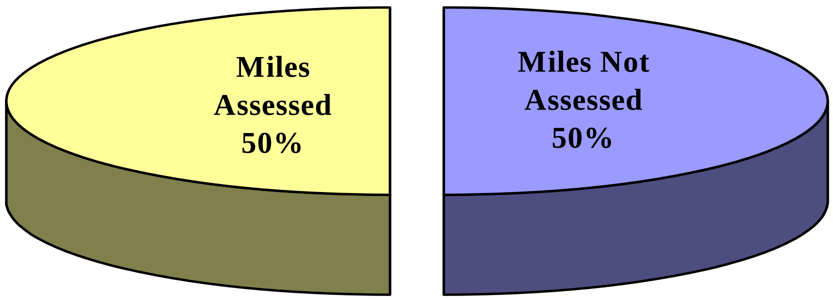


Figure 3: Percent of River and Stream Miles Monitored

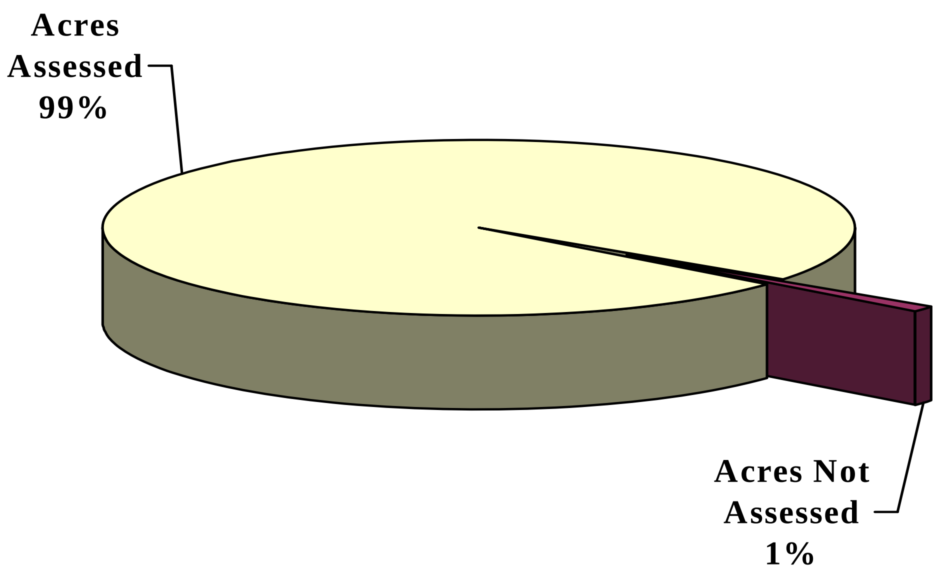


Figure 4: Percent of Reservoir and Lake Acres Monitored

Chapter 2
Water Quality Standards Attainment Status

Consistent with the rotating watershed approach, the 10 watersheds in Group 3 have been assessed for chemical, bacteriological, and biological parameters since the last 305(b) report was published in 2004. However, the 14 watersheds in Group 4 have only been assessed for chemical and bacteriological parameters, due to the volume of biological samples awaiting processing. These will be included in the 2008 report. The assessment process considers existing water quality data to place each waterbody into one of the five categories.

A. Streams and Rivers

According to EPA's National Hydrography Dataset (NHD), there are 60,507 miles of streams and rivers in Tennessee. Using recent and available data, the division was able to assess half (30,252 miles) of the stream miles in the state (Table 5 and Figure 5). Of the assessed streams, 64 percent are fully supporting of the designated uses for which they have been assessed.

1. 7,600 of the total stream miles (13%) are **Category 1**, fully supporting all designated uses.

2. 11,496 of the total stream miles (19%) are **Category 2**, which is fully supporting of some uses, but not assessed for others. Many of these streams and rivers have been assessed as fully supporting of fish and aquatic life, but have not been assessed for recreational uses.

3. 30,255 of the total stream miles (50%) are in **Category 3**. These waters have insufficient data to determine if classified uses are met.

4. 1,798 of the total stream miles (3%) have been identified as **Category 4,** impaired but TMDLs are not needed. 1,757 stream miles (3%) are **Category 4a**, which have had TMDLs for all impairments approved by EPA. 41 stream miles (0.1%) are **Category 4c** where it has been determined that the source of impairment is not a pollutant.

Table 5: Assessed Stream Miles

Category Assessment	**Miles**
Total Miles	60,507
Total Assessed Miles	30,252
Category 1	7,600
Category 2	11,496
Category 3	30,255
Category 4a	1,757
Category 4c	41
Category 5	9,358

5. 9,358 of the total stream miles (15%) are in **Category 5**, waters that are impaired or threatened and need TMDLs for the identified pollutants. These waters are placed on the 303(d) List.

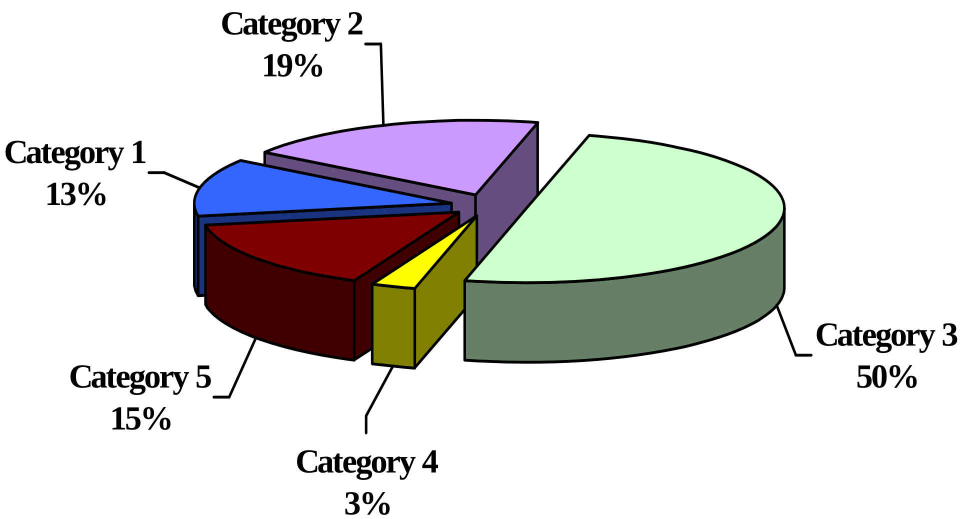


Figure 5: Percent of Rivers and Streams in Each Category

About 36 percent of the stream miles assessed for recreational use failed to meet the criteria assigned to that use. Over 30 percent of the assessed stream miles failed to meet fish and aquatic life criteria. Most or all waters classified for domestic water supply, irrigation, navigation, and industrial water supply uses were found to be fully supporting (Table 6 and Figure 6).

Table 6: Individual Classified Use Support for Rivers and Streams

Designated Uses	Miles Of Streams Classified	Classified Miles Assessed	Miles Meeting Use	Percentage Of Assessed Miles Meeting Use*
Fish and Aquatic Life Protection	60,507	29,471	20,511	70%
Recreation	60,507	15,282	9,868	64%
Irrigation	60,507	30,097	30,097	100%
Livestock Watering and Wildlife	60,507	30,051	30,048	100%
Domestic Water Supply	3,766	3,463	3,438	99%
Navigation	844	844	844	100%
Industrial Water Supply	3,507	3,326	3,326	100%

*Note- All waters are classified for more than one use, but may or may not have all uses fully supporting. Thus, this table cannot be used to derive percentages for overall use support in Tennessee. In addition, assessment rates for individual uses may not match overall use assessment rates.

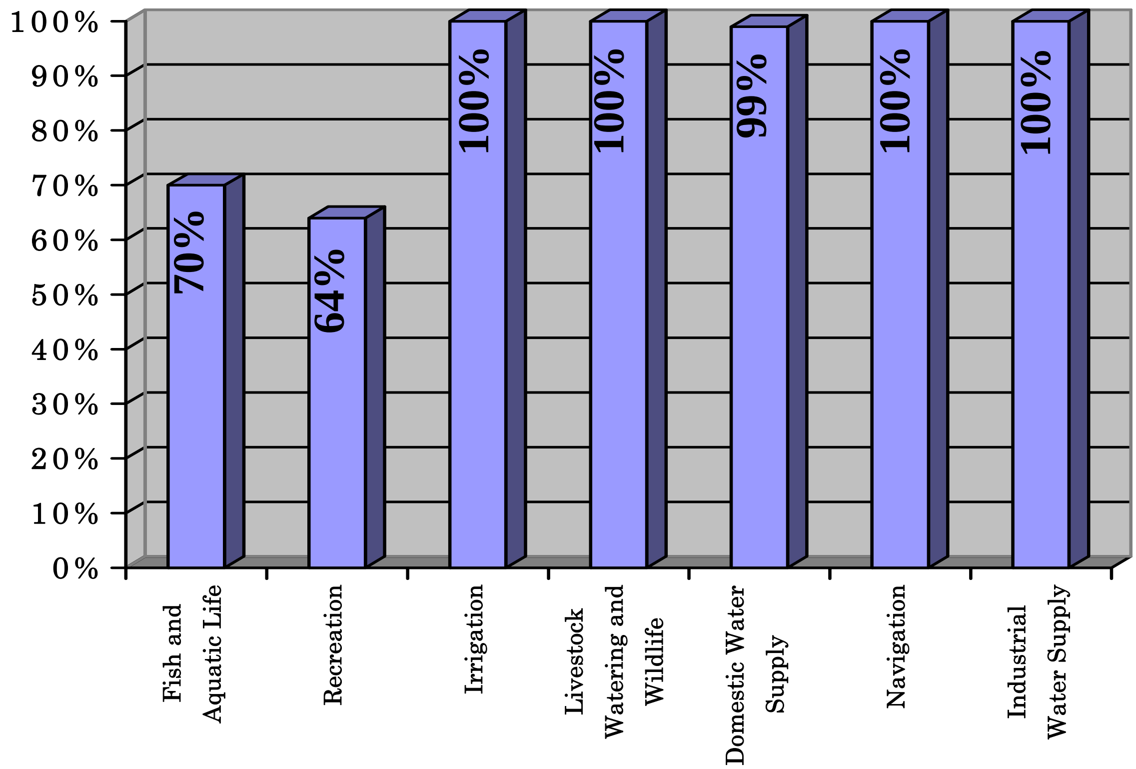


Figure 6: Percent Use Support for Individual Classified Uses in Assessed Rivers and Streams

B. Reservoirs and Reelfoot Lake

Overall Use Support

Table 7: Assessed Reservoir and Lake Acres

Category Assessment	Support Assessment
Total Acres	538,257
Total Assessed Acres	531,042
Category 1	414,509
Category 2	2,194
Category 3	7,215
Category 4	0
Category 5	114,339

Tennessee has over 90 publicly owned reservoirs or lakes with a total size of 538,000 lake acres (Table 7). For the purpose of this report, a public reservoir or lake is a publicly accessible reservoir or lake larger than five acres.

Most lakes in Tennessee are reservoirs that were created by the impoundment of a stream or river. One exception is Reelfoot Lake, thought to have been formed by a series of earthquakes in 1811 and 1812. For the purposes of this report, the generic term "lake acre" refers to both reservoirs and lakes.

By using available data, the Division of Water Pollution Control was able to assess 531,042 lake acres. This means that 98.6 percent of the lake acres in Tennessee have been assessed. Of the assessed lake acres, 78 percent are fully supporting of the designated uses for which they have been assessed. All reservoir acres were placed into one of five use categories. The majority of lake acres were assessed as Category 1 (Figure 7).

1. 414,509 of the total lake acres (77%) are Category 1, fully supporting of all designated uses.

2. 2,194 of the total lake acres (< 1%) are Category 2, fully supporting of some uses, but without sufficient data to determine if other uses are being meet.

3. 7,215 of the total lake acres (1%) are placed in Category 3, not assessed, due to insufficient data to determine if uses are being meet.

4. No lake acres are assessed as Category 4. (All the TMDLs approved by EPA thus far in Tennessee have been for rivers or streams.)

5. 114,339 of the total lake acres (21%) are assessed as Category 5, impaired for one or more uses and needing a TMDL. These reservoirs and lakes are placed on the 303(d) List of impaired waters in Tennessee.

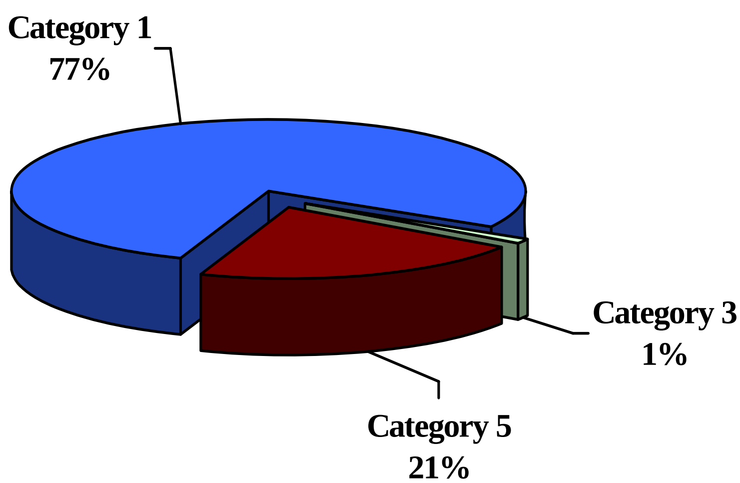


Figure 7: Percent of Reservoir and Lake Acres in Each Category (Category 2 has less than 1 percent)

Support of Individual Uses

Like streams and rivers, the two most common use designations not supported in lakes are fish and aquatic life and recreation (Table 8). Recreation was the classified use most frequently not maintained. More than 81 percent of the reservoir/lake acres support recreational uses. Over 96 percent of the reservoir/lake acres support fish and aquatic life uses. All other designated uses were fully supporting for all assessed acres (Figure 8).

Table 8: Individual Classified Use Support for Reservoirs and Lakes

Designated Uses	Acres Classified	Classified Acres Assessed	Acres Meeting Use	Percentage of Assessed Acres Meeting Use*
Fish and Aquatic Life Protection	538,257	531,042	510,835	96%
Recreation	538257	530,347	429,826	81%
Irrigation	538,257	531,042	531,042	100%
Livestock Watering and Wildlife	538,257	528,933	528,933	100%
Domestic Water Supply	506,917	505,622	505622	100%
Navigation	260,664	260,664	260,664	100%
Industrial Water Supply	431,420	431,405	431,405	100%

*Note: Reservoirs are classified for more than one use, but may or may not have all uses fully supporting. Thus, this table cannot be used to derive percentages for overall use support in Tennessee. Also, assessment rates for individual uses may not match overall use assessment rates.

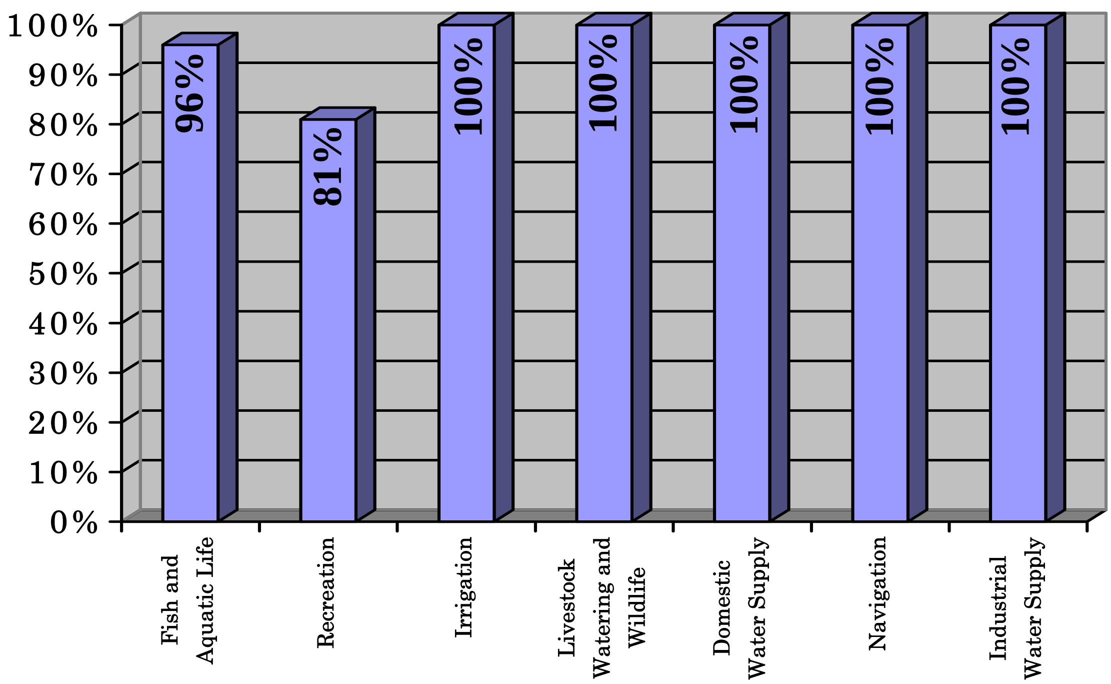


Figure 8: Percent Use Support for Individual Uses in Assessed Reservoirs and Lakes

C. Water Quality in Wetlands

Wetlands are some of Tennessee's most valuable natural resources. Wetlands serve as buffer zones along rivers, help filter pollutants from surface runoff, store floodwaters during times of high flows, provide spawning areas for fish, and provide habitat for specialized plant and wildlife species.

Over the last century, Tennessee has lost hundreds of thousands of wetland acres. This loss represents over 60 percent of Tennessee's wetlands. Today, approximately 787,000 acres of wetlands remain in Tennessee.

Tennessee Wetland Facts

Estimated Number of
Historical Wetland Acres…..1,937,000

Estimated Number of
Existing Wetland Acres………787,000

Percentage of Historical
Acres Lost …………………60%

Number of Existing Wetland
Acres Considered Impaired
by Pollution and/or Loss
of Hydrologic Function………..54,811

The largest single cause of impact to existing wetlands in Tennessee is loss of hydrologic function due to channelization and leveeing. These changes to wetlands were done initially to prevent flooding. Unfortunately, instead of preventing flooding, it merely diverts water downstream.

Another significant impact in wetlands is silt. Siltation is the movement of soil from the surrounding land into a waterway. Sources of silt include runoff from farms or construction projects like roads, shopping centers, and golf courses. Proper soil conservation practices at these sites are critical to prevent further siltation. While land development contributes most of the pollution, a few wetlands have been contaminated by historical industrial activities. Several of these wetlands are now Superfund sites.

Tennessee's Wetlands Conservation Strategy was first published in 1989, in cooperation with state and federal agencies, to plan for the protection and restoration of wetlands. Tennessee was one of the first states in the nation to have a protection strategy and has been recognized by EPA as establishing a national model for wetlands planning. To view the strategy, visit the web site at http://www.tdec.net/.

Tennessee has sought to stop the decline in wetlands through the implementation of a "no net loss" policy. This policy includes purchasing wetlands, establishing mitigation banks, and the issuance of permits.

The division has identified 54,811 impaired wetland acres. Wetlands that have been altered without prior approval and have not yet been adequately restored are considered impaired. Also, sites that were not altered according to the approved plan are considered impaired. In instances where the wetland was altered, but the state received compensatory mitigation for the loss of water resources, the resource was not considered impaired.

Chapter 3
Causes of Water Pollution

Pollution is an alteration of the physical, chemical, biological, bacteriological, or radiological properties of water that results in an impairment of designated uses. To assess the causes of pollution in streams, rivers and reservoirs, the division follows the guidance provided by EPA. In order to help standardize the names of impairment causes across the country, EPA has provided a list of potential pollutants in the ADB.

A. Causes of Pollution in Streams and Rivers

Pollutants such as sediment/silt, habitat alteration, pathogens, and nutrients are the leading causes of impairment in Tennessee streams and rivers. Other frequent pollutants in streams and rivers include toxic substances, such as metals and organic pollutants. Flow alteration, pH changes, and low dissolved oxygen are other common causes of pollution (Figure 9 and Table 9).

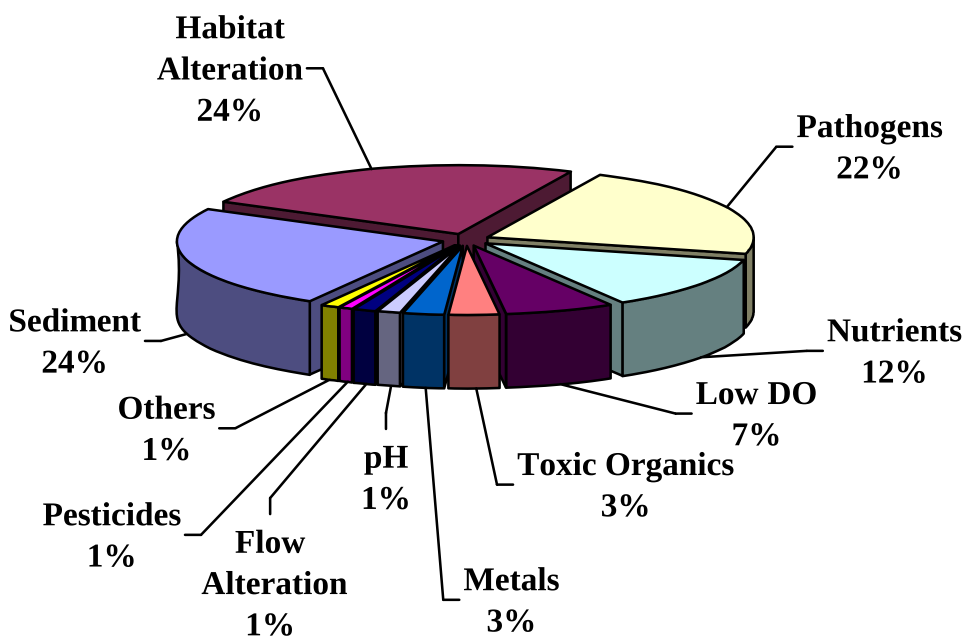


Figure 9: Relative Impacts of Pollution in Assessed Rivers and Streams (Stream Miles)

1. Sediment/Suspended Solids

The most frequently cited pollutant in Tennessee is sediment, impacting over 5,800 miles of streams and rivers. Sediment is generally associated with land disturbing activities such as agriculture and construction. Some of the significant economic impacts caused by sediment are increased water treatment costs, filling in of reservoirs, loss of navigation channels, and increased likelihood of flooding. Sediment can affect the biological, chemical, and physical properties of water.

Biological properties of waters are affected by:

- Smothering eggs and nests of fish
- Transporting other pollutants, in possibly toxic amounts, or providing a reservoir of toxic substances that may become concentrated in the food chain
- Clogging the gills of fish and other forms of aquatic life
- Covering substrate that provides habitat for aquatic insects, a main prey of fish
- Reducing biological diversity by altering habitats to favor burrowing species
- Accelerating growth of submerged aquatic plants and algae by providing more favorable substrate

Chemical properties of waters are affected by:

- Interfering with photosynthesis
- Decreasing available oxygen due to decomposition of organic matter
- Increasing nutrient levels that accelerate eutrophication in reservoirs
- Transporting organic chemicals and metals into the water column (especially if the original disturbed site was contaminated)

Physical properties of waters are affected by:

- Reducing or preventing light penetration
- Changing temperature patterns
- Decreasing the depth of pools or lakes
- Changing flow patterns

Whether calculated by volume or number of impaired stream miles, soil in the water is the largest single pollutant in Tennessee. Some bank erosion is natural. However, tons of soil are lost every year as a result of human activities.

Preventive planning in land development projects can protect streams from silt and protect valuable topsoil. Best Management Practices (BMPs) such as the installation of silt fences and maintenance of trees and undergrowth as buffer zones along creek banks can prevent soil from entering the creek. Farming practices that minimize land disturbance, such as fencing livestock out of creeks and no-till practices not only protect water quality but also prevent the loss of top soil.

2. Habitat Alteration

Types of Habitat Alterations

Habitat Alteration	**Stream Miles Impaired**
Alteration in stream-side or littoral vegetative cover…………….....	1,263
Other anthropogenic substrate alterations……………...………	499
Physical substrate habitat alterations……………..…………	3,973

Note: Streams can be impaired by more than one type of habitat alteration. These totals are not additive.

Many streams in Tennessee appear to have impaired biological communities, in the absence of obvious chemical pollutants. Often the cause is physical alteration of the stream, which results in a loss of habitat. Habitat is often removed by agricultural activities, urban development, bridge or other road construction, and /or dredging.

The division uses an EPA method to score the stream or river habitat by evaluating ten components of habitat stability (Barbour, et. al., 1999). This is a standardized way to identify and quantify impacts to stream habitat. Tennessee has developed regional guidance based on reference data to evaluate habitat (Arnwine and Denton, 2001).

A permit is required to modify a stream or river in Tennessee. The permit will not be issued unless the water resources can be protected. The Natural Resource Section of TDEC issues permits for Aquatic Resource Alteration Permits (ARAP). Additional information can be found at http://www.tdec.net/permits/arap.php.

3. Pathogens

Pathogens are disease-causing organisms such as bacteria or viruses that can pose an immediate and serious health threat if ingested. Many bacteria and viruses that can be transferred through water are capable of causing serious or even fatal diseases. The main sources for pathogens are untreated or inadequately treated human or animal fecal matter.

Indicator organisms are used for water quality criteria to test for the presence of pathogens. Historically, Tennessee used total fecal coliform counts as the indicator of risk, but has revised criteria to comply with EPA recommendation to shift to an *E. coli* - based criteria. The *E. coli* group is considered by EPA to be a better indicator of true human risk. Water quality criteria were revised to use *E.coli* as the indicator organism in January 2004. Swimming, wading, or fishing in water contaminated with these pathogens could have dangerous consequences. Currently, Tennessee has 32 streams and rivers posted with a water contact advisory due to high pathogen levels. See Chapter 5 for specific information on these streams and rivers.

4. Nutrients

Another common problem in Tennessee waterways is elevated nutrient concentrations. The main sources for nutrient enrichment are livestock, municipal wastewater systems, urban runoff, and improper application of fertilizers. Nutrients stimulate alga growth that produces oxygen during daylight hours, but uses oxygen at night, leading to significant diurnal fluctuations in oxygen levels. Elevated nutrient levels cause the aquatic life in a stream or river to shift towards groups tolerant to high nutrient levels and can lead to a reduction in biological diversity. Waters with elevated nutrients often have floating algal mats and clinging filamentous algae.

Types of Nutrients

Nutrient	**Stream Miles Impaired**
Nutrient Biological Indicators…………………	366
Phosphate……………….	1,081
Nitrate.…………………..	1,490
Ammonia (un-ionized)…	37
Phosphorus, Elemental…	18

Note: Streams can be impaired by more than one type of nutrient. These totals are not additive.

Nutrient pollution is difficult to control. Restrictions on point source dischargers alone may not solve this problem. The other major contributors to nutrient problems are agricultural activities such as over-application of fertilizers and intensive livestock grazing.

Some states have banned the use of laundry detergents containing phosphates. Therefore, most commercially available detergents do not contain phosphates. Many fertilizers for crops or lawn application contain both nitrogen and phosphorus. If fertilizers are applied in heavy concentrations, rain will carry the fertilizer into nearby waterways.

The ecoregion study has increased understanding of the natural distribution of nutrients throughout the state. Using this information, a narrative nutrient criterion has been revised to include goals identified in a document entitled *Development of Regionally-based Interpretations of Tennessee's Narrative Criteria* (Denton et al., 2001) or "other scientifically defensible methods" (TDEC-WQCB, 2004).

5. Low Dissolved Oxygen

Low levels of dissolved oxygen in water will restrict or eliminate aquatic life. Over 1,600 stream miles have been impaired by low dissolved oxygen. The water quality standard for dissolved oxygen in most non-trout streams is 5 mg/L. While some species of fish and aquatic insects can tolerate lower levels of oxygen for short periods, prolonged exposure will affect biological diversity and in extreme cases, cause massive fish kills.

Low dissolved oxygen levels are usually caused by the decay of organic material. This condition can be improved by reducing the amount of organic matter entering a stream or river. Streams and rivers that receive substantial amounts of ground water inflow, or have very sluggish flow rates, can have naturally low dissolved oxygen levels.

6. Metals

Types of Metals

Metal	**Stream Miles Impaired**
Manganese………………	153
Lead……………………..	96
Copper…………………..	60
Iron………………………	204
Mercury…………………	27
Zinc……………………...	48
Arsenic………………….	44
Chromium, Hexavalent….	4

Note: Streams can be impaired by more than one metal. These totals are not additive.

The most common metals impacting Tennessee waters include iron, copper, lead, and manganese. Occasionally, zinc, mercury, and arsenic levels can also violate water quality standards. The major concern regarding metal contamination is toxicity to fish and aquatic life, plus the danger it poses to people who come in contact with the water or eat fish from the contaminated waterbody. Additionally, the precipitation of metals in streams can affect habitat.

In particular, mercury can be a serious threat to human health due to its tendency to bioconcentrate in the food chain. East Fork Poplar Creek and North Fork Holston River are posted against fish consumption due to historical mercury contamination. This is discussed in more detail in Chapter 5.

Occasionally, metals are elevated in streams and rivers due to natural conditions. For example, elevated manganese levels in east Tennessee streams and rivers may be naturally occurring in the groundwater. However, it is relatively rare for waterbodies to violate criteria for metals simply based on natural conditions.

7. Toxic Organic Contaminants

Organic contaminants are man-made chemicals containing the element carbon. These include chemicals like PCBs, DDT, chlordane, and dioxins, which are listed by EPA as priority pollutants and classified as probable human carcinogens (cancer causing agents). In some waterbodies, these substances have accumulated in sediment and pose a health threat to those that consume fish or shellfish.

Currently, sections of seven rivers and streams are posted for dangerous levels of organic pollutants in fish tissue.

- Mississippi River (Chlordane, Dioxins)
- Loosahatchie River (Chlordane, Dioxins)
- Nonconnah Creek (Chlordane, Dioxins)
- Wolf River (Chlordane, Dioxins)
- Chattanooga Creek (PCBs, chlordane)
- East Fork Poplar Creek (PCBs)
- McKellar Lake (Chlordane, Dioxins)

Some organic pollutants in very low concentrations can pose a threat to human health. Many of these compounds have been banned from use for several decades. However, organic pollution that occurred decades ago still poses a serious threat, because these substances tend to remain in the environment for an extremely long time. This is discussed in more detail in Chapter 5.

Types of Organic Contaminants

Organic Contaminant	**Stream Miles Impaired**
Dioxin………..	256
PCBs…………	299
Creosote………	7
PAHs…………	33
RDX…………..	63
Chlordane…….	248

Note: Streams can be impaired by more than one type of organic contaminant. These totals are not additive.

Dioxins are man-made by-products of herbicide manufacturing, certain historical papermill manufacturing processes, and the incineration of chlorine-based chemicals. Dioxins are considered among the most toxic substances released into the environment. EPA has found no safe exposure level. In fact, EPA has determined that dioxins in addition to being probable human carcinogens, also cause reproductive and developmental problems.

One problem in identifying organic pollution is that water quality criteria are often below current detection levels. Detection of these substances is generally made either by analyzing fish tissue levels and/or by use of sediment screening values provided by EPA.

8. pH

Low pH, elevated alkalinity, or a significant change in the pH or acidity of the water over a relatively short period of time, can greatly impact aquatic life. A common reason for a change in pH is acidic runoff from active or abandoned mine sites. Excessive amounts of algae can cause streams and rivers to violate standards on the alkaline side, but this phenomenon more commonly occurs in lakes.

The pH level also plays an important role in the toxicity of metals, with pH levels below 5.5 generally increasing toxic effects. The statewide fish and aquatic life pH criterion for large rivers, reservoirs, and wetlands is 6.5 to 9.0. The pH criterion for wadeable streams and rivers is 6.0 – 9.0. Currently, 335 stream miles are listed as impaired by low pH, most with impaired streams in areas with historical mining activities. Disturbance of rock formations during road construction can also release acidity to streams.

9. Flow Alteration

Two hundred and seventy-five stream miles are currently assessed as impaired by flow alteration. Flow alteration is a change to the flow that leads to a loss of habitat and increase in sediment transported to downstream waters. Increased water velocities also cause extreme down-cutting of stream and river channels. Flow alterations can impair fish and aquatic life. In extreme cases, flow alterations cause stream channels to be dry.

Rivers impaired by flow alterations include:

- Obey River (Dale Hollow Reservoir)
- Caney Fork River (Center Hill Reservoir)
- Stones River (Percy Priest Reservoir)
- South Fork Holston River (Fort Patrick Henry Reservoir)
- Holston River (Cherokee Reservoir)
- French Broad (Douglas Reservoir)
- Tennessee River (Fort Loudoun Reservoir)
- Obed River (Lake Holiday)
- Hiwassee River (Appalachia Reservoir)
- Ocoee River (Ocoee 1, 2, & 3 Reservoirs)
- Elk River (Woods Reservoir and Tims Ford Reservoir)
- Duck River (Normandy Reservoir).

In 2004, the division initiated a study of wadeable streams below small to medium sized impoundments (Chapter 6). The results of this study will be available in late 2006.

Spillway on Davis Creek downstream of Westmoreland City Lake in Sumner County. Photo provided by Aquatic Biology Section of TDH Laboratories.

B. Causes of Pollution in Reservoirs and Lakes

Some of the same types of pollutants that occur in rivers and streams impact reservoirs, although to different magnitudes. The main pollutants in Tennessee reservoirs are toxic organics such as PCBs and dioxins. Other pollutants include nutrients, sediment/silt, low DO, and pesticides such as chlordane (Figure 10 and Table 9). The effects of most of these pollutants are the same as in flowing water, however, persistent substances are more likely to accumulate and remain in reservoirs for a very long time.

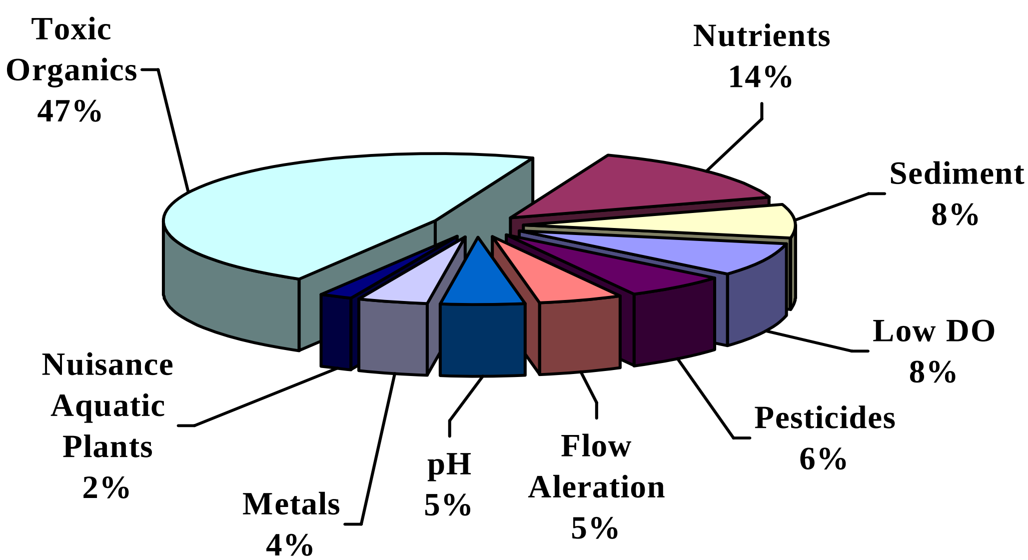


Figure 10: Relative Impacts of Pollution in Assessed Reservoir and Lake Acres

1. Organic Substances

Priority organic substances such as PCBs and dioxins are the cause of pollution in almost fifty percent of the impaired lake acres. Reservoirs serve as sediment traps and once a pollutant gets into the sediment it is very difficult to remove. These materials move through the food chain and can become concentrated in fish tissue. People eating fish from the waterbody may also concentrate these toxic substances in their bodies, which can lead to health problems.

PCBs were extensively used in the U.S. for industrial and commercial uses until they were banned in 1976. Unfortunately, over 1.5 billion pounds of PCBs were produced before the ban. It is not known how many tons ended up in waterways in Tennessee.

Types of Organic Contaminants

Organic Contaminant	Lake Acres Impaired
PCBs………….	94,928
Dioxins……….	10,370

Note: Lakes can be impaired by more than one organic substance. These totals are not additive.

Elevated levels of PCBs have been found in fish tissue collected from the following reservoirs:

- Fort Loudoun Reservoir
- Boone Reservoir
- Tellico Reservoir
- Watts Bar Reservoir
- Nickajack Reservoir
- Melton Hill Reservoir
- Woods Reservoir

Currently, 105,298 lake acres are posted for organic contamination. Chapter 5 has specific information on posted reservoirs and the health hazards of eating contaminated fish.

2. Nutrients

Nutrients

Nutrient	Lake Acres Impaired
Nutrient Biological Indicators………………..	15,641
Phosphate……….……….	15,500
Nitrate..…………………..	140

Note: Lakes can be affected by more than one nutrient. Totals are not additive.

Another major cause of impacts in reservoirs and lakes is nutrients. Reelfoot Lake is the only lake in Tennessee currently listed as impaired by nutrients. When reservoirs and lakes have elevated levels of nutrients, large amounts of algae and other aquatic plants can grow. Plants and algae produce oxygen during daylight hours. As aquatic vegetation dies and decays, oxygen can be depleted and dissolved oxygen may drop below the levels needed for fish and other aquatic life.

As reservoirs and lakes age, they go through a process called eutrophication. When this occurs naturally, it is caused by a gradual accumulation of the effects of nutrients over hundreds of years. Ultimately, eutrophication results in the filling of the lake from soil, silt, and organic matter from the watershed. Pollution from human activities can greatly accelerate this process. Eutrophication that naturally would occur over centuries can be accelerated to a few decades.

Tennessee's water quality criterion for nutrients in lakes and reservoirs is currently narrative. The assessment basis to consider lakes impaired is the level of eutrophication that interferes with the intended uses of the lake. This process is complicated by the complex nature of the public's uses for lakes and reservoirs. For example, algae production can help some species of fish thrive, benefiting sport fishermen. However, swimmers and boaters prefer clear water.

Stages of Eutrophication:

1. **Oligotrophic** lakes are young lakes with relatively low levels of nutrients and high levels of dissolved oxygen. Since these lakes have low nutrient levels, they also have little algae and aquatic vegetation.
2. **Mesotrophic** lakes have moderate amounts of nutrients, but maintain a high level of dissolved oxygen. This results in more algae and aquatic vegetation that serve as a good food source for other aquatic life yielding a high biological diversity.
3. **Eutrophic** lakes have high levels of nutrients and therefore, high amounts of algae. Often, in the summer, an algae bloom will occur which can cause the dissolved oxygen levels to drop in the lake's lower layer.
4. **Hypereutrophic** lakes have extremely high nutrient levels. The algae at this stage are so thick it can cause the lake to look like pea soup. The dissolved oxygen in the lower layer of the lake may drop to the point where fish and other aquatic life cannot survive. Lakes that are hypereutrophic do not typically support the uses for which they are designated.

3. Sediment/Suspended Solids

Sediment and silt cause significant problems in reservoirs as well as flowing water. Over 18,000 lake acres have been assessed as impaired by sediment and silt. Since reservoirs and lakes serve as sediment traps, once sediment enters a lake it tends to settle out, initially in embayment and headwater areas, but ultimately throughout the reservoir. It is difficult and expensive to remove sediment from reservoirs. Three reservoirs, Ocoee #3, Ocoee #2, and Davy Crockett, have almost filled in with sediment caused by upstream disturbances. Reelfoot Lake has also been impaired by sediment.

4. Dissolved Oxygen

The dissolved oxygen (DO) minimum water quality standard for reservoirs and lakes is 5 mg/L measured at a depth of five feet unless the lake is less than ten feet deep. If the lake is less than ten feet deep, the DO criterion is applied at mid-depth. In eutrophic reservoirs, the DO can be much lower than 5 mg/L. Even in reservoirs that have a DO of 5 mg/L at the prescribed depth, the dissolved oxygen levels can be near zero deeper in the reservoir.

The most common reason lakes and reservoirs have fish kills due to low DO is eutrophication. Overproduction of algae raises oxygen levels while the sun is shining, but on cloudy days and at night the resulting algae die-off can cause DO levels to plummet. Additionally, high levels of biomass will restrict light penetration to a few feet or even inches. Below the depth where light can penetrate, DO levels will be very low.

Lakes that are eutrophic often strongly stratify, which means that there is a layer of warm, well-oxygenated water on top of a cold, poorly oxygenated layer. Stratification limits the dissolved oxygen available to fish and other aquatic life. Currently, 17,339 lake acres are listed as impaired by low DO.

DO levels in lakes and reservoirs can also be affected by discharges from upstream dams. Water released from the bottom of the reservoir may have very low dissolved oxygen levels. This can result in very low DO levels in the receiving river, stream, or reservoir.

Low dissolved oxygen levels are a common cause for fish kills. Photo provided by Bill Hall, CKEFO.

5. Pesticides

Pesticides are designed to kill or otherwise adversely affect living organisms and can cause harm to humans, animals, and the environment. For these and other reasons, they are listed by EPA as priority pollutants. Many pesticides have been banned in the U.S. but pollution that occurred decades ago still poses a serious threat, because they tend to remain in the environment for an extremely long time. In some waterbodies, these substances have accumulated in sediment and pose a health threat to those that consume fish or shellfish. Currently, Boone Reservoir is posted for dangerous levels of chlordane in fish tissue.

6. pH

The pH of a lake or reservoir indicates the acidity or alkalinity of the water. The pH is measured on a scale of 0 to 14. A low pH (<7) indicates the water is acidic. A high pH (>7) indicates the water is alkaline. The fish and aquatic life pH criteria for lakes and reservoirs in Tennessee require that the pH not fluctuate more than 1.0 unit over a 24 hour period and that it must be within the range of 6.5 – 9.0 units. This range is relatively neutral.

The pH level also plays an important role in the toxicity of metals and organic compounds. Excessive algae can cause lakes and reservoirs to violate standards on the alkaline side. This phenomenon can be observed in the Blue Basin of Reelfoot Lake. As algae grows and dies it creates a nutrient cycle within the lake causing the water to become alkaline.

7. Flow Alteration

Natural lakes are bodies of water that gradually fill and become wetlands. Reservoirs also fill and become wetlands but much more quickly than natural lakes. Flow alteration of lakes and reservoirs can result in smaller volume of water and more shallow depth. The draining and filling of the Blue Basin of Reelfoot Lake is the primary source of this impairment.

8. Metals

Types of Metals

Metal	Lake Acres Impaired
Copper………..	2,254
Iron……………	2,254
Mercury………	2,336
Zinc…………...	2,254

Note: Reservoirs can be impaired by more than one metal. These totals are not additive.

As in rivers and streams, metals can pose a serious health threat in reservoirs and lakes. The concerns with metals contamination include the danger it poses to people who eat fish from contaminated reservoirs as well as toxicity to fish and aquatic life.

The reservoirs in Tennessee assessed as impaired by metals have been impacted by legacy activities. The copper, iron, and zinc found in the Ocoee Reservoirs are from historical mining operations. Mercury is found in the Clinch River section of Watts Bar Reservoir from legacy activities at the Department of Energy (DOE) Reservation.

Table 9: Causes Of Impairment in Assessed Rivers and Reservoirs*

Cause Category	Impaired Rivers and Stream Miles	Impaired Reservoir/Lake Acres
Flow Alteration		
Low Flow Alterations	275	11,444**
Nuisance Aquatic Species		
Non-native Aquatic Plants		4,555**
Nutrients		
Nutrient/Eutrophication Biological Indicators	366	15,641**
Phosphate	1,081	15,500**
Nitrate	1,490	140
Ammonia (un-ionized)	37	
Phosphorus, Elemental	18	
Oxygen Depletion		
Oxygen, Dissolved	1,637	17,339**
pH/Acidity/Caustic Conditions		
pH	335	10,955**
Sediment		
Sediment/Silt	5,812	18,190**
Solids (Suspended/Bedload)	15	
Pesticides		
Chlordane	248	13,685
Metals		
Manganese	153	
Lead	96	
Copper	60	2,254
Iron	204	2,254
Mercury	27	2,336
Zinc	48	2,254
Arsenic	44	
Chromium, Hexavalent	4	
Toxic Organics		
Dioxins	256	10,370
Polychlorinated Biphenyls (PCBs)	299	94,928
Creosote	7	
Polycyclic Aromatic Hydrocarbons (PAHs)	33	
RDX	63	

(Table continued on next page.)

Table 9: Causes Of Impairment in Assessed Rivers and Reservoirs* (continued)

Cause Category	Impaired Rivers and Stream Miles	Impaired Reservoir/Lake Acres
Pathogens		
Escherichia coli	5,155	994
Other		
Taste & Odor		45
Impairment Unknown	125	
Habitat Alterations		
Alteration in Stream-side or Littoral Vegetative Cover	1,263	
Other Anthropogenic Substrate Alterations	499	
Physical Substrate Habitat Alterations	3,973	
Radiation		
Cesium	5	
Radium 228	8	
Strontium	7	
Toxic Inorganics		
Chloride	22	
Chlorine	1	
Sulfates	31	
Hydrogen Sulfide	7	
Observed Effects		
Color	5	
Fish Kills	5	
Pollutant		
Odor Threshold Number	7	
Oil and Grease		
Oil and Grease	56	
Thermal		
Temperature, Water	98	
Bioassays		
Whole Effluent Toxicity (WET)	4	

*Note - Rivers and reservoirs can be impaired by more than one cause. Rivers include both river and stream miles. Data in this table should only be used to indicate relative contributions. Totals are not additive.

** The majority of impaired lake acres in these categories are in Reelfoot Lake.

Chapter 4
Sources of Water Pollution

Sources of pollutants in streams and rivers include agricultural activities, hydrologic modification (channelization, dams, and navigation dredging), municipal discharges, construction, industrial discharges, and mining activities. The major source of impairment to reservoirs is contaminated sediment from legacy pollutants. Table 10 provides a detailed break-down of the various sources of pollution in Tennessee's streams, rivers, lakes, and reservoirs.

A. Relative Sources of Impacts to Rivers and Streams

Some impacts, like point source discharges and urban runoff, are evenly distributed across the state, while others are concentrated in particular areas of the state. For instance, channelization and crop related agriculture is most widespread in west Tennessee. Dairy farming and other intensive livestock operations are concentrated in the Ridge and Valley region of east Tennessee and in southern middle Tennessee. An emerging threat in middle Tennessee is rapid commercial and residential development in Nashville and other urban areas. Mining continues to impair streams in the Cumberland Plateau and Central Appalachian regions. Figure 11 illustrates the percent contribution of pollution sources in impaired rivers and streams.

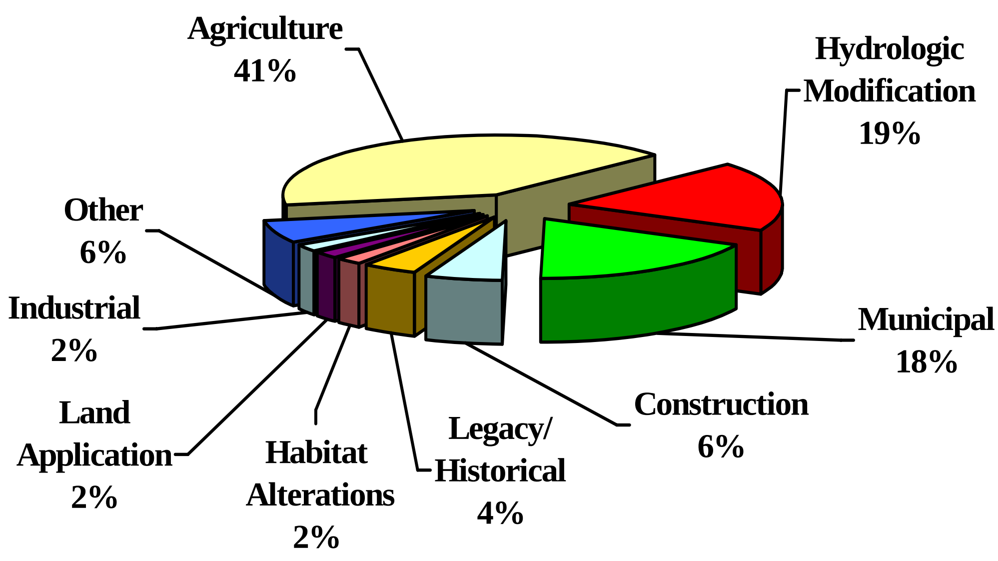


Figure 11: Percent Contribution of Pollution Sources in Impaired Rivers and Streams

Table 10: Sources of Pollutants in Assessed Rivers and Reservoirs*

Sources Category	Total Impaired River Miles	Total Impaired Reservoir Acres
Industrial Permitted Discharge		
RCRA Hazardous Waste Sites	120	
Industrial Point Source	171	3,595
Stormwater Discharge	26	
Petroleum/Natural Gas	19	
Municipal Permitted Dischargers		
Separate Storm Sewer (MS4)	1,959	1,009
Package Plants	17	
Combined Sewer Overflows	10	994
Sanitary Sewer Overflows	506	10
Urbanized (High Density Area)	322	45
Municipal Point Source	508	
Spills and Unpermitted Discharges		
Above Ground Storage Tank Leaks	0.5	
Illicit Storm Sewer Connections	4	
Other Spill Related Impacts	15	
Agriculture		
Specialty Crop Production	14	
CAFOs	22	
Unrestricted Cattle Access	272	
Managed Pasture Grazing	7	
Dairies (Outside Milk Parlor Areas)	12	
Irrigated Crop Production	9	
Grazing in Riparian or Shoreline Zones	4,632	606
Animal Feeding Operations (NPS)	207	34
Livestock (grazing or feeding)	6	
Aquaculture (permitted)	1	
Non-irrigated Crop Production	2,578	15,712**
Resource Extraction		
Surface Mining	27	
Subsurface/Hardrock	9	
Sand/Gravel/Rock	97	
Dredge Mining	27	
Coal Mining Discharge (permitted)	6	
Hydrologic Modification		
Channelization	3,003	
Dredging (Navigation Channel)	207	
Upstream Impoundment	303	2,288
Flow Regulation/Modification	17	2,905**
Dam Construction (other than flood control)	3	

(Table continued on next page.)

Table 10: Sources of Pollutants in Assessed Rivers and Reservoirs (continued)

Sources Category	Total Impaired River Miles	Total Impaired Reservoir Acres
Legacy/Historical		
Contaminated Sediment	334	97,182
CERCLA NPL (Superfund)	30	
Abandoned Mine Lands (Inactive)	384	2,254
Internal Nutrient Cycling		15,500**
Mill Tailings	33	2,254
Mine Tailings	33	2,254
Silviculture		
Forest Roads (construction and use)	2	
Harvesting	16	
Land Application/Waste Sites		
On-site treatment systems (septic systems and similar)	250	4
Land Application of Wastewater Biosolids (Non-agricultural)	3	
Landfills	46	
Leaking Underground Storage Tanks	9	
Construction		
Site Clearance	973	10,965**
Hwys. /Roads/Bridges, Infrastructure (new)	94	
Habitat Alterations (Not directly related to hydromodification)		
Stream Bank Modification/ Destabilization	113	
Loss of Riparian Habitat	180	
Drainage/Filling/Wetland Loss		10,950**
Channel Erosion/Incision from Upstream Modification	25	
Golf Courses	0.5	
Other Sources		
Sources Outside State Jurisdiction or Borders	367	383
Military Base (NPS)	32	
Sources Unknown	812	

*Rivers and reservoirs can be impaired by more than one source of pollutants. Data in this table should only be used to indicate relative contributions. Totals are not additive.

** Majority of impairment sources in these categories are in Reelfoot Lake.

1. Agriculture

Almost half of the land in Tennessee is used for agriculture. These activities contribute to approximately 41 percent of the impaired stream miles in the state. In west Tennessee, tons of soil are lost annually due to erosion from crop production (mostly cotton and soybean). Pesticide and fertilizer runoff is another significant source of pollution in this area. In middle Tennessee, cattle grazing and hog farms are the major agricultural activity and result in bank erosion and elevated bacteria and nutrient levels. In east Tennessee, runoff from feedlots and dairy farms greatly impact some waterbodies. Figure 12 illustrates the relative percentage of the primary agricultural impairment sources.

Sources of Agricultural Impairment

Agricultural Source	**Stream Miles Impaired**
Grazing in Riparian Zone……...	4,632
Non-irrigated Crop Production	2,578
Unrestricted Cattle Access…….	272
Animal Feeding Operations…...	210
CAFOs………………………...	22
Specialty Crop Production…….	14
Dairies (Outside Milk Parlor Areas)…………………………	12
Irrigated Crop Production……..	9
Managed Pasture Grazing……..	7
Livestock (grazing or feeding)...	6
Aquaculture (permitted)……….	1

Note: Pollutants in streams can come from more than one source. These totals are not additive.

The Tennessee Water Quality Control Act does not give the division authority to regulate water runoff originating from normal agricultural activities such as plowing fields, tending animals and crops, and cutting trees. However, agricultural activities that may result in significant point source pollution, such as animal waste system discharges from concentrated livestock operations are regulated.

Tennessee has made great strides in recent years to prevent agricultural and forestry impacts. Educational and cost-sharing projects promoted by the Department of Agriculture, Natural Resource Conservation Service (NRCS) and University of Tennessee Agricultural Extension Service have helped farmers install Best Management Practices (BMP's) all over the state. Farmers have voluntarily helped to decrease erosion rates and protect streams and rivers by increasing riparian habitat zones and setting aside conservation reserves.

The division has a memorandum of understanding with the Tennessee Department of Agriculture (TDA). Under this agreement, the division and TDA will continue to jointly resolve complaints about water pollution from agricultural activities. When a problem is found or a complaint has been filed, TDA has the lead responsibility to contact the farmer or logger. Technical assistance is offered to correct the problem. TDEC and TDA coordinate on water quality monitoring, assessment, 303(d) list development, TMDL generation, and control strategy implementation.

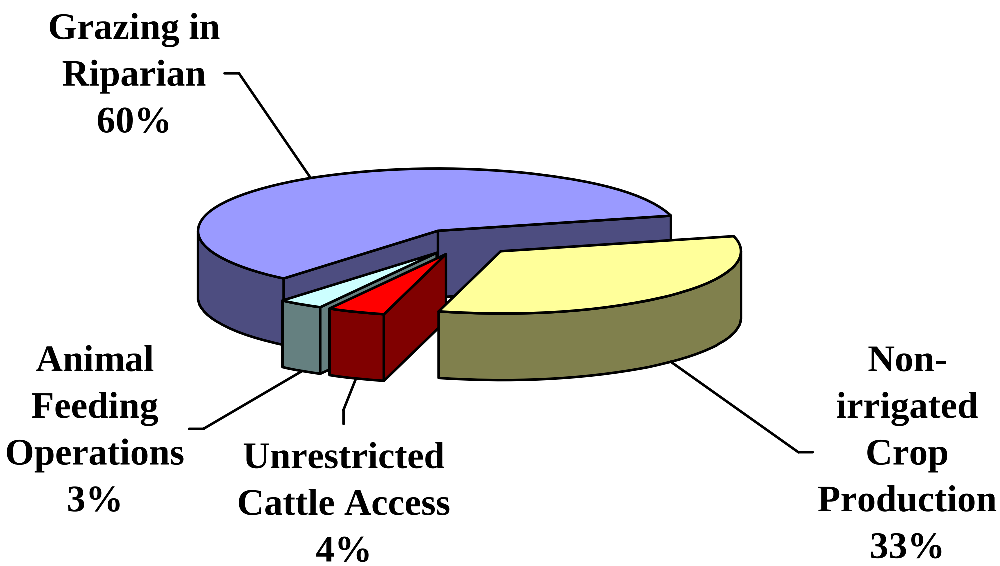


Figure 12: Sources of Agricultural Pollution in Impaired Rivers and Streams

2. Hydrologic Modification

Altering the physical and hydrological properties of streams and rivers is the source of impairment in over 18 percent of the impaired (Category 5) streams in Tennessee. Modifications include channelization (straightening streams), impoundments (construction of a reservoir), removing riparian vegetation, dredging for navigation, and stream bank modification. Figure 13 illustrates the types of modifications most frequently impairing streams and rivers.

Sources of Hydrologic Impairment

Sources of Hydrologic Modification	**Stream Miles Impaired**
Channelization…………………	3,003
Upstream Impoundment………..	303
Dredging (Navigation Channel)..	207
Flow Regulation/Modification…	17
Dam Construction……………...	3

Note: Pollutants in streams can come from more than one source. These totals are not additive.

Physical alteration of waterbodies can only be done as authorized by the state. Permits to alter streams or rivers called Aquatic Resource Alteration Permits (ARAPs) are issued by TDEC's Natural Resources Section. A 401 certification of a federal 404 permit is also considered an ARAP permit. Failure to obtain a permit before modifying a stream or river can lead to unnecessary impairment and enforcement actions.

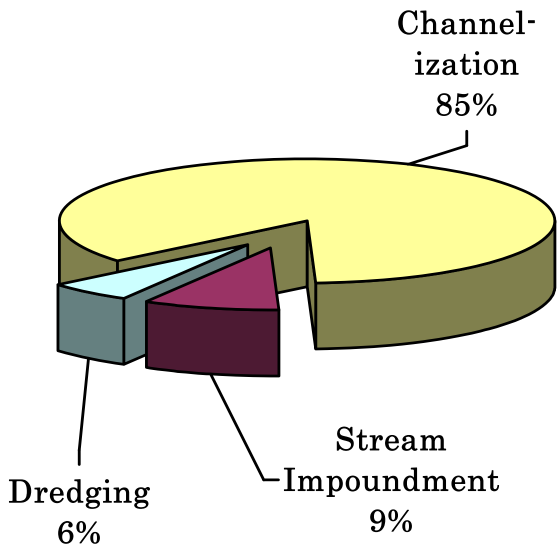


Figure 13: Sources of Habitat Alterations in Impaired Rivers and Streams. (Flow regulation and dam construction represent less than one percent of the impairments.)

a. Channelization

Channelization is the source of impairment for over 85 percent of the streams and rivers assessed as impacted by habitat alteration. Originally, channelization was implemented to control flooding and protect croplands along rivers. In west Tennessee, channelization was used extensively to drain wetlands to create cropland. Throughout Tennessee, streams continue to be impaired by channelization and bank destabilization from vegetation removal.

Costs associated with channelization or decreasing stream and river meanders include:

- Increased erosion rates and soil loss
- Elimination of valuable fish and wildlife habitat by draining wetlands and clearing riparian areas
- Destruction of bottomland hardwood forests
- Magnification of flooding problems downstream
- "Down-cutting" of streambeds as the channel tries to regain stability

In recent years, no large-scale channelization projects have been approved. Tennessee is working with the Corps of Engineers to explore methods to reverse some of the historical damage to water quality caused by channelization. Some streams and rivers continue to be channelized by landowners. However, stream alteration without proper authorization is a violation of the Water Quality Control Act subject to enforcement.

b. Stream and River Impoundment

Problems associated with the impoundment of streams and rivers are increasing as more free flowing streams are dammed. It has been the experience of the division that very few of these impoundments can be managed in such a way as to avoid water quality problems.

Problems often associated with stream and river impoundment include:

- Erosion during dam construction
- Loss of stream or river for certain kinds of recreational use
- Changes in the water flow downstream of the dam
- Elevated metals downstream of the dam
- Low dissolved oxygen levels in tailwaters, which decrease biological diversity downstream and threaten aquatic life, including endangered species
- Habitat change resulting in loss of aquatic organisms
- Barriers to fish migration

c. Loss of Riparian Habitat

Riparian habitat (streamside vegetation) is very important to help maintain a healthy aquatic environment. Optimal riparian habitat is a mature vegetation zone at 60 feet wide on both banks.

Riparian habitat is important because it:

- Provides a buffer zone that prevents sediment in runoff from entering the water
- Provides roots to hold banks in place, preventing erosion
- Provides habitat for fish and other aquatic life
- Provides canopy that shades the stream or river. This shading keeps water temperatures down and prevents excessive algal growth, which in turn prevents large fluctuations in dissolved oxygen levels.

d. Dredging

Dredging or removing substrate from a stream or river is done to deepen river channels for navigation or to mine sand or gravel for construction. Problems from dredging include habitat disruption, substrate alteration, sedimentation, and erosion. Unfortunately, dredging is sometimes done without the proper permit. The Mississippi River is the only river that is assessed as impaired by dredging. The dredging on the Mississippi River is to provide navigation channels.

Example of unpermitted dredging on Long Hungry Creek in Macon County. Photo provided by Annie Goodhue, NEFO

e. Bank Modification/Destabilization

Modification of river or stream banks causes many water quality and habitat problems. Disturbing banks removes important habitat for fish and other aquatic life. Water quality problems include erosion, sedimentation, and loss of riparian habitat.

3. Municipal Discharges

a. Municipal Stormwater Discharge

As stormwater drains through urban areas, it picks up pollutants from yards, streets, and parking lots and deposits them into nearby waterways. This non-specific runoff can be laden with silt, bacteria, metals, and nutrients. Following heavy rains, streams have been found to have various pollutants at elevated levels for several days. Water quality standards violations have been documented in Tennessee's four largest cities: Memphis, Nashville, Chattanooga, and Knoxville, plus many other smaller towns.

The regulation of stormwater runoff falls under the federal National Pollutant Discharge Elimination System (NPDES) program. Industries and large commercial operations such as junkyards are required to operate under the state's general NPDES permit for industrial stormwater discharge. This permit requires the development of site specific stormwater pollution prevention plans and mandatory installation of pollution control measures. Construction sites must obtain coverage under the state's general NPDES permit for construction stormwater runoff if clearing, grading or excavating is planned on any site larger than one acre or any disturbance of less than one acre if it is part of a larger common plan of development or sale.

Under Tennessee Municipal Separate Storm Sewer Systems (MS4) permits, cities must develop stormwater programs and regulate sources at a local level. In addition to Tennessee's four MS4 Phase I cities (Memphis, Nashville, Chattanooga, and Knoxville) that are covered under individual NPDES permits, 85 other cities and counties are now covered by the MS4 Phase II general permits.

There are six Phase II MS4 program elements that result in reductions of pollutants from stormwater discharged into receiving waterbodies. These program elements are called "minimum control measures" which include public education and outreach along with public participation and involvement. Another element of the program includes implementing a plan to detect and eliminate illicit discharges to the storm sewer system. Municipalities must implement techniques and measures to prevent pollution through stormwater runoff. Construction sites are now required to control erosion and runoff from their activities, as well as address post-construction stormwater runoff.

b. Combined Sewer Overflow

There remain only three cities (Nashville, Chattanooga, and Clarksville) in the state that have combined sewers (sanitary waste and storm water carried in the same sewer). Permits require that when these sewers overflow during large storm events, monitoring must be conducted. No exceedances of water quality standards have been found to be directly caused by these discharges.

c. Municipal Point Source Discharge

Impairment due to point source discharge from municipal wastewater treatment plants continues to decline. Municipal sewage treatment plants have permits designed to prevent impacts to the receiving waterbody. On rare occasions, sewage treatment systems fail to meet permit requirements. Sometimes, a waterbody downstream of a facility is found to not meet biological criteria and the upstream facility is listed as a potential source of the pollutant of concern, even if permit limits are being met. In those cases, permit requirements must be adjusted along with other watershed improvements to address water quality concerns.

d. Sanitary Sewer Overflows

Collection systems convey raw sewage to treatment plants through a series of pipes and pump stations. Unfortunately, these systems occasionally malfunction or become overloaded, which can result in the discharge of high volumes of untreated sewage to a stream or river. A serious concern near urban areas is children being exposed to elevated bacteria levels while playing in streams and rivers after heavy rains.

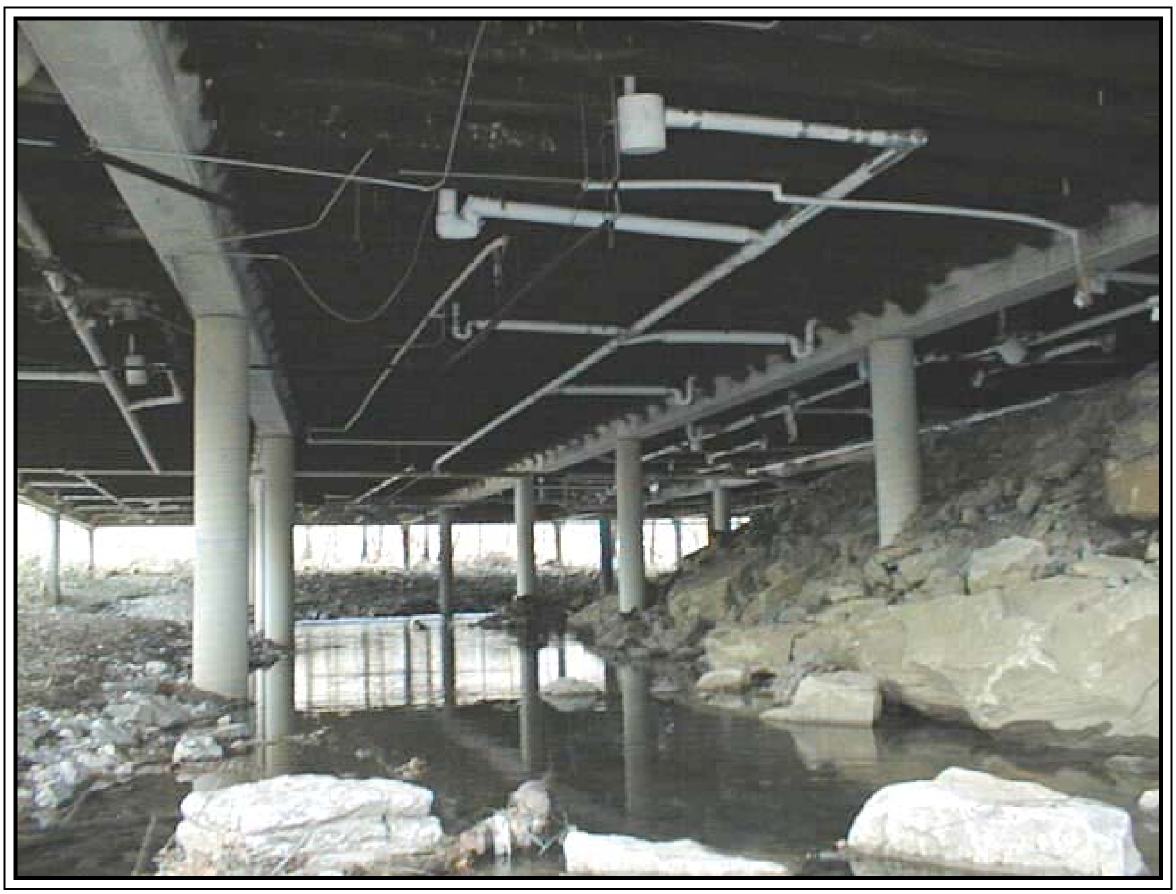
Sanitary sewer collection systems are monitored by municipalities to insure that they are not leaking. NPDES permits contain provisions that prohibit overflows and require that any overflows be reported to TDEC. Enforcement action must be taken against cities that fail to report and correct sewage system problems.

4. Construction

The population of many Tennessee communities has rapidly expanded in the last decade. The construction of subdivisions, shopping malls, and highways can harm water quality if the sites are not properly stabilized. The impacts most frequently associated with land development are silt and habitat alteration.

Construction sites must obtain coverage under the state's general NPDES permit for construction stormwater runoff if clearing, grading or excavating is planned on any site larger than one acre or any disturbance of less than one acre if it is part of a larger common plan of development or sale.

In addition, local stormwater control programs and regulations have been helpful in controlling water quality impacts from land development. MS4 Phase I cities (Memphis, Nashville, Chattanooga, and Knoxville) already have construction stormwater control programs in effect. The eighty-five cities and counties covered under the Phase II MS4 general permit are also developing construction stormwater control programs. In these cities, local staff help identify sources of stormwater runoff and develop control strategies.



This shopping complex was built over Richland Creek in Davidson County. Photo provided by Annie Goodhue, NEFO.

5. Legacy/Historical

a. Impacts from Abandoned Mining

In the 1970's, coal mining was one of the largest pollution sources in the state. "Wildcat" operators strip-mined land without permits or regard for environmental consequences to provide low-priced coal to the growing electric industry. When the miners had removed all the readily available coal, they would abandon the site. In 1983, the price for coal fell so low it was no longer profitable to run "wildcat" mining operations, so most illegal mining operations stopped.

Although many streams and rivers are still impaired by runoff from abandoned mines, which contain pollutants such as silt, pH, manganese, and iron, significant progress has been made in site reclamation. Some abandoned strip mines are being reclaimed under the Abandoned Mine Reclamation program and others are naturally revegetating. New mining sites are required to provide treatment for runoff.

b. Contaminated Sediments

The main problem with toxic contaminants in sediment is they can become concentrated in the food chain. In most places in Tennessee, it is safe to eat the fish. However, in some streams and rivers organic pollutants, primarily PCBs, dioxins, chlordane and other pesticides in the sediment, are bioconcentrated through the food chain in the fish. See Chapter 5 for a list of streams, rivers, and reservoirs posted due to fish tissue contamination.

Fish tissue samples are collected and analyzed from waterbodies across the state. The results of these analyses are compared to the criteria developed by the Food and Drug Administration (FDA) and EPA. If fish tissue is contaminated and the public's ability to safely consume fish is impaired, the stream or river is appropriately posted and assessed as not supporting recreational uses. The advisories are also posted on the TDEC website and included in sport fishing regulations. The Tennessee Valley Authority (TVA) and the Tennessee Wildlife Resources Agency (TWRA) share resources and expertise in this process.

Many substances, like DDT, PCBs, and chlordane, found in fish tissue today were widely distributed in the environment before they were banned. The levels of these substances will slowly decrease over time. Currently companies with permits to discharge organic substances have very restrictive limits.

6. Industrial Discharges

Although the number of waters impaired by industrial pollution is lower than it was a few decades ago, industrial facilities impact some streams and rivers in Tennessee. Streams impacted by industrial discharges include East Fork Poplar Creek, Pigeon River, North Fork Holston River, and Russell Branch. See the current 303(d) list of impaired waters for all waterbodies assessed as impacted by industrial discharges.

Industrial impacts include sporadic spills, temperature alterations, and historical discharge of substances that can concentrate in the food chain. Occasionally, industrial dischargers fail to meet permit requirements. Industries and large commercial operations such as junkyards are required to operate under the state's general NPDES permit for industrial stormwater discharge. This permit requires the development of site specific stormwater pollution prevention plans and mandatory installation of pollution control measures.

7. Habitat Alteration

Many Tennessee streams have impaired biological communities but do not have obvious chemical pollution. One of the reasons the water quality may be good but the biology of the stream less than expected is the condition of the habitat in which the biological community lives. Changes in habitat can lead to a lack of diversity and density of certain species important to the health of the stream.

Habitat alteration is the physical modification of a stream within the channel or along the banks. Common types of habitat alteration include loss of riparian habitat such as cutting down trees along stream banks or mowing to the banks, destabilization of the banks from channelization or riparian grazing, gravel dredging or filling, culverting or directing streams through pipes, and upstream modifications such as impoundments that dam streams.

8. Land Application/Waste Sites

Solid waste and wastewater contribute to water quality problems in various ways. Solid waste in landfills can leach into groundwater and surface water if not controlled. Wastewater in septic tanks can leak into the ground causing water contamination. Treated wastewater and sludge are applied to land as fertilizers and sometimes are washed into streams causing nutrient loading. Another concern is the use and maintenance of underground storage tanks that can contain substances like petroleum products, solvents, and other hazardous chemicals and wastes. These can leak into the groundwater and may reach the surface water.

B. Distribution of Sources of Impacts to Reservoirs

Like streams and rivers, reservoirs are impaired by many sources of pollution. However, the dominant pollutant impacting reservoirs is sediment contaminated by legacy toxic organic substances. Other significant sources are agricultural activities, hydrologic modification, and construction (Figure 14).

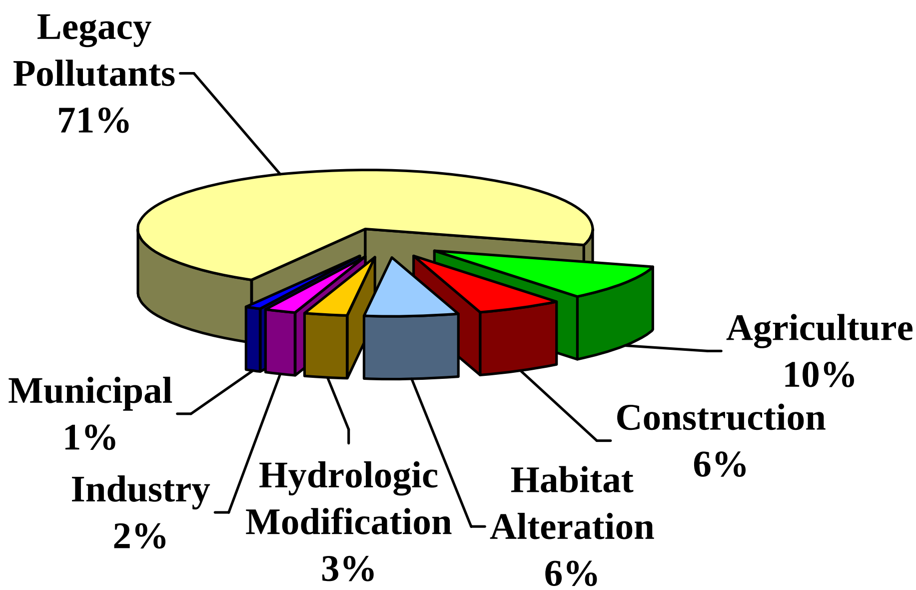


Figure 14: Percent Contribution of Pollution Sources in Impaired Reservoirs and Lakes

1. Legacy Pollutants

Legacy or historical pollutants are the number one source of contamination in reservoirs and lakes. These are pollutants that were introduced into the waterbodies prior to the enactment of water quality regulations or before EPA banned their use. Legacy pollutants include contaminated sediments, superfund sites, and abandoned mine lands (Figure 15).

a. Contaminated Sediments

The biggest problem with legacy pollutants is contaminated sediments. Two organic substances banned in the 1970's, chlordane and PCBs, are responsible for most of the continuing problem of sediment contamination today. These substances bind with the sediment and remain in the environment for a long time. Once in the sediment, they become part of the aquatic food chain. Bioaccumulation in fish tissue has resulted in consumption advisories in several reservoirs (Chapter 5). The levels of these substances will slowly decrease over time.

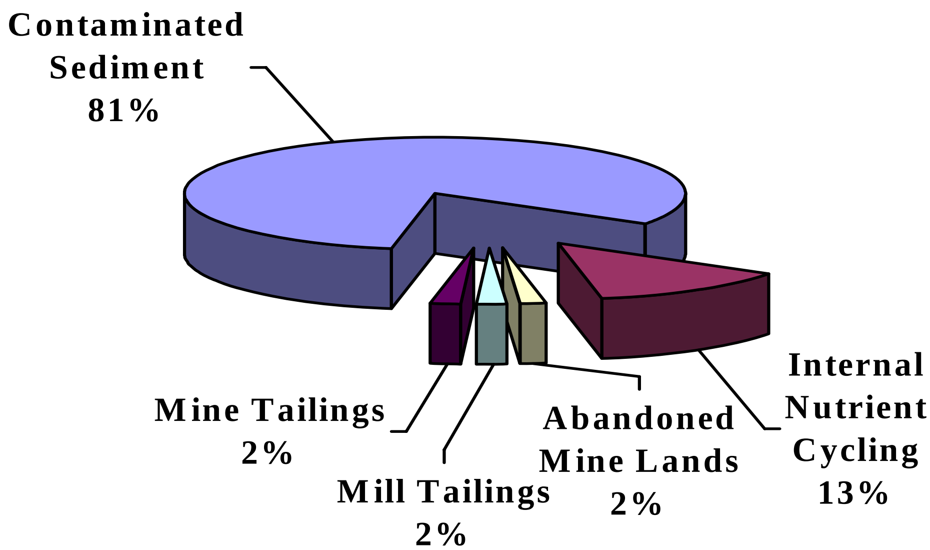


Figure 15: Sources of Legacy Pollutants in Reservoirs and Lakes

b. Internal Nutrient Cycling

Internal nutrient cycling is the release and recapture of nutrients from the sediment of a lake or reservoir, which functions to accelerate eutrophication. Reelfoot Lake in west Tennessee accounts for all the lake acres assessed as impaired by nutrient cycling. This lake is in an advanced state of eutrophication due to sediment and nutrients.

Eutrophication is a natural process that will occur in any lake. It becomes pollution when it is accelerated by human activities, interferes with the desired uses of the lake, or causes water quality standards to be violated in the reservoir or receiving stream. For additional information on eutrophication, see Chapter 3.

c. Abandoned Mines/Mine Tailings/Mill Tailings

The Copper Basin in the tri-state area of Tennessee, Georgia, and North Carolina was extensively mined beginning in 1843. Before 1900, this was the largest metal mining area in the southeast. The last mine closed in 1987. Runoff from disturbed areas has contaminated three downstream reservoirs on the Ocoee River.

2. Agriculture

Similar to streams and rivers, reservoirs can be greatly impacted by agricultural activities. Plowing and fertilizing croplands can result in the runoff of tons of soil and nutrients annually. Over 16,000 lake acres in Tennessee are listed as impaired by farming activities. Most of these acres are represented by Reelfoot Lake, which is listed as impaired due to erosion from agricultural activities. Sources of agricultural impacts include non-irrigated crop production and livestock grazing.

3. Habitat Alterations

Loss of wetlands in Reelfoot Lake accounts for the majority of lake/reservoir acres impaired due to habitat modification. A small percentage of habitat impairment is due to hydrostructure flow modification and upstream impoundments.

4. Construction

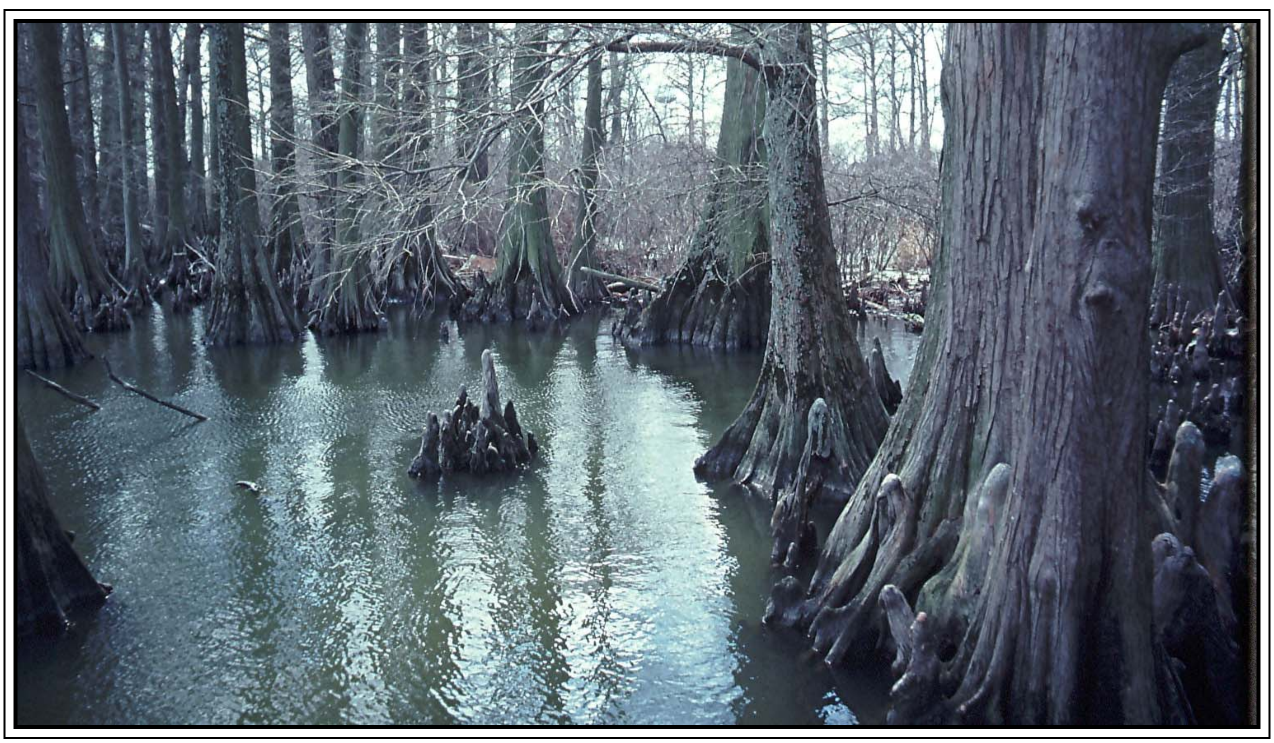
Almost 100 percent of the lake acres assessed as impaired by construction is land development around Reelfoot Lake. Clearing land for development results in increased sedimentation, nutrient runoff, drainage, filling, and loss of wetlands.

5. Industrial and Municipal

Pollution from industrial and municipal sources continues to decrease. Impairment to lakes and reservoirs from municipal sources includes discharges from separate storm sewer systems, collection system failures, and combined sewer overflows. Industrial sources include point source discharges.

6. Sources Outside the State

Davy Crockett Reservoir on the Nolichucky River in east Tennessee is impaired by sediment/silt deposits from activities in North Carolina.



Reelfoot Lake photo provided by the Division of Natural Heritage.

Chapter 5
Posted Streams, Rivers, and Reservoirs

When streams or reservoirs are found to have significantly elevated bacteria levels or when fish tissue contaminant levels exceed risk-based criteria, it is the responsibility of the Department of Environment and Conservation to post warning signs so that people will be aware of the threat to public health. In Tennessee, the most common reasons for a river or reservoir to be posted are the presence of high levels of bacteria in the water or PCBs, chlordane, dioxins, or mercury in fish tissue. Currently 62 streams, rivers, and reservoirs in Tennessee have been posted due to a public health threat. A current list of advisories is posted on the department's home page at http://www.tdec.net/wpc/.

The Commissioner shall have the power, duty, and responsibility to…post or cause to be posted such signs as required to give notice to the public of the potential or actual dangers of specific uses of such waters.
Tennessee Water Quality Control Act

Consistent with EPA guidance, any stream or reservoir in Tennessee with an advisory is assessed as not meeting the recreational designated use and therefore, included in the biennial 303(d) List of impaired waters. Clearly, if the fish cannot be safely eaten, the waterbody is not fully supporting its goal to be fishable. Likewise, streams, rivers, and reservoirs with high levels of bacteria are not suitable for recreational activities such as swimming or wading.

A. Bacteriological Contamination

Bacteria in Tennessee's streams and reservoirs affect the public's ability to safely swim, wade, and fish in these waters.

About 150 river miles are posted due to bacterial contamination (Table 11). No reservoirs or lakes are posted due to bacterial contamination. (Some stream miles are posted for more than one source of pollution. Totals are not additive.)

The presence of pathogens, disease-causing organisms, affects the public's ability to safely swim, wade, and fish in streams, rivers and reservoirs. Bacteria, viruses, and protozoa are the primary water-borne pathogens in Tennessee. The division's current water quality criterion for bacteria is based on levels of *E. coli*. While this test is not considered direct proof of human health threats, it can indicate the presence of other water-borne diseases that are potentially more dangerous.

This outhouse is located on the bank of Charlie Branch in Overton County. Photo provided by Aquatic Biology section of TDH Laboratory.

Research is currently underway to find better indicators of risk and to differentiate between human and animal sources of bacteria. The presence of prescription medicines, caffeine, and hormones in streams, rivers, and reservoirs has been suggested as potential markers for contamination by human waste.

Improperly treated human wastes from such sources as septic tank or collection system failure and improper connection to sewer or sewage treatment plants contaminate over 59 percent of the posted river miles (Figure 16). All streams posted for improper connection to sewers are in Sevier County in the Little Pigeon River and its tributaries. The remaining stream miles are posted due to bacteria levels from other sources such as failing animal waste systems or urban runoff (Figure 17).

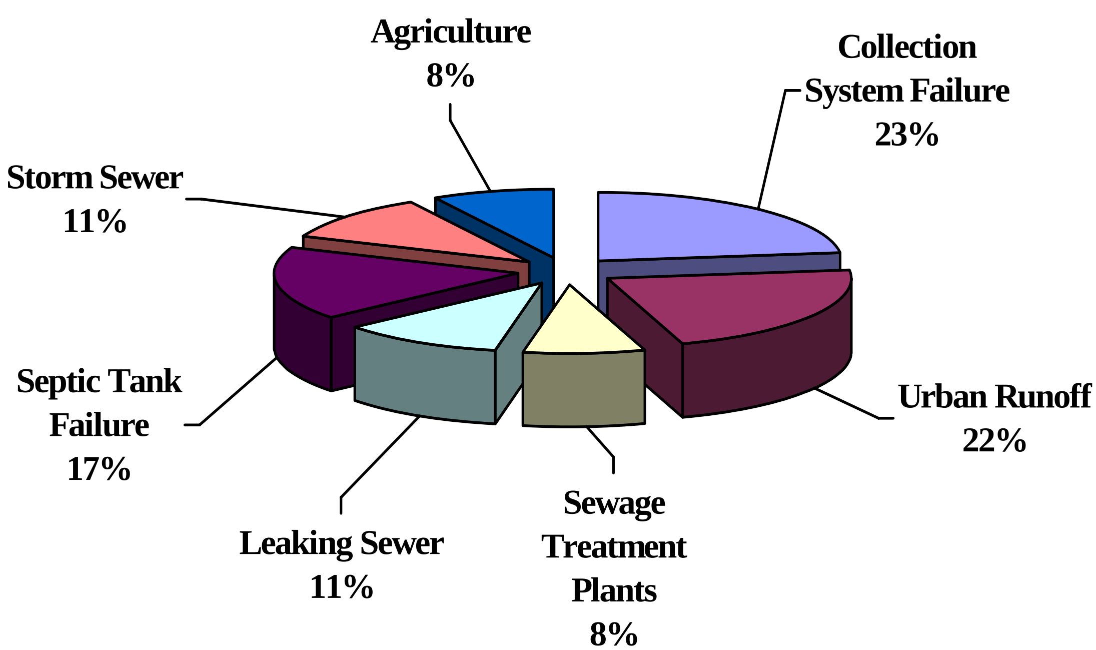


Figure 16: Percent Contribution of Stream Miles Posted for Pathogen Contamination

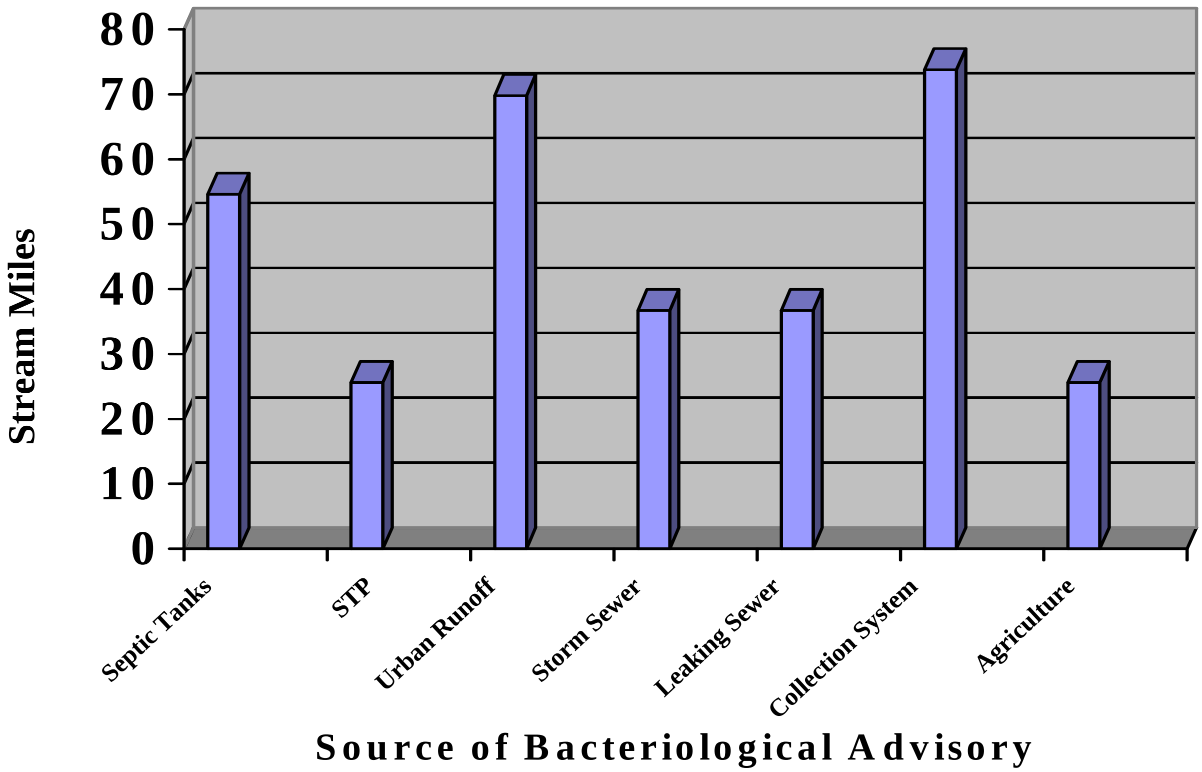


Figure 17: **Stream Miles Contaminated by Various Pathogen Sources.** (The same stream may be impaired by more than one source of pollution. Totals are not additive.)

Terry Whalen, environmental specialist with the Chattanooga EFO posts a sign warning the public to avoid contact with contaminated water. Photo provided by Richard Urban, CHEFO.

Table 11: Bacteriological Advisories in Tennessee

(April 2006. This list is subject to revision.)

For additional information: http://www.tdec.net/wpc/publications/advisories.pdf.

East Tennessee

Waterbody	Portion	County	Comments
Beaver Creek (Bristol)	TN/VA line to Boone Lake (20.0 miles)	Sullivan	Agriculture, urban runoff, and collection system failure.
Cash Hollow Creek	Mile 0.0 to 1.4	Washington	Septic tank failures.
Coal Creek	STP to Clinch R. (4.7 miles)	Anderson	Lake City STP.
East Fork Poplar Creek	Mouth to Mile 15.0	Roane	Oak Ridge area.
First Creek	Mile 0.2 to 1.5	Knox	Knoxville urban runoff.
Goose Creek	Entire Stream (4.0 miles)	Knox	Knoxville urban runoff.
Leadvale Creek	Douglas Lake to headwaters (1.5 miles)	Jefferson	White Pine STP.
Little Pigeon River	Mile 0.0 to 4.6	Sevier	Improper connections to storm sewers, leaking sewers, and failing septic tanks.
Pine Creek	Mile 0.0 to 10.1	Scott	Oneida STP and collection system.
Litton Fork	Mile 0.0 to 1.0		
South Fork	Mile 0.0 to 0.7		
East Fork	Mile 0.0 to 0.8		
North Fork	Mile 0.0 to 2.0		
Second Creek	Mile 0.0 to 4.0	Knox	Knoxville urban runoff.
Sinking Creek	Mile 0.0 to 2.8	Washington	Agriculture & urban runoff.
Sinking Creek Embayment of Fort Loudoun Reservoir	From head of embayment to cave (1.5 miles)	Knox	Knoxville Sinking Creek STP.
Third Creek	Mile 0.0 to 1.4, Mile 3.3	Knox	Knoxville urban runoff.

(Table continued on the next page)

Table 11: Bacteriological Advisories in Tennessee
(Continued from previous page)

East Tennessee (continued)

Waterbody	Portion	County	Comments
East Fork of Third Creek	Mile 0.0 to 0.8	Knox	Knoxville urban runoff.
Johns Creek	Downstream portion (5.0 miles)	Cocke	Failing septic tanks.
Baker Creek	Entire stream (4.4 miles)	Cocke	Failing septic tanks.
Turkey Creek	Mile 0.0 to 5.3	Hamblen	Morristown collection system.
West Prong of Little Pigeon River	Mile 0.0 to 17.3	Sevier	Improper connections to storm sewers, leaking sewers, and failing septic tanks.
Beech Branch	Entire stream (1.0 mile)		
King Branch	Entire stream (2.5 miles)		
Gnatty Branch	Entire stream (1.8 miles)		
Holy Branch	Entire stream (1.0 mile)		
Baskins Branch	Entire stream (1.3 miles)		
Roaring Creek	Entire stream (1.5 miles)		
Dudley Creek	Entire stream (5.7 miles)		

Southeast Tennessee

Waterbody	Portion	County	Comments
Chattanooga Creek	Mouth to GA line (7.7 mi.)	Hamilton	Chattanooga collection system.
Little Fiery Gizzard	Upstream natural area to Grundy Lake (3.7 miles).	Grundy	Failing septic tanks in Tracy City.
Clouse Hill Creek	Entire Stream (1.9 miles)		
Hedden Branch	Entire Stream (1.5 miles)		
Oostanaula Creek	Mile 28.4 -31.2 (2.8 miles)	McMinn	Athens STP and upstream dairies.
Stringers Branch	Mile 0.0 to 5.4	Hamilton	Red Bank collection system.
Citico Creek	Mouth to headwaters (7.3 miles)	Hamilton	Chattanooga urban runoff and collection system.

(Table continued on the next page)

Table 11: Bacteriological Advisories in Tennessee
(Continued from previous page)

Middle Tennessee

Waterbody	Portion	County	Comments
Duck River	Old Stone Fort State Park (0.2 mile)	Coffee	Manchester collection system.
Little Duck River	Old Stone Fort State Park (0.2 mile)		
Mine Lick Creek	Mile 15.3 to 15.8 (0.5 mile)	Putnam	Baxter STP.
Nashville Area		Davidson	Metro Nashville collection system overflows and urban runoff.
Brown's Creek	Entirety (3.3 miles)		
Dry Creek	Mile 0.0 to 0.1		
Gibson Creek	Mile 0.0 to 0.2		
McCrory Creek	Mile 0.0 to 0.2		
Tributary to McCrory Creek	Mile 0.0 to 0.1		
Richland Creek	Mile 0.0 to 2.2		
Whites Creek	Mile 0.0 to 2.1		
Cumberland River	Bordeaux Bridge (Mile 185.7) to Woodland Street Bridge (Mile 190.6)		

B. Fish Tissue Contamination

Approximately 94,400 reservoir acres and 119 river miles are currently posted due to contaminated fish (Table 12). The contaminants most frequently found at elevated levels in fish tissue are PCBs and chlordane (Figure 18). Additional pollutants found in streams include dioxins and mercury (Figure 19). Mercury has been found in fish tissue in the East Fork Poplar Creek and North Fork Holston River.

The list of waterbodies with advisories is on the TDEC website and in TWRA fishing regulations given to sports fisherman when they purchase a fishing license. Caution signs are also mounted at common entry points to posted waterbodies. Fish are posted by species with two types of consumption advisories. The no consumption advisory targets the general population and warns that no one should eat specific fish from this body of water. The precautionary advisory specifies that children, pregnant women, and nursing mothers should not consume the fish species named, while all other people should limit consumption to one meal per month. If needed, TWRA can enforce a fishing ban.

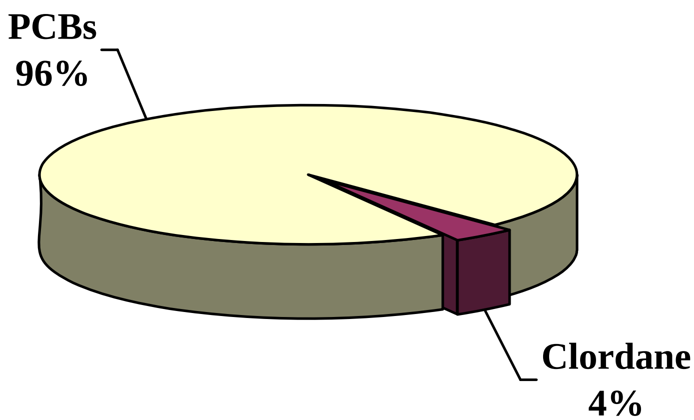


Figure 18: Percent Contribution of Reservoir Acres Posted for Fish Tissue Contamination

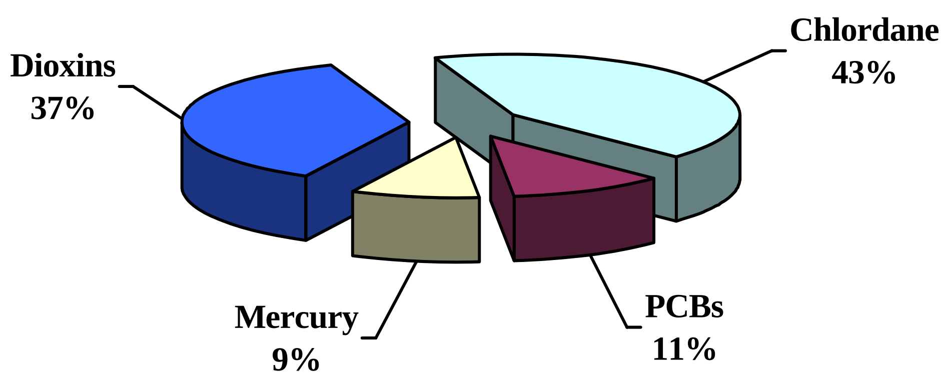


Figure 19: Percent Contribution of Stream Miles Posted for Fish Tissue Contamination

Organic substances tend to bind with the sediment, settle out of the water, and persist in the environment for a very long time. In the sediment, they become part of the aquatic food chain and over time, concentrate in fish tissue. Contaminants can be found in fish tissue even if the substance has not been used or manufactured in decades. A brief synopsis of the effects of some of these specific carcinogens and/or toxic substances appears below.

1. **PCBs -** PCBs were used in hundreds of commercial and industrial processes including electrical insulation, pigments for plastics, and plasticizers in paints. Over 1.5 billion pounds of PCBs were produced in the U.S. prior to the ban on the manufacture and distribution of PCBs in 1976. Once PCBs enter a river or reservoir, they tend to bind with sediment particles. Over time, they enter the food chain and are concentrated in fish tissue. When people eat contaminated fish, PCBs are stored in the liver, fat tissue, and even excreted in breast milk. EPA has determined that PCBs are a probable human carcinogen (cancer causing agent). Additionally, in high enough concentrations, PCBs are likely to damage the stomach, liver, thyroid gland, and kidneys and cause a severe skin disorder called chloracne.

2. **Chlordane -** Chlordane is a pesticide that was used on crops, lawns, and for fumigation from 1948 to 1978 when EPA banned all above ground use. For the next decade, termite control was the only approved usage of chlordane. In 1988, all use of chlordane in the U.S. was banned. Like PCBs, chlordane bioconcentrates in the food chain and is detected in fish throughout Tennessee. In people, chlordane is stored in the liver and fat tissue. EPA has determined that chlordane is a probable human carcinogen. Other possible effects to people are damage to the liver, plus nervous and digestive system disorders.

3. **Dioxins -** Dioxins are the unintentional by-product of certain industrial processes and the combustion of chlorine-based chemicals. Dioxins refer to a class of compounds with a similar structure and toxic action. Most of these chemicals are produced from the incineration of chlorinated waste, the historical production of herbicides, the production of PVC plastics, and the bleaching process historically used by papermills. Like many other organic contaminants, dioxins are concentrated in fish. Even at extraordinarily low levels (i.e. parts per quadrillion), dioxins can exert a toxic effect on larval fish. Dioxins are classified as a probable human carcinogen. Other likely effects in people are changes in hormone levels and developmental harm to children.

4. **Mercury -** Mercury is a persistent toxic metal used in the production of batteries, thermostats, thermometers, cameras, and many other commercial products. It is thought that the primary man-induced source of mercury in the environment is the burning of coal. Mercury is concentrated through the food chain in fish and is a potent neurological toxicant. Additionally, EPA has determined that mercury is a probable human carcinogen. Some of the other dangers mercury poses to people are damage to stomach, brain, and kidneys, and harm to unborn children.

Fish are an important part of a balanced diet and a good source of low fat protein. They also provide essential fatty acids that are crucial for the proper functioning of the nervous system and help prevent heart disease. The department recommends that residents and visitors continue to eat fish from Tennessee rivers and reservoirs, but they should also follow the published advisories on consumption hazards in individual reservoirs and rivers.

In March of 2004, the U.S. Department of Health and Human Services in conjunction with the U.S. Environmental Protection Agency, issued a mercury advisory for the consumption of fish and shellfish by pregnant women, nursing mothers, young children, and women who might become pregnant. The advisory specifically warns this sensitive sub-population to avoid eating ocean fish that have been found to have elevated mercury levels: shark, swordfish, king mackerel, and tilefish.

For specific information on this federal advisory see EPA's website at: http://www.epa.gov/waterscience/fishadvice/advice.html.

Catfish are commonly the species of concern in the rivers and reservoirs posted with fishing advisories.

Reducing Risks from Contaminated Fish

The best way to protect yourself and your family from eating contaminated fish is by following the advice provided by the Department of Environment and Conservation. Cancer risk is accumulated over a lifetime of exposure to a carcinogen (cancer-causing agent). For that reason, eating an occasional fish, even from an area with a fishing advisory, will not measurably increase your cancer risk.

At greatest risk are children and people who eat contaminated fish for years, such as recreational or subsistence fishermen. People with a previous occupational exposure to a contaminant should also limit exposure to that pollutant. Studies have shown that contaminants can cross the placental barrier in pregnant women to enter the baby's body, thereby increasing the risk of developmental problems. These substances are also concentrated in breast milk.

The Division's goal in issuing fishing advisories is to provide the information necessary for people to make **informed choices** about their health. People concerned about their health will likely choose not to eat fish from contaminated sites. If you choose to eat fish in areas with elevated contaminant levels, here is some advice on how to reduce this risk:

1. **Throw back the big ones.** Smaller fish generally have lower concentrations of contaminants.

2. **Avoid fatty fish.** Organic carcinogens such as DDT, PCBs, and dioxins accumulate in fatty tissue. In contrast, however, mercury tends to accumulate in muscle tissue. Large carp and catfish tend to have more fat than gamefish. Moreover, the feeding habits of carp, sucker, buffalo, and catfish tend to expose them to the sediments, where contaminants are concentrated.

3. **Broil or grill your fish.** These cooking techniques allow the fat to drip away. Frying seals the fat and contaminants into the food.

4. **Throw away the fat if the pollutant is PCBs, dioxins, chlordane, or other organic contaminants.** Organic pesticides tend to accumulate in fat tissue, so cleaning the fish so the fat is discarded will provide some protection from these contaminants.

5. **If the pollutant is mercury, children in particular should not eat the fish.** Fish from the North Fork Holston and East Fork Poplar Creek are likely to be contaminated with mercury, which is concentrated in the muscle tissue. It is very important that children not eat fish contaminated with mercury, as developmental problems have been linked to mercury exposure.

Table 12: Fish Tissue Advisories in Tennessee

(April 2006. This list is subject to revision.
For additional information: http://www.tdec.net/wpc/publications/advisories.pdf)

West Tennessee

Waterbody	County	Portion	HUC Code	Pollutant	Comments
Loosahatchie River	Shelby	Mile 0.0 – 20.9	08010209	Chlordane, Dioxins	Do not eat the fish.
McKellar Lake	Shelby	Entirety (13 miles)	08010100	Chlordane, Dioxins	Do not eat the fish.
Mississippi River	Shelby	Mississippi Stateline to just downstream of Meeman-Shelby State Park (31 miles)	08010100	Chlordane, Dioxins	Do not eat the fish. Commercial fishing prohibited by TWRA.
Nonconnah Creek	Shelby	Mile 0.0 to 1.8	08010201	Chlordane, Dioxins	Do not eat the fish. Advisory ends at Horn Lake Road bridge.
Wolf River	Shelby	Mile 0.0 – 18.9	08010210	Chlordane, Dioxins	Do not eat the fish.

Middle Tennessee

Waterbody	County	Portion	HUC Code	Pollutant	Comments
Woods Reservoir	Franklin	Entirety (3,908 acres)	06030003	PCBs	Catfish should not be eaten.

(Table continued on next page)

Table 12: Fish Tissue Advisories in Tennessee

(continued from previous page)

East Tennessee

Waterbody	County	Portion	HUC Code	Pollutant	Comments
Boone Reservoir	Sullivan, Washington	Entirety (4,400 acres)	06010102	PCBs, chlordane	Precautionary advisory for carp and catfish. *
Chattanooga Creek	Hamilton	Mouth to Georgia Stateline (11.9 miles)	06020001	PCBs, chlordane	Fish should not be eaten. Also, avoid contact with water.
East Fork of Poplar Creek including Poplar Creek embayment	Anderson, Roane	Mile 0.0 – 15.0	06010207	Mercury, PCBs	Fish should not be eaten. Also, avoid contact with water.
Fort Loudoun Reservoir	Loudon, Knox, Blount	Entirety (14,600 acres)	06010201	PCBs	Commercial fishing for catfish prohibited by TWRA. No catfish or largemouth bass over two pounds should be eaten. Do not eat largemouth bass from the Little River embayment.
Melton Hill Reservoir	Knox, Anderson	Entirety (5,690 acres)	06010207	PCBs	Catfish should not be eaten.

(Table continued on next page.)

Table 12: Fish Tissue Advisories in Tennessee
(continued from previous page)

East Tennessee

Waterbody	County	Portion	HUC Code	Pollutant	Comments
Nickajack Reservoir	Hamilton, Marion	Entirety (10,370 acres)	06020001	PCBs	Precautionary advisory for catfish. *
North Fork Holston River	Sullivan, Hawkins	Mile 0.0 - 6.2 (6.2 miles)	06010101	Mercury	Do not eat the fish. Advisory goes to TN/VA line.
Tellico Reservoir	Loudon	Entirety (16,500 acres)	06010204	PCBs	Catfish should not be eaten.
Watts Bar Reservoir	Roane, Meigs, Rhea, Loudon	Tennessee River portion (38,000 acres)	06010201	PCBs	Catfish, striped bass, & hybrid (striped bass-white bass) should not be eaten. Precautionary advisory* for white bass, sauger, carp, smallmouth buffalo and largemouth bass.
Watts Bar Reservoir	Roane, Anderson	Clinch River arm (1,000 acres)	06010201	PCBs	Striped bass should not be eaten. Precautionary advisory for catfish and sauger. *

*Precautionary Advisory - Children, pregnant women, and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to one meal per month.

Chapter 6
Special Projects

An important goal of the division is to supplement current narrative criteria and to refine existing numeric criteria to reflect natural regional differences. The regional dissolved oxygen project looked at regional differences in diurnal dissolved oxygen. Another objective is to augment routine monitoring with specific studies such as the impounded stream project and the national wadeable streams project

A. Probabilistic Impounded Stream Project

The Division of Water Pollution Control receives many requests to impound streams through the Aquatic Resources Alteration Program (ARAP). Where dams were authorized, the majority of these streams have not been monitored to determine if water quality criteria are being met. The impairments listed include flow alteration, iron, habitat alteration, organic enrichment, low DO, nutrients, and silt.

To study these issues, 75 streams downstream of reservoirs less than 250 acres were randomly selected. It was necessary to look at 200 streams to find 75 that were appropriate for the study. At the time of the reconnaissance in the summer of 2003, 65 streams (32 percent) had no flow and 14 (7 percent) had intermittent flow (Figure 20). No access was available for 22 potential sites (11 percent), while 11 potential sites (6 percent) did not have enough habitat to provide an adequate sample. Either the impoundment was never constructed or had been removed at seven (4 percent) of the potential study sites.

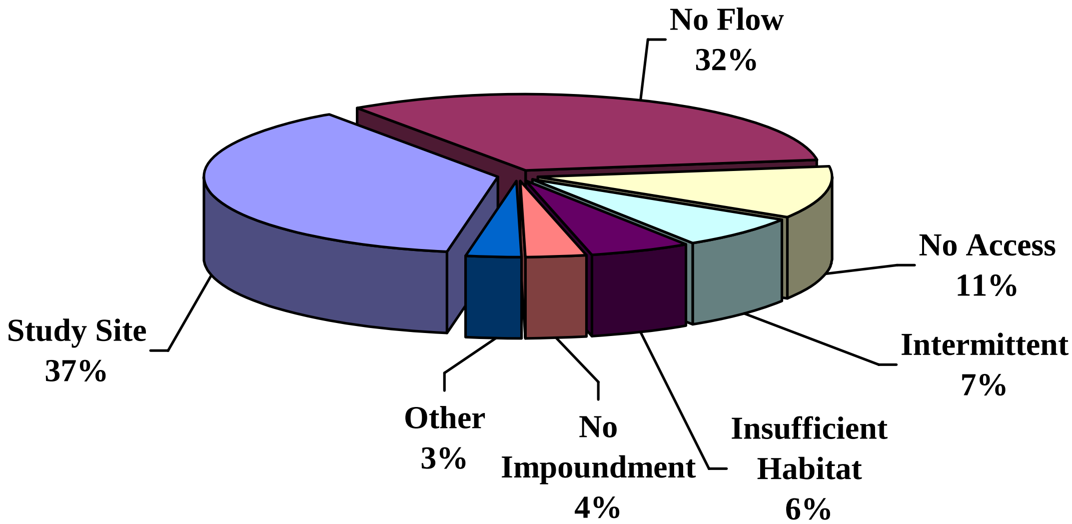


Figure 20: Reconnaissance Results of Impounded Stream Study

Intensive sampling began in the fall of 2003. By then, 17 (23 percent) of the study sites were dry or had insufficient flow to collect samples. Chemical and benthic macroinvertebrate (semi-quantitative single habitat) samples were collected at the other 58 sites that still had adequate flow. In the winter and spring of 2004, all study sites had sufficient flow to collect chemical samples and measure field readings. Biological samples were also collected in the spring. In the summer of 2004, 72 of the study sites had sufficient flow to collect chemical samples, while three sites were dry or almost dry.

All chemical and biological analyses have been completed and data analyses are currently underway. Statistical testing and interpretation of chemical, geomorphological, habitat periphyton, benthic macroinvertebrate, and precipitation data is on going. The final report is scheduled to be completed in September 2006.

B. Diurnal Dissolved Oxygen Project

The 2004 *Regional Characterization of Streams in Tennessee with Emphasis on Diurnal Dissolved Oxygen, Nutrients, Habitat, Geomorphology and Macroinvertebrates* (Arnwine et al, 2005) project is a continuation of the 2002 *Evaluation of Regional Dissolved Oxygen Patterns of Wadeable Streams in Tennessee Based on Diurnal and Daylight Monitoring* (Arnwine and Denton, 2003) study. The 2002 DO study indicated that minimum reference DO levels were 6 mg/L or above in most of the state, while DO levels were often below 5 mg/L in two regions. Results also suggested that the magnitude of the diurnal fluctuation was an important consideration even when minimum DO levels were met. The results of this preliminary study have led the division to realize that the current criterion may need to be further refined on a regional basis and that diurnal patterns need to be taken into account. However, the initial study was limited and a follow up study was proposed to further investigate diurnal dissolved oxygen patterns.

The follow up study was designed to provide additional information in eight subregions where preliminary data suggested criteria may need to be raised and in two ecoregions to determine whether lower DO levels would be supportive of fish and aquatic life. Both studies showed that streams in the Northern Mississippi Valley Alluvial Plain (73a) typically have daytime dissolved oxygen levels approximating 3 ppm. They also showed levels can drop to near 1 ppm for short periods while still supporting aquatic life typically found in the least disturbed streams in this region.

The 2004 study reiterated that streams in the Inner Nashville Basin with dissolved oxygen periodically falling to 3 ppm can be supportive of a healthy biological community in this region. However, since diurnal swings are typically between 2 and 4 ppm, it is important to include diurnal monitoring in this region and not rely only on daylight measurements when levels approach 5 ppm.

In the 2002 study, ten ecological subregions had diurnal dissolved oxygen levels that were generally at or above 6 ppm. The 2004 study endeavored to verify minimum DO levels of 6 ppm in these regions. DO data from six of the subregions (65j, 67h, 69d, 71e, 71f, 74b) were also above 6 ppm during the 2004 study.

This study was also designed to characterize streams based on geomorphology, periphyton, and nutrients. The geomorphology scheme used was the Rosgen stream classification system, which characterized the geomorphology of reference streams found in the 19 ecoregions surveyed. This stream classification is based on physical processes and assumes that stream morphology is dependent on landscape position (Rosgen, 1999). Another goal of this project was to characterize periphyton abundance in reference streams and evaluate algal abundances in test streams in ecoregions where nutrient levels are generally elevated.

There were two goals for the nutrient data collection. One was to increase the reference database, which could be used to refine regional goals. The second goal was to test the reliability of using nitrate probes that could potentially cut monitoring time and decrease analysis costs while providing diurnal nutrient information. The nitrate probes proved impractical during field-testing.

The final goal of this study was to characterize non-wadeable streams that cross ecoregions in west Tennessee. Five non-wadeable rivers originate in the Southeastern Plains, cross into the Loess Plains, and enter the Northern Mississippi Alluvial Plain on their way to the Mississippi River. These include the Obion, Forked Deer, Hatchie, Loosahatchie, and Wolf River systems. Result of the non-wadeable stream monitoring indicated that data were generally not directly comparable to existing wadeable streams guidelines. This report is available on the division's website at http://www.tdec.net/wpc/publications/DO_RegionsRpt04.pdf.

C. National Demonstration of Randomized-design for Assessment of Wadeable River and Streams Project

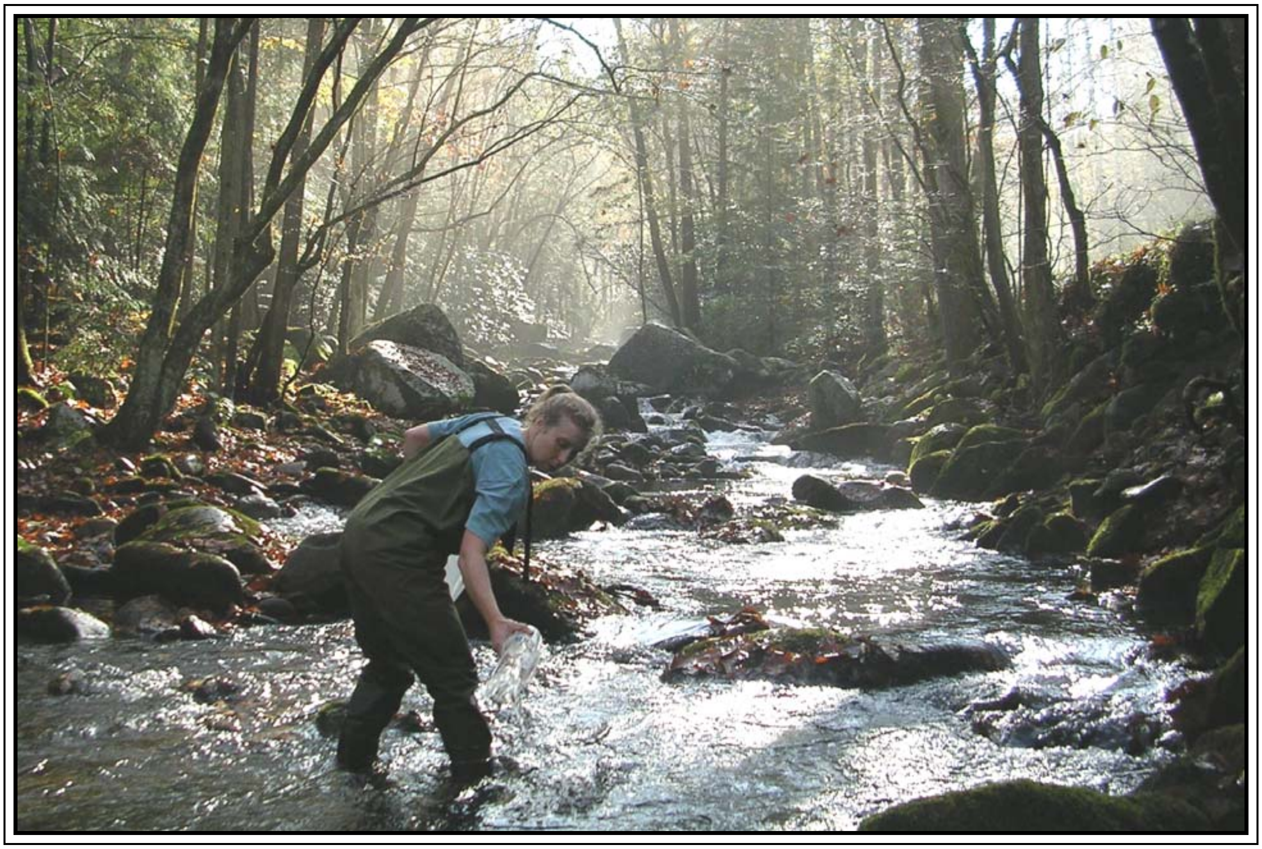
TDEC in partnership with EPA and other states participated in a national study to generate statistically valid estimates of the biological health of wadeable rivers and streams at Level II ecoregions and aggregate estimates to the national scale. EPA designed the sampling protocol and randomly selected wadeable streams in every Level II ecoregion. TDEC monitored the streams located within the state in accordance with the Environmental Monitoring and Assessment Programs (EMAP) protocols.

The first phase of this study was the Wadeable Streams Western Study in 12 western states between 2000 and 2004. The second phase of the project was sampling 500 randomly selected wadeable streams and rivers in 36 eastern states in summer and fall of 2004. The 20 randomly selected sites and 3 reference sites located in Tennessee were sampled by TDEC staff in the summer and fall of 2004.

In the summer of 2004, before sample collection began, all potential sites were reconned to check for access and see if the site met project objectives. Of the 57 potential sites located in Tennessee, 30 (52 percent) met project objectives (Figure 21). Seventeen (30 percent) of the potential sites were dry, while 3 potential sites (5 percent) were too deep to wade.

Access was denied at 1 potential site (2 percent) and 4 sites (7 percent) were inaccessible. Of the final two sites, one was located in a cave and the other was not a creek.
Of the 30 sites that met project objectives, 20 were randomly selected by EPA to be included in the EMAP project. Three additional sites were selected as reference sites. These sites were surveyed in the summer and fall of 2004.

At each site, benthic macroinvertebrate samples were collected following both EMAP protocols and TDEC's *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys* (TDEC, 2003). Chemical, geomorphological, bank height, hydrological, and other samples and measurements were collected and analyzed following EMAP protocols.



Kim Sparks (WPC) collects a chemical sample as part of the Wadeable Streams Assessment Project. Photo provided by PAS.

The duplicate biological samples, which were collected according to TDEC's protocol, are being used for comparability analyses. Results of the benthic macroinvertebrate sampling methodologies are being compared to see if they yield similar assessments of stream conditions. The report on the results of this study should be completed in December 2006.

EPA's goal is to extend this probabilistic study beyond wadeable streams to large rivers and reservoirs. EPA is currently developing standardized protocols to study non-wadeable rivers, lakes and reservoirs.

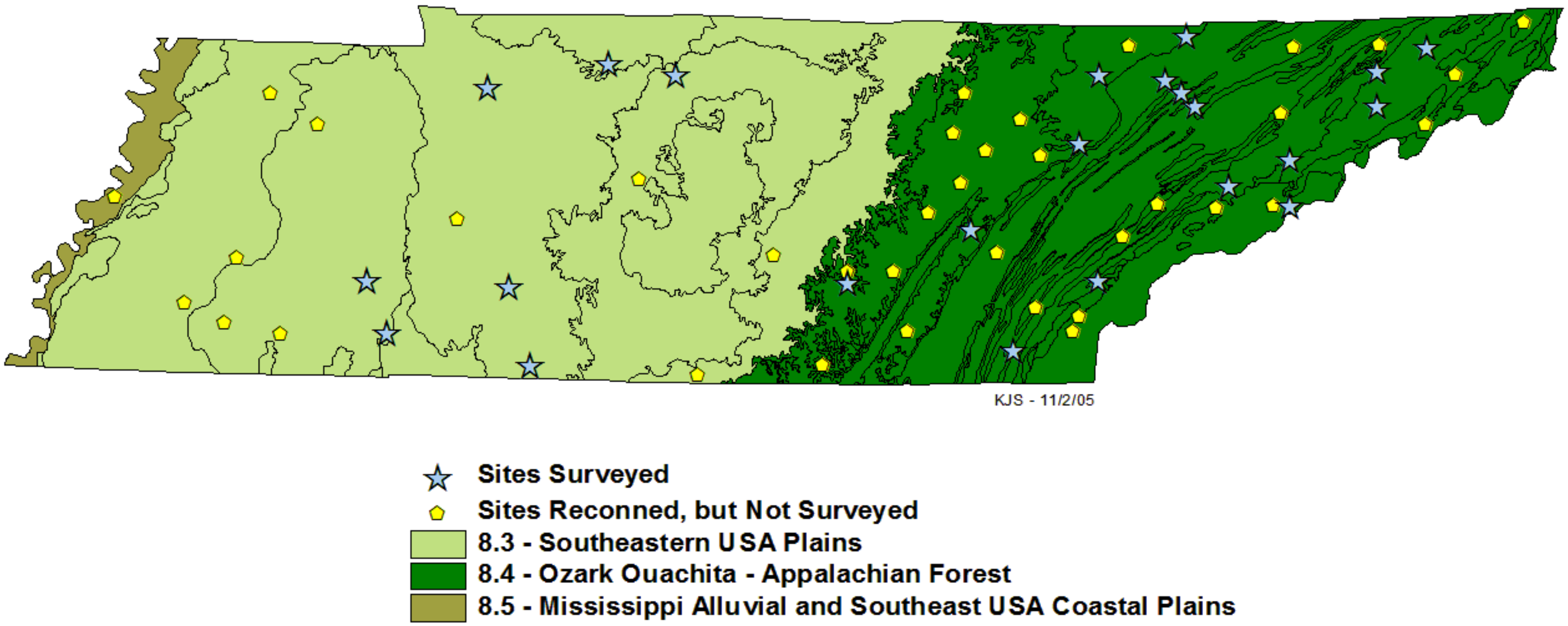


Figure 21: Randomly Selected Wadeable Streams Assessment Sites in Tennessee

Chapter 7
Public Participation

Everyone contributes pollution in large or small ways. Often a careless or thoughtless act results in far reaching damage. By understanding how pollution impacts our planet and what each of us can do to reduce pollution, collectively we can make a difference in Tennessee and the world.

Get Involved

Environmental laws encourage public participation. Ask that environmental issues be considered in the local planning process.

Find out which watershed you live in and attend TDEC's watershed meetings. Watershed meetings are held in the third and fifth years of the watershed cycle.

The meeting dates and times are posted on our website at:

http://www.tdec.net/wpc/wpcppo/

Annie Goodhue and Jimmy Smith (WPC, NEFO) teach about aquatic life at the Catfish Rodeo in Centennial Park, Nashville. Photographer Paul Davis (WPC).

Reduce, Reuse, and Recycle

Whenever possible recycle metal, plastic, cardboard, and paper, so it can be reused to make new products. Always dispose of toxic materials properly. Most auto parts stores and many service stations collect used motor oil and auto batteries for recycling. Most counties have annual toxic waste collection days for old paints, pesticides, and other toxic chemicals. Check with your local waste management service for specific dates and times.

Conserve water and electricity both at home and at work. Every gallon of water that enters the sewer must be treated. The production of energy uses natural resources and produces pollution. You will not only prevent pollution, but also save money.

For further information on pollution prevention please see the website.
http://www.tdec.net/

Be Part of the Solution, Not Part of the Problem

1. Dispose of chemicals properly

Always dispose of toxic chemicals properly. Never pour oil, paint, or other leftover toxic chemicals on the ground, in a sinkhole, or down a drain. If you have a septic system, check it periodically to make sure it is functioning correctly to protect surface and ground water.

2. Use chemicals properly

Use all chemicals, especially lawn chemicals, exactly as the label instructs. Every year millions of pounds of fertilizer and pesticides are applied to crops and lawns and some portion is carried by runoff to streams, rivers, and reservoirs. Over-application of fertilizers and pesticides wastes money, risks damage to vegetation, and pollutes waterways. Therefore, use all chemicals, especially lawn chemicals, cautiously.

3. Prevent erosion and runoff

It is important for farmers and loggers to work closely with the Department of Agriculture (TDA) personnel to prevent erosion and runoff pollution. TDA can recommend Best Management Practices (BMP's) to reduce soil loss and prevent pollution of waterbodies.

4. Obtain a permit

Contractors wishing to alter a stream, river, or wetland need to obtain a permit from the TDEC, Natural Resources Section. Additionally, construction sites must be covered under a General Permit for the Discharge of Stormwater for a Construction Activity. Coverage can be obtained by contacting the local TDEC Environmental Field Office (EFO) at 1-888-891-TDEC. Never buy gravel or rocks that were illegally removed from streams or rivers.

A work site must be properly stabilized to avoid erosion. All silt retention devices must be properly installed to protect a site from soil loss and waterbodies from siltation. If you hire a contractor to do any work around a stream or river, make sure they obtain the proper permits and know how to protect the waterbody. The landowner is ultimately responsible for any work done on his land.

Report Pollution

The public is an important source of information on pollution. Call your local Water Pollution Control office if you see a water pollution problem. A map of Tennessee's Environmental Field Offices (EFO) appears on the next page. If your EFO is not a local call, please use our toll free number that will connect you to your nearest office.

If you see any of the following problems, please call.

More than just a few dead fish in a stream or lake.

Someone pumping a liquid from a truck into a stream (especially at night).

Unusual colors, odors, or sheen in a stream or lake.

Construction activities without proper erosion control (silt fences, hay bales, matting).

Bulldozers or backhoes in a stream removing gravel or rocks.

Groups of people removing rocks from streams, especially on the Cumberland Plateau.

Sewage pumping stations discharging directly or indirectly into a stream.

Manholes overflowing.

Call your local Environmental Field Office. See Figure 22 on the next page.

or

If your local EFO is a long distance phone call, please call toll free.
1-888-891-TDEC
1-888-891-8332

You may also contact the division by leaving a message on our website.

http://www.tdec.net/

When a call is received from a citizen, division staff investigate the complaint and attempt to identify the source of pollution. If the polluter is identified, enforcement action can be taken.

Figure 22: TDEC Environmental Field Office Boundaries

Definitions and Acronyms

Definitions

Acute Toxicity: An adverse effect (usually death) resulting from short-term exposure to a toxic substance.

Benthic Community: Animals living on the bottom of the stream.

Biocriteria: Numerical values or narrative expressions that describe the reference biological condition of aquatic communities and set goals for biological integrity. Biocriteria are benchmarks for water resources evaluation and management decisions.

Biometeric: A calculated value representing some aspect of the biological population's structure, function or other measurable characteristic that changes in a predictable way with increased human influence.

Bioregion: An ecological subregion, or group of ecological subregions, with similar aquatic macroinvertebrate communities that have been grouped for assessment purposes.

Chronic Toxicity: Sublethal or lethal effects resulting from repeated or long-term exposure to low doses of a toxic substance.

Ecoregion: A relatively homogenous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables.

Ecological Subregion (or subecoregion): A smaller area that has been delineated within an ecoregion that has even more homogenous characteristics than does the original ecoregion.

Ecoregion Reference: Least impacted, yet representative, waters within an ecoregion that have been monitored to establish a baseline to which alteration of other waters can be compared.

Habitat: The instream and riparian features that influence the structure and function of the aquatic community in a stream.

Macroinvertebrate: Animals without backbones that are large enough to be seen by the unaided eye and which can be retained by a U.S. Standard No. 30 sieve (28 meshes/inch, 0.595 mm).

Pathogens: Disease causing micro-organisms.

Definitions (continued)

Regulated Sources: Pollution originating from sources governed by state or federal permitting requirements. These sources are typically from discrete conveyances, but also include stream alterations, urban runoff, and stormwater runoff from construction sites.

Non-Point Source Pollution: Pollution from diffuse sources as a result of rainfall or snowmelt moving over and through the ground into lakes, reservoirs, rivers, streams, wetlands, and aquifers.

Non-Regulated Sources: Activities exempted from state or federal permitting requirements. In Tennessee, these sources are agricultural and forestry activities which utilize appropriate management practices. Additionally, sources such as atmospheric deposition might be considered unregulated sources, since they are not controllable through the water program.

Point Source Pollution: Waste discharged into receiving waters from a single source such as a pipe or drain.

Riparian Zone: An area that borders a waterbody.

Water Pollution: Alteration of the biological, physical, chemical, bacteriological or radiological properties of water resulting in loss of use support.

Watershed: A geographic area, which drains to a common outlet, such as a point on a larger lake, underlying aquifer, estuary, wetland, or ocean.

Acronyms

ADB:	Assessment Database
ARAP:	Aquatic Resource Alteration Permit
BMP:	Best Management Practices
CAFO:	Confined Animal Feeding Operation
CERLA:	Comprehensive Environmental Response, Compensation, and Liability Act
CHEFO:	Chattanooga Environmental Field Office
CKEFO:	Department of Interior Office of Surface Mining
CLEFO:	Columbia Environmental Field Office
CWSRF:	Clean Water State Revolving Fund
DDT:	Dichloro-diphenyl-trichloroethane
DO:	Dissolved Oxygen
DOE:	Department of Energy
DIOSM:	U.S. Department of Interior Office of Surface Mining
EFO:	Environmental Field Office
EMAP:	Environmental Monitoring and Assessment Program

Acronyms (continued)

EPA:	United States Environmental Protection Agency
EPT:	Ephemeroptera (Mayflies) Plecoptera (Stoneflies) Trichoptera (Caddisflies)
FAL:	Fish and Aquatic Life
FDA:	Food and Drug Administration
GIS:	Geographic Information System
GPS:	Global Positioning System
HUC:	Hydrological Unit Code (Watershed Code)
JEFO:	Jackson Environmental Field Office
JCEFO:	Johnson City Environmental Field Office
KEFO:	Knoxville Environmental Field Office
MCL:	Maximum Contaminant Level
MEFO:	Memphis Environmental Field Office
MS4:	Municipal Separate Storm Sewer Systems
NHD:	National Hydrography Dataset
NEFO:	Nashville Environmental Field Office
NPDES:	National Pollutant Discharge Elimination System
NPL:	National Priorities List
NPS:	Non-point Source
NRCS:	Natural Resource Conservation Service
ONRW:	Outstanding Natural Resource Waters
OSM:	Office of Surface Mining
PCB:	Polychlorinated Biphenyls
QSSOP:	Quality System Standard Operating Procedure
PAH:	Polycyclic Aromatic
PAS:	Planning and Standards Section
RDX:	Cyclotrimethylenetrinitramine
RIT:	Reach Indexing Tools
SOP:	Standard Operating Procedure
STORET:	EPA's STOrage and RETrieval Database
TDEC:	Tennessee Department of Environment and Conservation
TDA:	Tennessee Department of Agriculture
TDH:	Tennessee Department of Health
TMDL:	Total Maximum Daily Load
TVA:	Tennessee Valley Authority
TWRA:	Tennessee Wildlife Resource Agency
USACE:	U.S. Army Corps of Engineers
USGS:	U.S. Geological Survey
USFWS:	U.S. Fish and Wildlife Service
WPC:	Water Pollution Control
WSA:	Wadeable Streams Assessment
WQCB:	Water Quality Control Board
WET:	Whole Effluent Toxicity

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Section II - Detailed Watershed Information

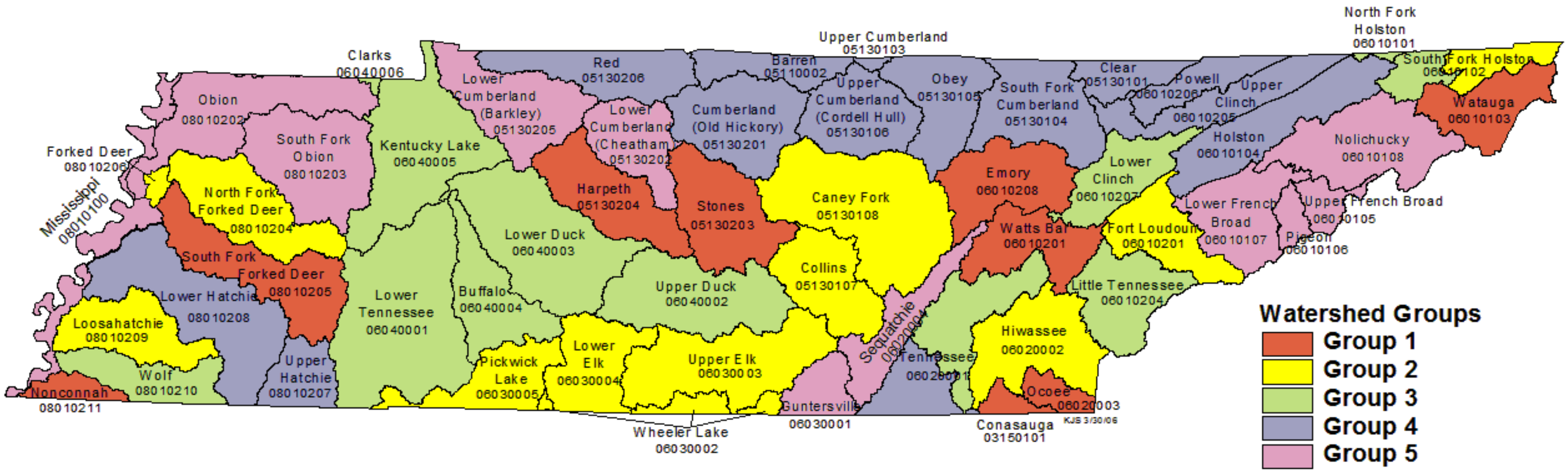


Figure 23: Watersheds of Tennessee

Introduction

This section contains specific information on Tennessee's watersheds. A unique eight-digit hydrological unit code (HUC) has been assigned to each watershed in the country by the U.S. Geological Survey (USGS). Fifty-five of these watersheds are partially or completely located in Tennessee (Figure 23). Each watershed description includes watershed statistics, a table of category assessments, a graph of river and stream water quality assessment, and a general discussion of water quality in the watershed. Each watershed table includes the counties and ecoregions and other relevant information.

Programs to Restore Water Quality

The 55 watersheds in Tennessee have been organized into five groups to systematically approach water quality monitoring, assessment, TMDL, and permit issuance. This watershed management approach coordinates public and government pollution prevention programs as well as waterbody assessments, facility inspections, and permit issuance. By viewing the drainage area as a whole, the department is better able to address water quality problems. This unified approach affords a more in-depth study of watersheds and encourages participation and coordination of public and governmental parties.

Each year, every watershed group is in a different phase of the watershed cycle. On a five-year rotation, all watersheds are monitored, assessed, Total Maximum Daily Loads (TMDLs) are developed, and National Pollutant Discharge Elimination System (NPDES) permits are issued. The watershed management approach was previously discussed in Chapter 1.

Since one watershed group is intensively monitored each year, this allows the assessment of an average of 20 percent of the state's waters each year, with all 55 watersheds assessed every five-years. The first five-year assessment cycle was completed in 2002. The division is currently in the second rotation of cycle. This report includes new assessments of waterbodies located Group in 3 watersheds. New chemical and bacteriological data analyzed with Group 4 watersheds have also been assessed. However, due to the time constraints of biological analyses, Group 4 watershed biological samples are not included in this report.

Programs to Assess Water Quality

The information used to assess each watershed came from a variety of sources. The majority of the information came from the division of Water Pollution Control (WPC). Additional information was furnished by various other government agencies, universities, private consultants, NPDES permit holders, volunteer groups and the general public. The number of TDEC and other governmental stations are identified in each watershed. The number of stations submitted by consultants and volunteer agencies are included in watersheds where data have been submitted.

See Chapter 1 for specific information on other data sources. Detailed information on fish and water contact advisories can be found in Chapter 5. A current list of high quality waters is maintained on the TDEC webpage at http://www.tdec.net/wpc/publications/hqwlist.pdf. This list includes ONRW and waters designated as Tier II. Chapter 1 has specific information on how these waters are designated.

Additional Assessment Information

Specific assessment information on individual waterbody segments can be found on the TDEC webpage at http://www.tdec.net/water.php under Tennessee's Online Water Quality Assessment. This interactive map allows a user to select a waterbody of interest and find the assessment information for that particular reach. The data management section of Chapter 1 includes an explanation of how to use this website to view assessment results.

Note: Due to rounding differences in charts, categories may not total 100 percent.

Table of Watersheds

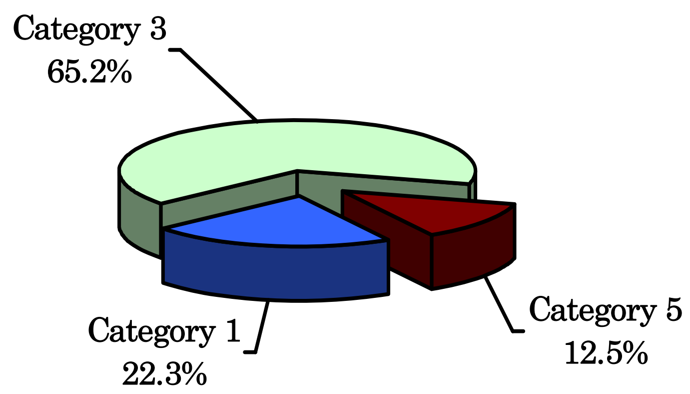
Watershed Name:	**Conasauga**
HUC Code:	**TN03150101**
Watershed Group:	1
Counties:	Bradley Polk
Ecoregions:	66g, 67f, 67g, & 67i
Reference Sites:	1
Drainage Area:	560 square miles
Tennessee Drainage:	123 square miles
TDEC Stations:	10
Advisories:	0
High Quality Waters:	26

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	220.2	0
Assessed	76.7	0
Category 1	49.2	0
Category 2	0.0	0
Category 3	143.5	0
Category 4	0.0	0
Category 5	27.5	0

Conasauga River Watershed

The Conasauga River watershed is unique in Tennessee because it does not flow into the Mississippi River but enters the Gulf of Mexico via the Mobile River. Only 17 percent of this watershed is in Tennessee, the remainder is in Georgia. Less than half of the streams and rivers have been assessed. Riparian grazing and septic tanks are the main sources of the pollution in this rural area.

The General Assembly has designated a portion of the Conasauga River in the Cherokee National Forest as a State Scenic River and it has been designated as critical habitat by USFWS. This watershed also has an subecoregion reference site on Sheeds Creek in 66g (Southern Metasedimentary Mountains).



2006 Assessment of Rivers and Streams in Conasauga River Watershed

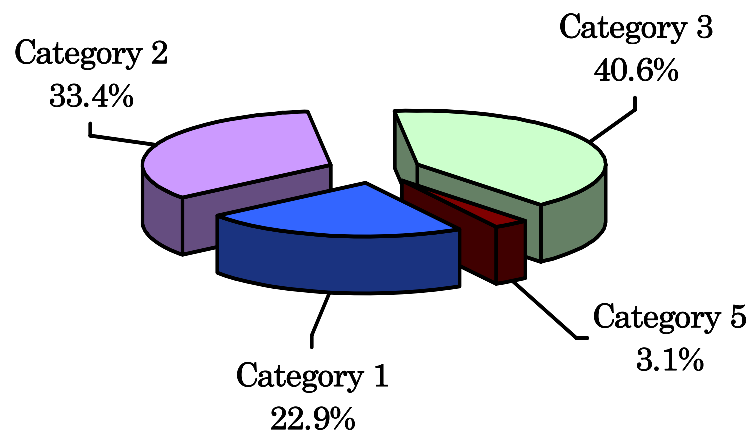
Barren River Watershed

Watershed Name:	**Barren**
HUC Code:	**TN05110002**
Watershed Group:	4
Counties:	Clay Macon Sumner
Ecoregions:	71e, 71g, & 71h
Reference Sites:	0
Drainage Area:	1,661 square miles
Tennessee Drainage:	432 square miles
TDEC stations:	106
Advisories:	0
High Quality Waters:	2

Only 20 percent of the Barren River Watershed is in Tennessee. The remainder is in Kentucky. From Tennessee, the Barren River flows north into Kentucky's Green River.

Livestock, farms, forests, and small towns are principle land uses. Only a small percentage of streams is impaired, generally as a result of nutrients and pathogens. Two small municipal lakes (Portland and Westmoreland) are impaired by urban runoff, animal feeding operations and livestock grazing in riparian areas.

Category Assessment	Stream Miles	Reservoir Acres
Total	563.2	45
Assessed	334.6	45
Category 1	128.7	0
Category 2	188.2	0
Category 3	228.6	0
Category 4	0.0	0
Category 5	17.7	45



2006 Assessment of Rivers and Streams in Barren River Watershed

Watershed Name:	**Clear Fork**
HUC Code:	**TN05130101**
Watershed Group:	4
Counties:	Campbell Claiborne Scott
Ecoregions:	69d
Reference Streams:	2
Drainage Area:	2,282 square miles
Tennessee Drainage:	329 square miles
TDEC Stations:	55
Advisories:	0
High Quality Waters:	38

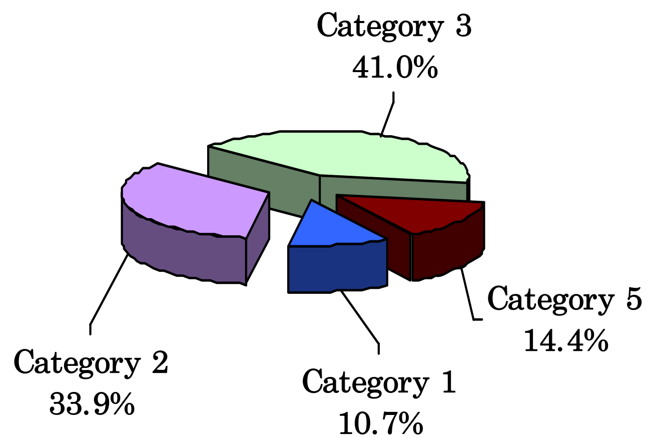
Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	441.6	0
Assessed	260.5	0
Category 1	47.3	0
Category 2	149.6	0
Category 3	181.1	0
Category 4	0.0	0
Category 5	63.6	0

Clear Fork Watershed

Only 14 percent of the Clear Fork watershed is in Tennessee, with the majority of the watershed in Kentucky.

Land uses include farms, timber harvesting, coal mines, with some oil and natural gas wells. Very few assessed stream miles were impaired. Pathogens and silt were the primary causes of impairment in this watershed.

This watershed lies totally within a single ecoregion and has two subecoregion reference sites: No Business Branch and Stinking Creek in 69d (Cumberland Mountains).



2006 Assessment of Rivers and Streams in Clear Fork Watershed

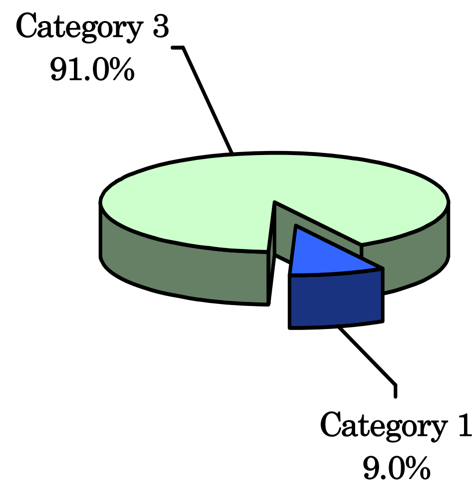
Watershed Name:	**Upper Cumberland**
HUC Code:	**TN05130103**
Watershed Group:	4
Counties:	Clay
Ecoregions:	71g & 71h
Reference Streams:	0
Drainage Area:	1,823 square miles
Tennessee Drainage:	34 square miles
TDEC Stations:	2
USACE Stations	1
Advisories:	0
High Quality Waters:	0

Category Assessment	Stream Miles	Reservoir Acres
Total	52.2	0
Assessed	4.7	0
Category 1	4.7	0
Category 2	0.0	0
Category 3	47.5	0
Category 4	0.0	0
Category 5	0.0	0

Upper Cumberland River Watershed

Less than two percent of the Upper Cumberland River watershed is in Tennessee with the remainder in Kentucky.

Additional monitoring was not conducted in this watershed during the Group 4 cycle in 2005 due to the small size of the watershed, lack of pollution sources, and limited personnel. Resources were targeted on larger watersheds with more pollution problems. Due to this lack of data, the division has not assessed many of the small tributaries in this watershed. The mainstem of the Upper Cumberland River is fully supporting designated uses.



2006 Assessment of Rivers and Streams in Upper Cumberland Watershed

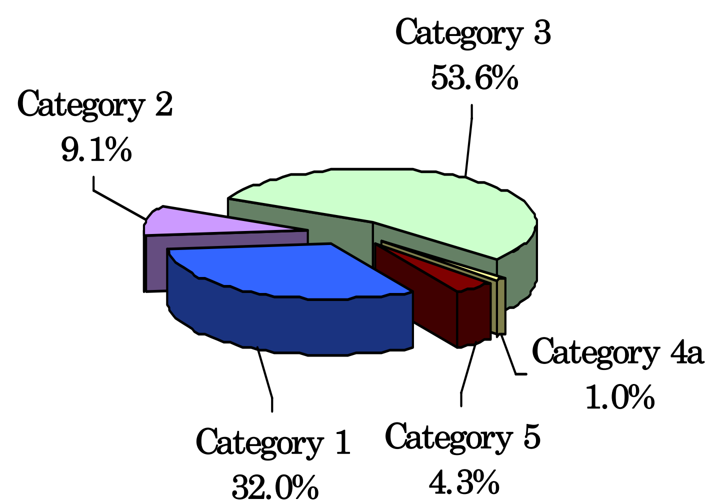
Watershed Name:	**South Fork Cumberland**
HUC Code:	**TN05130104**
Watershed Group:	4
Counties:	Anderson, Morgan, Campbell, Pickett, Fentress, Scott
Ecoregions:	68a, 68c, & 69d
Reference Streams:	4
Drainage Area:	1,365 square miles
Tennessee Drainage:	976 square miles
TDEC Stations:	75
Advisories:	5
High Quality Waters:	151

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	1,378.0	5
Assessed	639.7	5
Category 1	441.6	0
Category 2	125.3	0
Category 3	738.3	0
Category 4a	14.1	0
Category 5	58.7	5

South Fork Cumberland River Watershed

Seventy-two percent of this watershed is in Tennessee with the remainder in Kentucky. Logging, abandoned coalmines, small farms, some oil wells, and a national park characterize this watershed. Only 5 percent of assessed stream miles are non-supporting. A small lake in Pickett State Park is not supporting due to eutrophication, pH, and exotic plants.

This watershed has an Outstanding National Resource Water (ONRW), the Big South Fork Cumberland River. There are four subecoregion reference sites: Rock Creek and Laurel Fork Station Camp Creek in 68a (Cumberland Plateau) and New River and Round Rock Creek in 69d (Cumberland Mountains).



2006 Assessment of Rivers and Streams in South Fork Cumberland River Watershed

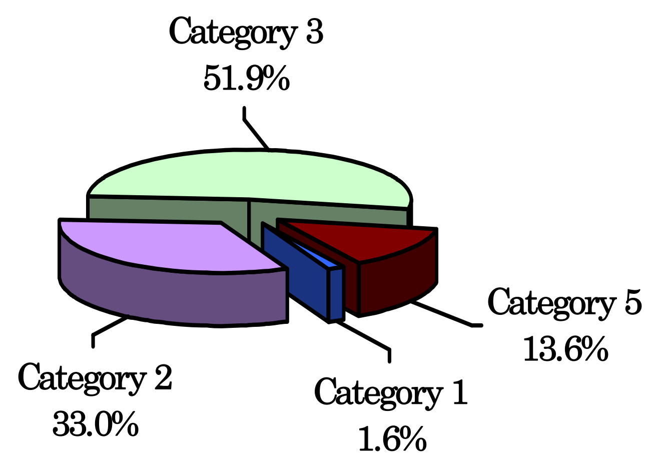
Watershed Name:	**Obey**	
HUC Code:	**TN05130105**	
Watershed Group:	4	
Counties:	Clay	Overton
	Cumberland	Pickett
	Fentress	Putnam
Ecoregions:	68a, 68c, 71g, & 71h	
Reference Streams:	0	
Drainage Area:	961 square miles	
Tennessee Drainage:	775 square miles	
TDEC Stations:	56	
USACE Stations:	15	
Advisories:	0	
High Quality Waters:	10	

Category Assessment	Stream Miles	Reservoir Acres
Total	776.4	22,000
Assessed	373.6	22,000
Category 1	12.1	22,000
Category 2	255.9	0
Category 3	402.8	0
Category 4	0.0	0
Category 5	105.6	0

Obey River Watershed
(including Dale Hollow Reservoir)

Eighty percent of the Obey River watershed is in Tennessee with the remainder in Kentucky. Dale Hollow Dam (1943) is operated as a hydroelectric plant by the U.S. Army Corps of Engineers (USACE). Dale Hollow is one of the cleanest reservoirs in the state and a popular recreation area in both Kentucky and Tennessee.

Twenty-eight percent of assessed streams miles are not supporting designated uses. Runoff from abandoned mines affect many of these stream miles with pollutants such as low pH, sediment, iron, and manganese.



2006 Assessment of Rivers and Streams in Obey River Watershed

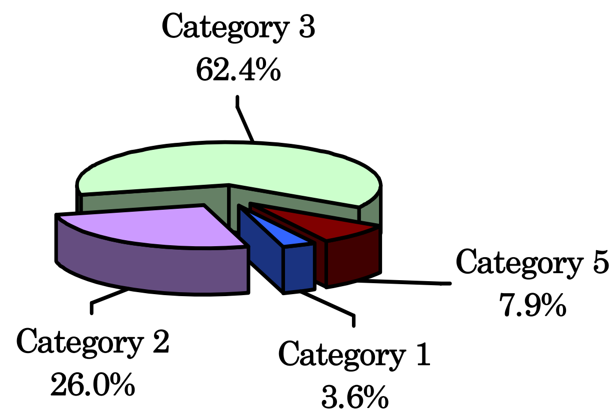
Watershed Name:	**Cordell Hull**	
HUC Code:	**TN05130106**	
Watershed Group:	4	
Counties:	Clay	Overton
	Jackson	Putnam
	Macon	Smith
Ecoregions:	68c, 71g, & 71h	
Reference Streams:	4	
Drainage Area:	782 square miles	
TDEC Stations:	67	
USACE Stations:	15	
Advisories:	0	
High Quality Waters:	17	

Category Assessment	Stream Miles	Reservoir Acres
Total	893.8	13,901
Assessed	336.0	13,901
Category 1	32.5	13,901
Category 2	232.6	0
Category 3	557.8	0
Category 4	0.0	0
Category 5	70.9	0

Cordell Hull Reservoir Watershed

This entire watershed is in Tennessee. Cordell Hull Reservoir on the Cumberland River supports all designated uses.

The Tennessee General Assembly has designated three Scenic Rivers in this watershed, Spring Creek, Blackburn Fork, and Roaring River. There are four subecoregion reference sites: Flat Creek, Spring Creek, and Blackburn Creek in 71g (Eastern Highland Rim) and Flynn Creek in 71h (Outer Nashville Basin).



2006 Assessment of Rivers and Streams in Cordell Hull Reservoir Watershed

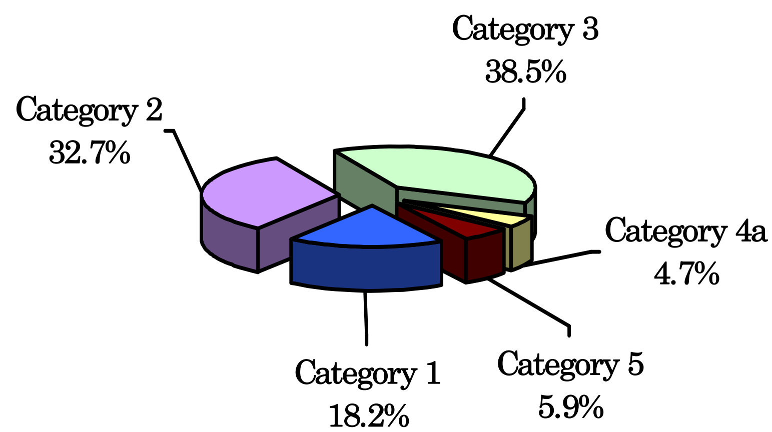
Watershed Name:	**Collins**		
HUC Code:	**TN05130107**		
Watershed Group:	2		
Counties:	Cannon	Sequatchie	
	Coffee	Warren	
	Grundy	Van Buren	
Ecoregions:	68a, 68c, 71g, & 71h		
Reference Streams:	0		
Drainage Area:	795 square miles		
TDEC Stations:	59		
USACE Station:	0		
Advisories:	0		
High Quality Waters:	26		

Category Assessment	Stream Miles	Reservoir Acres
Total	1,010.4	69
Assessed	621.1	69
Category 1	184.3	0
Category 2	329.9	69
Category 3	389.3	0
Category 4a	47.7	0
Category 5	59.2	0

Collins River Watershed

The entire Collins River watershed is in Tennessee and primarily drains rural areas. Agricultural activities including both livestock and crops as well as abandoned and active mines are the leading source of pollution. Alteration of stream side cover, sediment, and manganese and iron precipitates impair most of the stream miles.

The Tennessee General Assembly has designated the portion of the Collins River that flows through the Savage Gulf State Natural Area as a State Scenic River.



2006 Assessment of Rivers and Streams in Collins River Watershed

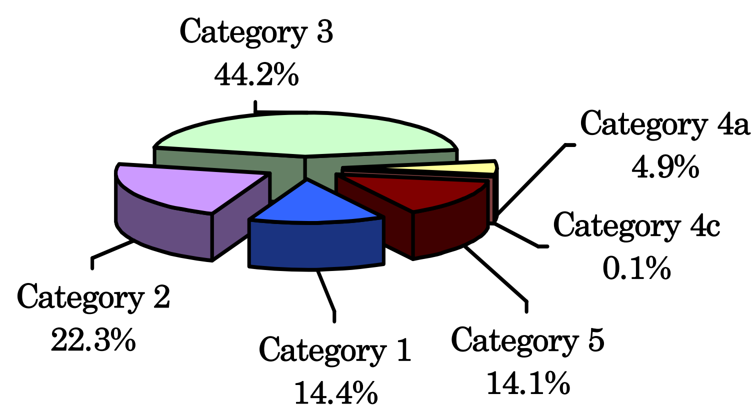
Watershed Name:	**Caney Fork**	
HUC Code:	**TN05130108**	
Watershed Group:	2	
Counties:	Bledsoe	Smith
	Cannon	Warren
	Cumberland	White
	DeKalb	Wilson
	Putnam	Van Buren
Ecoregions:	68a, 68c, 71g, & 71h	
Reference Streams:	1	
Drainage Area:	1,780 square miles	
TDEC Stations:	152	
USACE Stations:	18	
TDOT Stations:	2	
Advisory:	1	
High Quality Waters:	46	

Caney Fork River Watershed (including Center Hill Reservoir)

The entire Caney Fork watershed is in Tennessee. Two hydroelectric facilities are operated in this watershed, Center Hill Reservoir (USACE) and Great Falls Reservoir (TVA).

Live stock grazing in stream riparian, runoff from abandoned mines, and municipal stormwater runoff (MS4) are the primary sources of impairment. These activities affect the streams through habitat alteration, sediment, elevated nutrients and pathogens. Mine Lick Creek has a bacteriological advisory. This watershed has a subecoregion reference site on Clear Fork in 71h (Outer Nashville Basin).

Category Assessment	Stream Miles	Reservoir Acres
Total	2,012.6	25,887
Assessed	1,076.1	25,527
Category 1	305.4	23,418
Category 2	472.9	2,109
Category 3	936.5	360
Category 4a	104.8	0
Category 4c	1.4	0
Category 5	297.8	0



2006 Assessment of Rivers and Streams in Caney Fork River Watershed

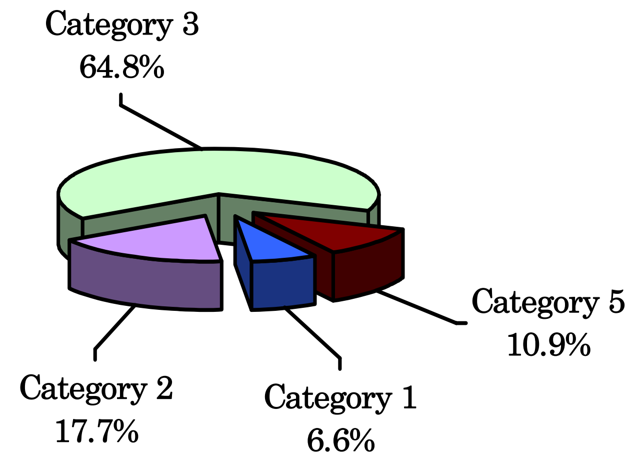
Watershed Name:	**Old Hickory**
HUC Code:	**TN05130201**
Watershed Group:	4
Counties:	Davidson Sumner Macon Trousdale Smith Wilson
Ecoregions:	71h, 71i, & 71g
Reference Streams:	1
Drainage Area:	975 square miles
TDEC Stations:	146
USACE Stations:	16
Advisories:	0
High Quality Waters:	8

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	1,161.3	27,439
Assessed	402.2	27,439
Category 1	76.7	27,439
Category 2	206.1	0
Category 3	752.1	0
Category 4	0.0	0
Category 5	126.4	0

Old Hickory Reservoir Watershed

This entire watershed is in Tennessee. Old Hickory Reservoir is an impoundment of the Cumberland River providing electricity, drinking water, and recreation for nearby metropolitan areas. The most common sources of pollution include livestock grazing in stream riparian, highway construction, and construction site clearance. A few stream miles are affected by MS4 runoff and municipal point source discharge. These activities have resulted in habitat alteration, sediment, and pathogens.

One subecoregion reference site is located on Cedar Creek in 71i (Inner Nashville Basin).



2006 Assessment of Rivers and Streams in Old Hickory Reservoir Watershed

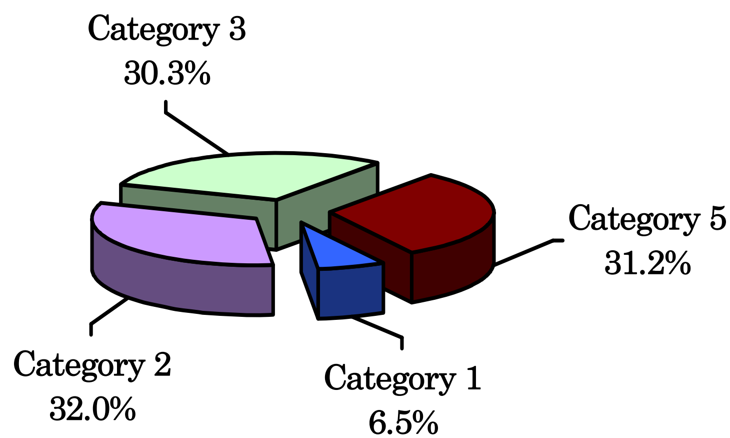
Watershed Name:	**Cheatham**
HUC Code:	**TN05130202**
Watershed Group:	5
Counties:	Cheatham Sumner Davidson Williamson Robertson
Ecoregions:	71e, 71f, 71h, & 71i
Reference Streams:	0
Drainage Area:	642 square miles
TDEC Stations:	210
USACE Stations:	16
Advisories:	10
High Quality Waters:	29

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	773.3	7,507
Assessed	539.0	7,447
Category 1	50.5	6,453
Category 2	247.6	0
Category 3	234.3	60
Category 4	0.0	0
Category 5	240.9	994

Cheatham Reservoir Watershed

The entire Cheatham Reservoir watershed is within Tennessee and provides electricity, drinking water, recreation, and commercial transportation for the Nashville area. Portions of the reservoir have elevated pathogens due to MS4 systems and combined sewer overflows.

About half of the assessed streams are impaired. The most frequently cited pollution sources are urban runoff, MS4 systems, sewer overflows as well as industrial and municipal point sources resulting in elevated pathogen and silt levels and habitat alteration.



2006 Assessment of Rivers and Streams in Cheatham Reservoir Watershed

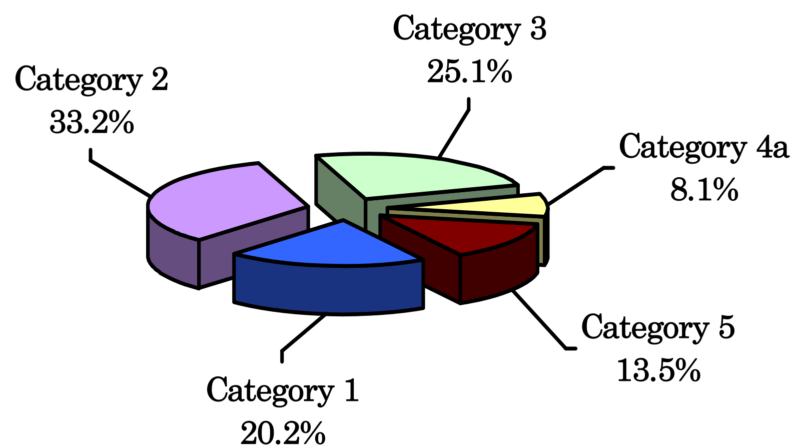
Stones River Watershed (including Percy Priest Reservoir)

Watershed Name:	**Stones**	
HUC Code:	**TN05130203**	
Watershed Group:	1	
Counties:	Cannon	Rutherford
	Davidson	Wilson
Ecoregions:	71h & 71i	
Reference Streams:	2	
Drainage Area:	921 square miles	
TDEC Stations:	109	
USACE Stations:	17	
Advisories:	0	
High Quality Waters:	18	

Category Assessment	Stream Miles	Reservoir Acres
Total	1,021.9	22,691
Assessed	765.8	22,691
Category 1	206.1	22,691
Category 2	339.0	0
Category 3	256.1	0
Category 4a	82.6	0
Category 5	138.1	0

The entire watershed is in Tennessee. Percy Priest Reservoir is formed by an impoundment of the Stones River by a USACE hydroelectric dam. Percy Priest Reservoir is considered fully supporting its designated uses. The majority of stream miles have been assessed for some uses. Less than a fourth of the stream miles are non supporting. Livestock, urban runoff, and land development are the primary sources of pollution in the watershed.

There are two subecoregion reference sites on West Fork Stones River in 71i (Inner Nashville Basin) and Carson Fork in 71h (Outer Nashville Basin).



2006 Assessment of Rivers and Streams in Stones River Watershed

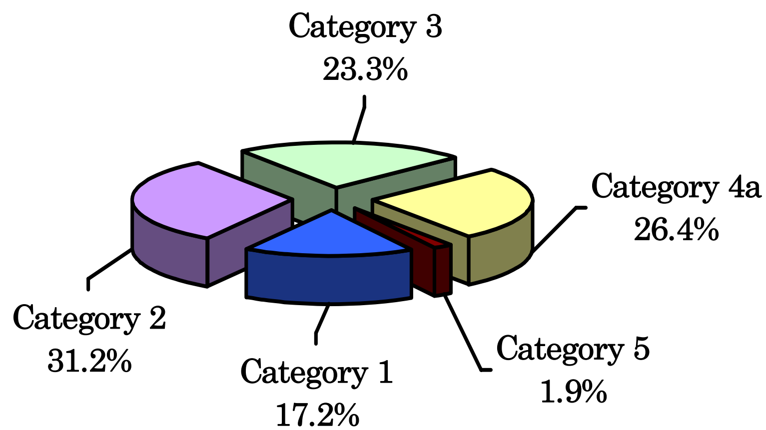
Watershed Name:	**Harpeth**
HUC Code:	**TN05130204**
Watershed Group:	1
Counties:	Cheatham, Hickman, Davidson, Rutherford, Dickson, Williamson
Ecoregions:	71f, 71h, & 71i
Reference Streams:	2
Drainage Area:	861 square miles
TDEC Stations:	239
USACE Stations:	1
Private Sector Stations:	42
Advisories:	0
High Quality Waters:	30

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	1,324.9	655
Assessed	1,016.8	655
Category 1	227.8	0
Category 2	413.4	0
Category 3	308.1	655
Category 4a	350.0	0
Category 5	25.6	0

Harpeth River Watershed

The entire Harpeth River watershed is in Tennessee. The majority of stream miles in this watershed have been assessed for fish and aquatic life and are fully supporting. Silt and habitat alteration due to livestock grazing, highway construction and site clearance are frequently cited problems in impaired waterbodies.

The Tennessee General Assembly has designated the portion of the Harpeth River within Davidson County as a State Scenic River. This watershed also has two subecoregion reference sites: South Harpeth Creek in 71f (Western Highland Rim) and the upper Harpeth River in 71i (Inner Nashville Basin).



2006 Assessment of Rivers and Streams in Harpeth River Watershed

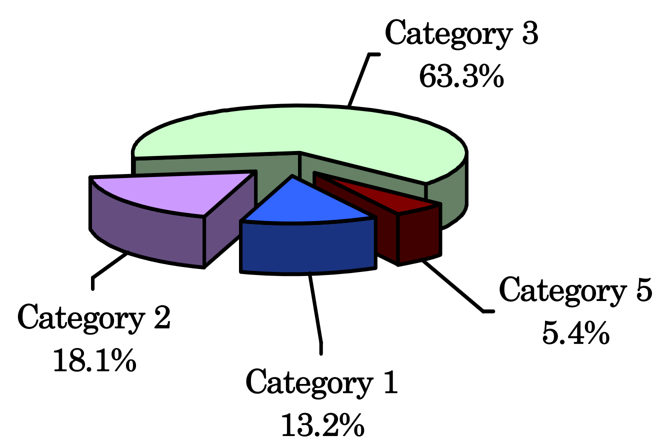
Watershed Name:	**Barkley**	
HUC Code:	**TN05130205**	
Watershed Group:	5	
Counties:	Cheatham	Montgomery
	Dickson	Stewart
	Houston	
Ecoregions:	71e & 71f	
Reference Streams:	0	
Drainage Area:	2,289 square miles	
Tennessee Drainage:	999 square miles	
TDEC Stations:	86	
USACE Stations:	9	
TWRA Station:	1	
Advisories:	0	
High Quality Waters:	37	

Category Assessment	Stream Miles	Reservoir Acres
Total	1,257.9	37,000
Assessed	461.5	37,000
Category 1	166.6	37,000
Category 2	227.6	0
Category 3	796.4	0
Category 4	0.0	0
Category 5	67.3	0

Barkley Reservoir Watershed

Less than half of Barkley Reservoir is in Tennessee, with the remainder in Kentucky. Barkley Dam, on the Cumberland River in Kentucky, is operated by the USACE as a hydroelectric facility. Barkley Reservoir forms the eastern boundary of Land Between the Lakes National Recreation Area, a popular recreation location.

Of the 37 percent of waterbodies in this watershed that have been assessed, 85 percent are fully supporting. The portion of Lake Barkley Reservoir in Tennessee has been assessed and is fully supporting.



2006 Assessment of Rivers and Streams in Barkley Reservoir Watershed

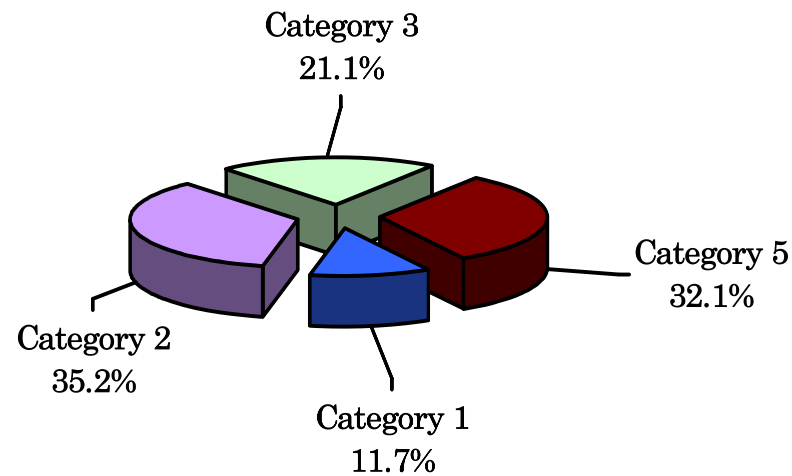
Watershed Name:	**Red**	
HUC Code:	**TN05130206**	
Watershed Group:	4	
Counties:	Montgomery	Stewart
	Robertson	Sumner
Ecoregions:	71e, 71f, & 71g	
Reference Streams:	2	
Drainage Area:	1,444 square miles	
Tennessee Drainage:	801	
TDEC Stations:	147	
USACE Stations:	1	
Advisories:	0	
High Quality Waters:	6	

Category Assessment	Stream Miles	Reservoir Acres
Total	788.9	15
Assessed	622.3	15
Category 1	92.0	0
Category 2	277.3	0
Category 3	166.6	0
Category 4	0.0	0
Category 5	253.0	15

Red River Watershed

The Red River originates in Tennessee, flows into Kentucky, then returns to Tennessee where it is a tributary to the Cumberland River (Barkley Reservoir) near Clarksville. Fifty-five percent of the watershed is in Tennessee with the remainder in Kentucky.

The majority of streams in this watershed have been assessed. Silt, habitat alteration, pathogens, and nutrients are the leading causes of pollution in impaired streams. Dunbar Cave Lake has elevated nitrates and sediment due to MS4 discharges and land development. This watershed has two subecoregion reference sites: Buzzard and Passenger Creeks in 71e (Western Pennyroyal Karst).



2006 Assessment of Rivers and Streams in Red River Watershed

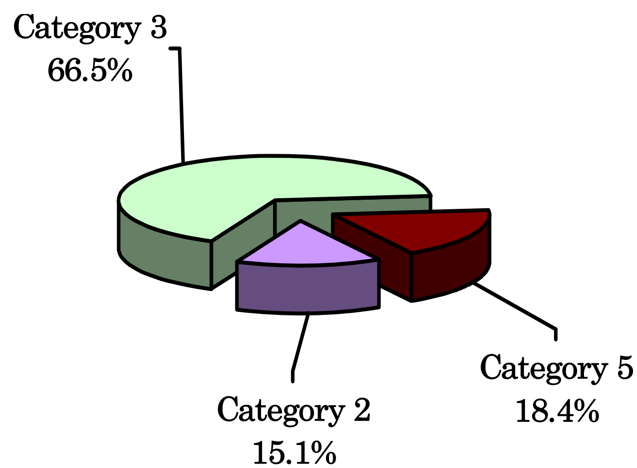
Watershed Name:	**North Fork Holston**
HUC Code:	**TN06010101**
Watershed Group:	3
Counties:	Hawkins Sullivan
Ecoregions:	67f, 67h, & 67i
Reference Stream:	0
Drainage Area:	714 square miles
Tennessee Drainage:	21 square miles
TDEC Stations:	3
TVA Stations	2
Advisories:	1
High Quality Waters:	1

Category Assessment	Stream Miles	Reservoir Acres
Total	33.1	0
Assessed	11.1	0
Category 1	0.0	0
Category 2	5.0	0
Category 3	22.0	0
Category 4	0.0	0
Category 5	6.1	0

North Fork Holston River Watershed

Only about four percent of the North Fork Holston River watershed is in Tennessee, with 96 percent of the watershed in Virginia.

The North Fork Holston River from the state line to its confluence with the South Fork is posted due to elevated levels of mercury in fish tissue and does not support recreational uses. The mercury is a legacy pollutant from an industry in Virginia.



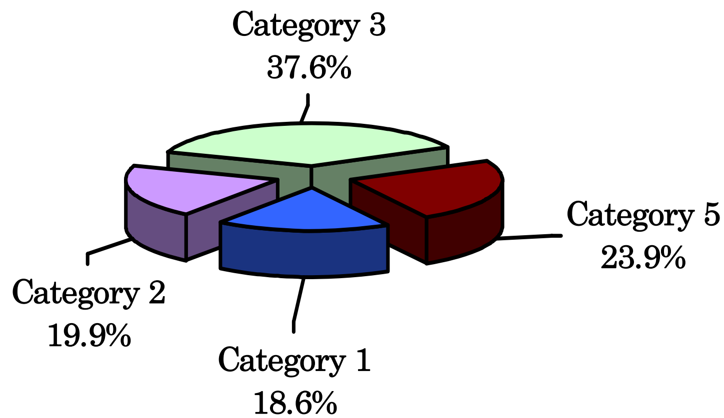
2006 Assessment of Rivers and Streams in North Fork Holston River Watershed

Watershed Name:	**South Fork Holston**
HUC Code:	**TN06010102**
Watershed Groups:	2 (downstream Boone Dam) & 3 (upstream Boone Dam)
Counties:	Carter Sullivan Johnson Washington
Ecoregions:	66d, 66e, 66f, 67f, 67g, 67h, & 67i
Reference Streams:	3
Drainage Area:	1,134 square miles
Tennessee Drainage:	551 square miles
TDEC Stations:	191
TVA Stations:	17
Advisories:	2
High Quality Waters:	101

South Fork Holston River Watershed (including Boone, South Holston, and Fort Patrick Henry Reservoirs)

Forty-eight percent of the South Fork Holston River Watershed is in Tennessee with the remainder in Virginia. Fort Patrick Henry, South Holston and Boone Reservoirs are TVA impoundments on the river. Boone Reservoir, which also impounds Watauga River water, is impaired due to PCBs and chlordane from contaminated sediment. There are three subecoregion reference sites: Gentry Creek in 66e (Southern Sedimentary Ridges), Beaverdam Creek in 66f (Limestone Valleys and Coves), and North Prong Fishdam Creek in 67g (Southern Shale Valley).

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	868.8	12,884
Assessed	542.4	12,884
Category 1	161.5	8,484
Category 2	172.9	0
Category 3	326.4	0
Category 4	0.0	0
Category 5	208.0	4,400



2006 Assessment of Rivers and Streams in South Fork Holston River Watershed

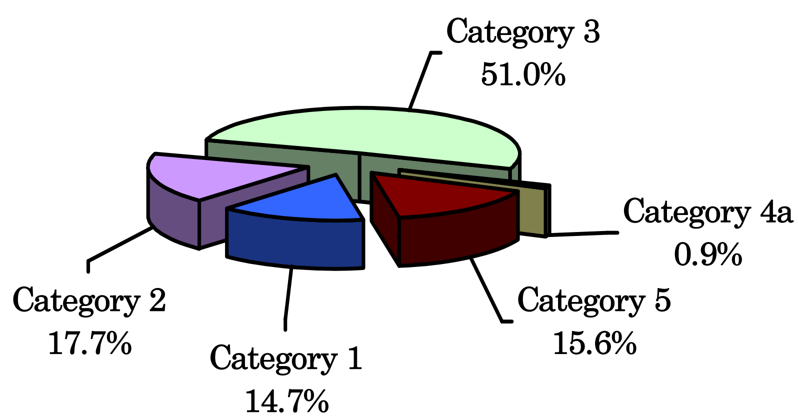
Watershed Name:	**Watauga**	
HUC Code:	**TN06010103**	
Watershed Group:	1	
Counties:	Carter	Washington
	Johnson	Unicoi
	Sullivan	
Ecoregions:	66d, 66e, 66f, 67f, & 67g	
Reference Streams:	5	
Drainage Area:	871 square miles	
Tennessee Drainage:	663 square miles	
TDEC Stations:	145	
TVA Stations:	18	
Advisories:	0	
High Quality Waters:	184	

Watauga River Watershed (including Watauga Reservoir)

Seventy-six percent of this watershed is in Tennessee with the remainder in North Carolina. Two reservoirs, Watauga and Wilbur in the Cherokee National Forest, are fully supporting. The majority of assessed stream miles are supporting. MS4 discharges and livestock grazing are chief sources of pollution in impaired waters.

In addition to the national forest, several state parks are within this watershed. There are five subecoregion reference sites: Doe River, Laurel Fork, Black, and Little Stony Creeks in 66d (Southern Igneous Ridges and Mountains) and Stony Creek in 66f (Limestone Valleys and Coves).

Category Assessment	Stream Miles	Reservoir Acres
Total	1,060.9	6,499
Assessed	519.9	6,499
Category 1	156.4	6,499
Category 2	188.1	0
Category 3	541.0	0
Category 4a	10.0	0
Category 5	165.4	0



2006 Assessment of Rivers and Streams in Watauga River Watershed

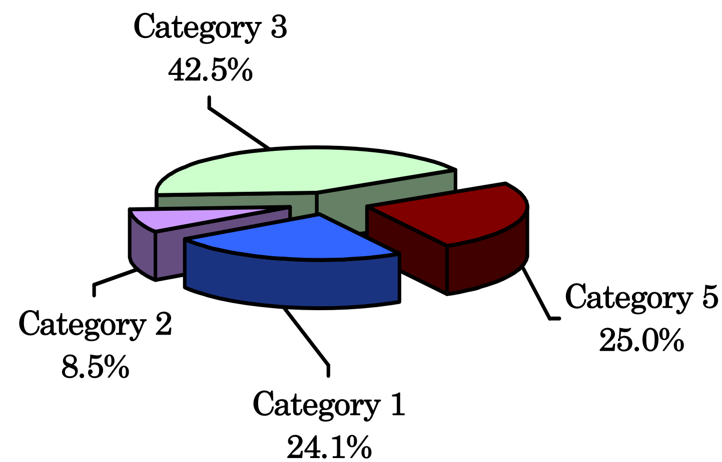
Watershed Name:	**Holston**	
HUC Code:	**TN06010104**	
Watershed Group:	4	
Counties:	Grainger	Knox
	Hamblen	Sevier
	Hawkins	Sullivan
	Jefferson	Union
Ecoregions:	67f, 67g, 67h, & 67i	
Reference Streams:	3	
Drainage Area:	990 square miles	
TDEC Stations:	103	
TVA Stations:	21	
Private Sector Station:	1	
Advisories:	1	
High Quality Waters:	11	

Category Assessment	Stream Miles	Reservoir Acres
Total	1,175.6	5,109
Assessed	646.5	5,109
Category 1	299.9	5,109
Category 2	105.6	0
Category 3	529.1	0
Category 4	0.0	0
Category 5	311.0	0

Holston River Watershed (including Cherokee Reservoir)

The entire Holston River watershed is in Tennessee. TVA impounded the Holston River in 1940 to create Cherokee Reservoir. Livestock grazing and MS4 discharges are the most common sources of impairment in streams. This results in habitat alteration, and elevated nutrients and sediment.

This watershed has a subecoregion (Level IV) reference site, Parker Branch in 67h (Southern Sandstone Ridges). In addition, Big Creek and Fisher Creek are ecoregion (Level III) reference sites for the Ridge and Valley ecoregion.



2006 Assessment of Rivers and Streams in Holston River Watershed

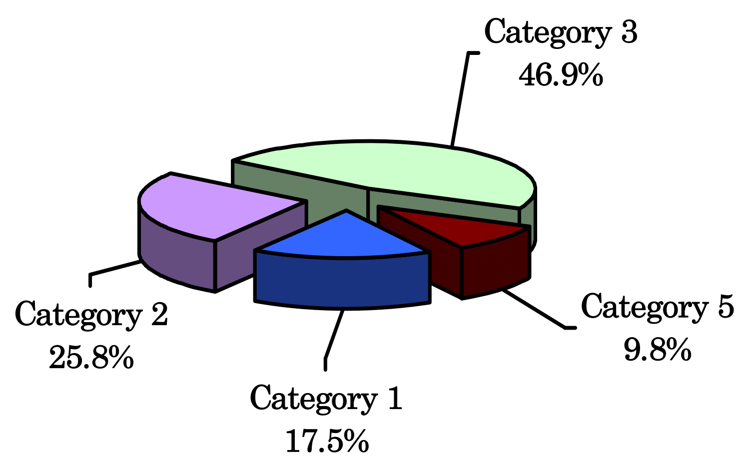
Watershed Name:	**Upper French Broad**
HUC Code:	**TN06010105**
Watershed Group:	5
Counties:	Cocke Greene
Ecoregions:	66d, 66e, 66g, 67f, & 67g
Reference Sites:	0
Drainage Area:	1,863 square miles
Tennessee Drainage:	213 square miles
TDEC Stations:	13
TVA Stations:	8
Advisories:	2
High Quality Waters:	72

Upper French Broad River Watershed

Only 11 percent of the Upper French Broad River watershed is in Tennessee with 89 percent in North Carolina. The watershed is sparsely populated with small farms and logging the principal land uses. The river drains a portion of the Cherokee National Forest in Tennessee and the Pisgah National Forest in North Carolina. The majority of stream miles support uses for which they were assessed. The only listed impairments are pathogens from livestock and septic tanks.

The Tennessee General Assembly has designated the French Broad River from the North Carolina border downstream to Douglas Reservoir as a State Scenic River.

Category Assessment	Stream Miles	Reservoir Acres
Total	380.0	0
Assessed	202.0	0
Category 1	66.6	0
Category 2	97.9	0
Category 3	178.1	0
Category 4	0.0	0
Category 5	37.4	0



2006 Assessment of Rivers and Streams in Upper French Broad Watershed

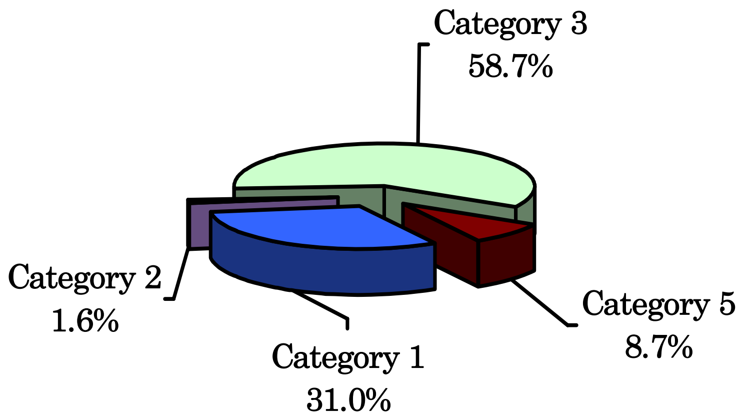
Watershed Name:	**Pigeon**
HUC Code:	**TN06010106**
Watershed Group:	5
Counties:	Cocke
Ecoregions:	66e, 66g, & 67f
Reference Stations:	0
Drainage Area:	543 square miles
Tennessee Drainage:	156 square miles.
TDEC Stations:	21
TVA Stations:	3
Advisories:	0 (Pigeon River advisory lifted in 2003)
High Quality Waters:	57

Pigeon River Watershed

Only 22 percent of the Pigeon River watershed is in Tennessee with 78 percent in North Carolina. The stream drains the Great Smoky Mountains National Park and national forests in Tennessee and North Carolina. The watershed is relatively undeveloped. There is an impoundment, Walters Dam, just upstream of the stateline.

The Pigeon River in Tennessee previously had a precautionary fish consumption advisory due to dioxins originating from a paper mill in North Carolina. Due to the documentation of lower dioxins levels recently, the advisory was lifted in 2003. A portion of the river is still impaired due to color from sources in North Carolina.

Category Assessment	Stream Miles	Reservoir Acres
Total	310.8	0
Assessed	128.5	0
Category 1	96.5	0
Category 2	4.9	0
Category 3	182.3	0
Category 4	0.0	0
Category 5	27.1	0



2006 Assessment of Rivers and Streams in Pigeon River Watershed

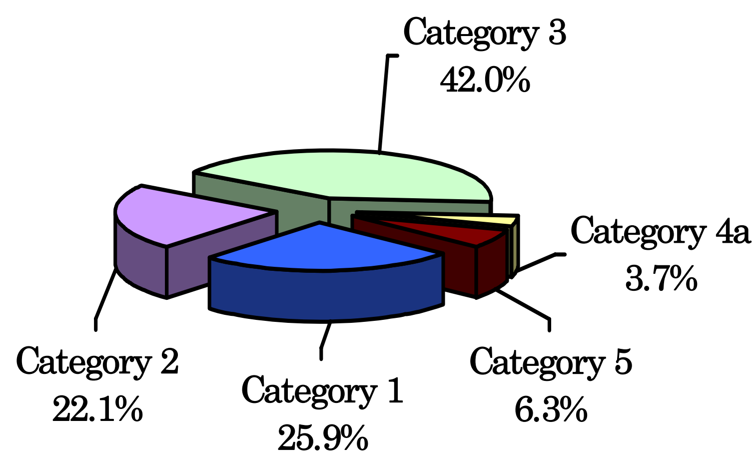
Watershed Name:	**Lower French Broad**
HUC Code:	**TN06010107**
Watershed Group:	5
Counties:	Cocke Knox Jefferson Sevier
Ecoregions:	66e, 66f, 66g, 67f, 67g, & 67i
Reference Sites:	2
Drainage Area:	728 square miles
TDEC Stations:	88
TVA Stations:	12
Advisories:	10
High Quality Waters:	103

Category Assessment	Stream Miles	Reservoir Acres
Total	1,210.1	30,400
Assessed	702.4	30,400
Category 1	313.4	30,400
Category 2	268.0	0
Category 3	507.7	0
Category 4a	44.8	0
Category 5	76.2	0

Lower French Broad River Watershed (including Douglas Reservoir)

Ninety-two percent of the Lower French Broad watershed is in Tennessee with the remainder in North Carolina. Douglas Reservoir provides hydroelectric power and water recreation. The majority of assessed waterbodies support designated uses. Elevated pathogens from septic tanks and sewer overflows as well as sediment are the biggest concern.

A portion of Tuckahoe Creek is designated as a State Scenic River. Two ONRWs, West Prong Little Pigeon River and Little Pigeon River in the Great Smoky Mountains National Park, are in this watershed. Middle Prong Little Pigeon River is an ecoregion reference stream in 66g (Southern Metasedimentary Mountains) and Flat Creek is an ecoregion reference stream in 67g (Southern Shale Valleys).



2006 Assessment for River and Streams in Lower French Broad River Watershed

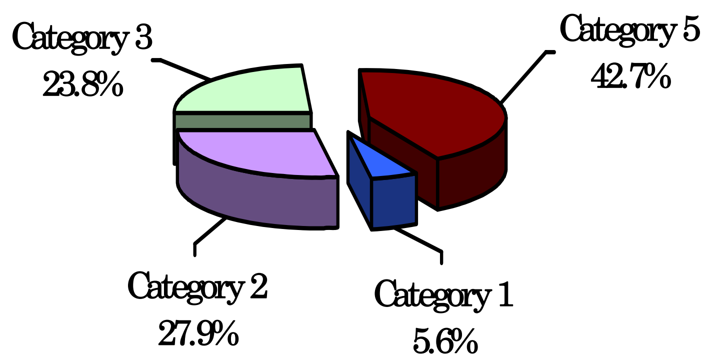
Nolichucky River Watershed
(including Davy Crockett Reservoir)

Watershed Name:	**Nolichucky**	
HUC Code:	**TN06010108**	
Watershed Group:	5	
Counties:	Cocke	Jefferson
	Greene	Unicoi
	Hamblen	Washington
	Hawkins	
Ecoregions:	66d, 66e, 66f, 66g, 67f, 67g, 67h, & 67i	
Reference Sites:	4	
Drainage Area:	1,773 square miles	
Tennessee Drainage:	1,140 square miles	
TDEC Stations:	374	
TVA Stations:	18	
Advisories:	0	
High Quality Waters:	104	

Sixty-four percent of the Nolichucky River watershed is in Tennessee with the remainder in North Carolina. TVA ceased operation of Davy Crockett Reservoir (Nolichucky Dam) in 1972 as a hydroelectric facility due to excessive silt deposits. The reservoir is partially supporting of aquatic life. Many streams are impaired by silt, habitat alteration, and elevated pathogens, primarily from livestock grazing.

Four streams are subecoregion reference sites: Tumbling Creek in 66d (Southern Igneous Ridges and Mountains), Clark Creek and Lower Higgins Creek in 66e (Southern Sedimentary Ridges), as well as Bent Creek in 67g (Southern Shale Valleys).

Category Assessment	Stream Miles	Reservoir Acres
Total	1,920.0	383
Assessed	1,462.3	383
Category 1	107.0	0
Category 2	535.1	0
Category 3	457.7	0
Category 4	0.0	0
Category 5	820.2	383



2006 Assessment of Rivers and Streams in Nolichucky River Watershed

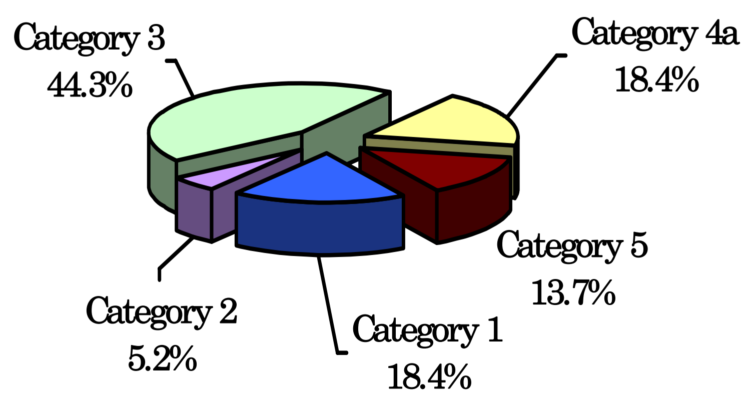
Watershed Name:	**Upper Tennessee**	
HUC Code:	**TN06010201**	
Watershed Groups:	1 (Watts Bar) & 2 (Fort Loudoun)	
Counties:	Bledsoe	McMinn
	Blount	Monroe
	Cumberland	Rhea
	Loudon	Roane
	Knox	Sevier
Ecoregions:	66f, 66g, 66e, 67f, 68c, 67g, 67h, 67i, & 68a	
Reference Sites:	3	
Drainage Area:	1,326 square miles	
TDEC Stations:	197	
TVA Stations:	36	
Volunteer Stations:	48	
Advisories:	8	
High Quality Waters:	167	

	Stream Miles	**Reservoir Acres**
Total	1,843.5	50,465
Assessed	1,027.2	50,465
Category 1	339.2	0
Category 2	96.7	0
Category 3	816.3	0
Category 4a	338.4	0
Category 5	252.9	50,465

Upper Tennessee River Watershed (including Fort Loudoun and Watts Bar Reservoirs)

Over 99 percent of this watershed is in Tennessee. TVA operates two hydroelectric dams, Watts Bar Dam and Fort Loudoun Dam. Both reservoirs are considered impaired due to PCB accumulation in fish tissue. Pathogens, silt, nutrients, and habitat alteration are common problems in streams. Sources of these impairments are MS4 discharges and livestock grazing.

The portion of the Little River in Great Smoky Mountains National Park has been designated as an ONRW. There are three subecoregion reference sites: Double Branch in 66e (Southern Sedimentary Ridges), Little River in 66g (Southern Metasedimentary Mountains) and Piney Creek in 68a (Cumberland Plateau).



2006 Assessment of Rivers and Streams in Upper Tennessee River Watershed

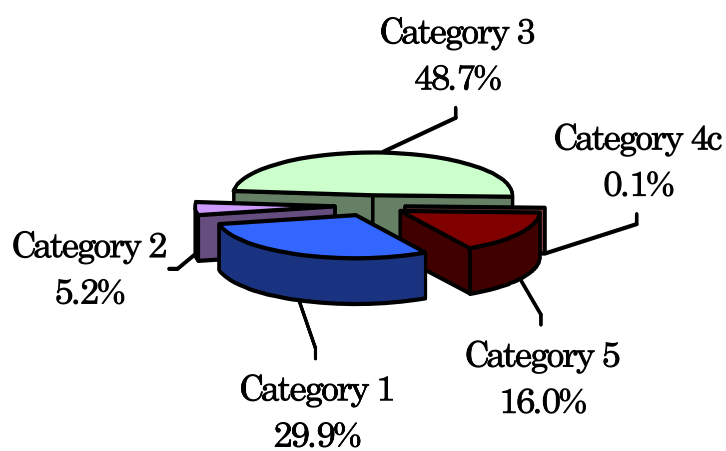
Watershed Name:	**Little Tennessee**
HUC Code:	**TN06010204**
Watershed Group:	3
Counties:	Blount Monroe Loudon
Ecoregions:	66e, 66f, 66g, 67f, 67h, 67i, & 67g
Reference Sites:	4
Drainage Area:	1,062 square miles
Tennessee Drainage:	779 square miles
TDEC Stations:	56
TVA Stations:	17
Advisories:	1
High Quality Waters:	227

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	1,088.0	18,878
Assessed	558.0	18,782
Category 1	325.0	2,282
Category 2	57.1	0
Category 3	530.0	96
Category 4c	1.6	0
Category 5	174.3	16,500

Little Tennessee River Watershed (including Tellico Reservoir)

Seventy-four percent of this watershed is in Tennessee with the remainder in North Carolina. The watershed is mostly small farms and public lands. Pathogens, habitat alteration, and sediment are the most common stream pollutants. TVA's Tellico Reservoir is impaired due to PCBs from contaminated sediment. Chilhowee and Calderwood Reservoirs are fully supporting.

Abrams Creek in the Great Smoky Mountains National Park has been designated as an ONRW. There are four subecoregion reference sites: Abrams Creek in 66f (Limestone Valleys and Coves), Citico Creek and North River in 66g (Southern Metasedimentary Mountains) as well as Laurel Creek in 67h (Southern Sandstone Ridges).



2006 Assessment of Rivers and Streams in Little Tennessee River Watershed

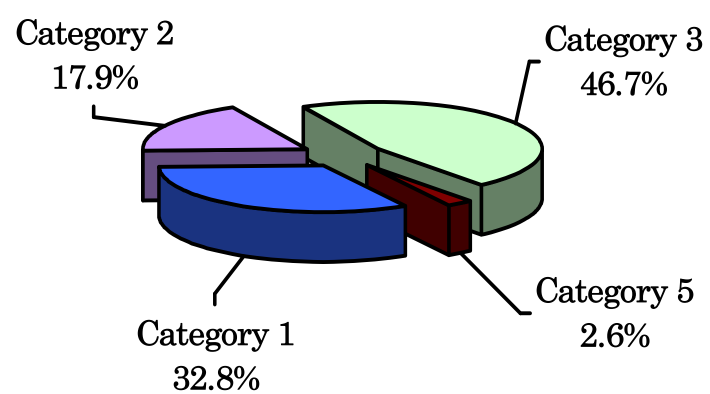
Upper Clinch River Watershed (including Norris Reservoir)

Watershed Name:	**Upper Clinch**	
HUC Code:	**TN06010205**	
Watershed Group:	4	
Counties:	Anderson	Hancock
	Campbell	Hawkins
	Claiborne	Union
	Grainger	
Ecoregions:	67f, 67h, & 67i	
Reference Sites:	2	
Drainage Area:	1,944 square miles	
Tennessee Drainage:	709 square miles	
TDEC Stations:	89	
TVA Stations:	17	
Advisories:	0	
High Quality Waters:	29	

Only 36 percent of the upper Clinch River is in Tennessee with the remainder in Virginia. Norris Reservoir is a large TVA impoundment in this watershed. This is a rural watershed with small farms and logging the primary land uses. Very few assessed stream miles are impaired. Pathogens and nitrates from livestock and municipal sources impair a few stream miles.

This watershed has two subecoregion reference sites: White and Big War Creeks in 67f (Southern Limestone Dolomite Valleys and Low Rolling Hills).

Category Assessment	Stream Miles	Reservoir Acres
Total	757.1	34,681
Assessed	403.8	34,187
Category 1	248.6	34,187
Category 2	135.4	0
Category 3	353.3	494
Category 4	0.0	0
Category 5	19.8	0



2006 Assessment of Rivers and Streams in Upper Clinch River Watershed

Watershed Name:	**Powell**	
HUC Code:	**TN06010206**	
Watershed Group:	4	
Counties:	Campbell	Hancock
	Claiborne	Union
Ecoregions:	67f, 67h, & 69d	
Reference Sites:	3	
Drainage Area:	954 square miles	
Tennessee Drainage:	402 square miles	
TDEC Stations:	51	
TVA Stations:	9	
Advisories:	0	
High Quality Waters:	6	

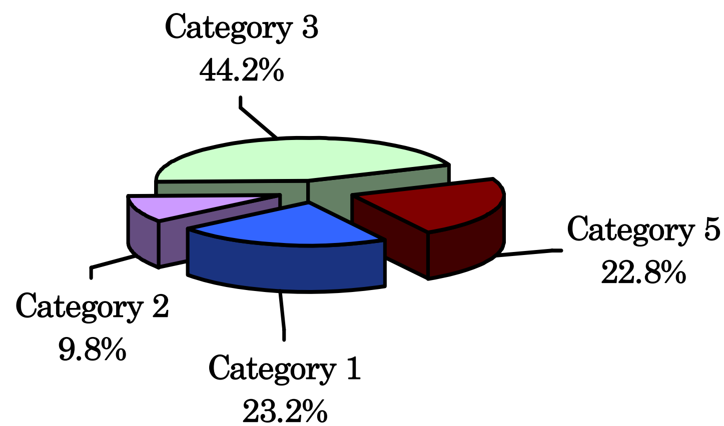
Category Assessment	Stream Miles	Reservoir Acres
Total	429.0	0
Assessed	239.3	0
Category 1	99.5	0
Category 2	42.2	0
Category 3	189.7	0
Category 4	0.0	0
Category 5	97.6	0

Powell River Watershed

Forty-two percent of this watershed is in Tennessee with the remainder in Virginia. The Powell River arm of Norris Reservoir is included in this watershed.

Dairies, beef cattle, and tobacco farming are the dominant land uses with logging, mining, and drilling for oil and natural gas also occurring. Silt, nutrients, habitat alteration, and pathogens impair the most stream miles.

This watershed has three subecoregion reference sites: Powell River, Hardy Creek, and Martin Creek in 67f (Southern Limestone Dolomite Valleys and Low Rolling Hills).



2006 Assessment of Rivers and Streams in Powell River Watershed

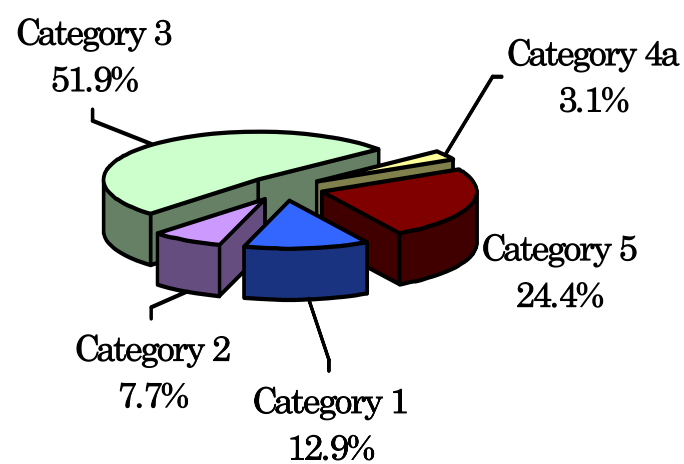
Watershed Name:	**Lower Clinch**	
HUC Code:	**TN06010207**	
Watershed Group:	3	
Counties:	Anderson	Loudon
	Campbell	Morgan
	Grainger	Roane
	Knox	Union
Ecoregions:	67f, 67i, 68a, & 69d	
Reference Streams:	2	
Drainage Area:	628 square miles	
TDEC Stations:	101	
TVA Stations:	16	
Advisories:	4	
High Quality Waters:	17	

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	854.4	8026
Assessed	411.3	8026
Category 1	110.5	0
Category 2	66.0	0
Category 3	443.1	0
Category 4a	26.4	0
Category 5	208.4	8026

Lower Clinch River Watershed (including Melton Hill Reservoir)

The entire lower Clinch watershed is in Tennessee. Land use is predominantly small farms, industry, and urban development. Historic Department of Energy activities have resulted in mercury and PCB contamination of East Fork Poplar Creek embayment and PCBs in Melton Hill Reservoir. MS4 and point source discharges as well as livestock grazing results in stream impairment from pathogens, nutrients and habitat alteration.

A portion of the Clinch River is designated as a State Scenic River. There are two subecoregion reference sites: Clear Creek in 67f (Southern Limestone Dolomite Valley and Low Rolling Hills) and Mill Branch in 67i (Southern Dissected Ridges and Knobs).



2006 Assessment of Rivers and Streams in Lower Clinch River Watershed

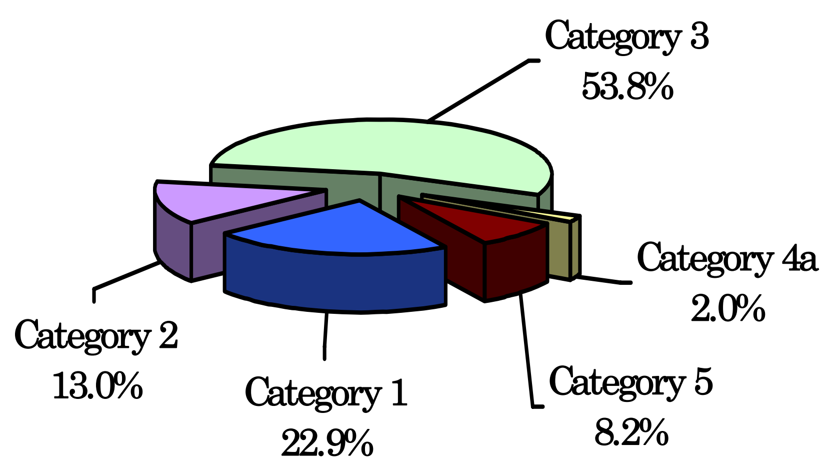
Watershed Name:	**Emory**	
HUC Code:	**TN06010208**	
Watershed Group:	1	
Counties:	Cumberland	Morgan
	Fentress	Roane
Ecoregions:	67f, 67i, 68a, 68c, & 69d	
Reference Sites:	5	
Drainage Area:	866 square miles	
TDEC Stations:	78	
TVA Stations:	18	
Advisories:	0	
High Quality Waters:	116	

Category Assessment	Stream Miles	Reservoir Acres
Total	1,299.9	1,305.7
Assessed	600.2	1,258.7
Category 1	297.4	0
Category 2	169.6	0
Category 3	699.7	47
Category 4a	26.5	0
Category 5	106.7	1,258.7

Emory River Watershed

The entire watershed is within Tennessee. The majority of assessed waterbodies are fully supporting. Abandoned mines impair many stream miles, however most of these areas are recovering. Other pollution sources include livestock grazing and point source discharges. Watts Barr Reservoir is impaired by chlordane and PCBs from contaminated sediment.

The state's only Wild and Scenic River as designated by the National Park Service is the Obed River from the western border of the Cattoosa Wildlife Management Area to the Emory River. This designation also includes a portion of Clear Creek and Daddy's Creek. There are five subecoregion reference sites in this watershed: Clear, Daddy's, Island, and Rock Creeks in 68a (Cumberland Plateau) and Flat Creek in 69d (Cumberland Mountains).



2006 Assessment of Rivers and Streams in Emory River Watershed

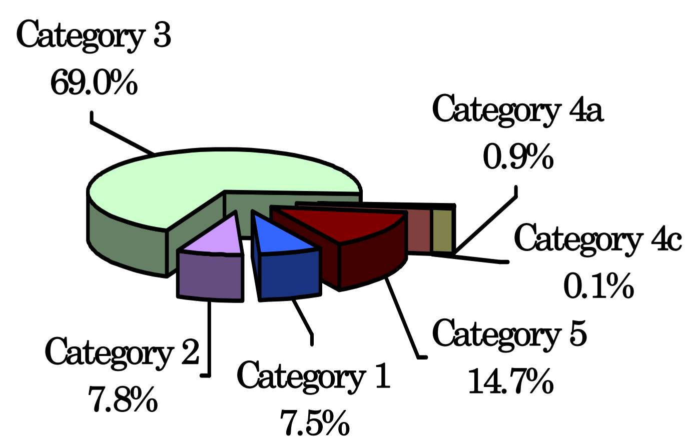
Lower Tennessee River Watershed (including Chickamauga and Nickajack Reservoirs)

Watershed Name:	**Lower Tennessee**	
HUC Code:	**TN06020001**	
Watershed Groups:	3 (Chickamauga) & 4 (Nickajack)	
Counties:	Bledsoe	McMinn
	Bradley	Meigs
	Hamilton	Rhea
	Loudon	Roane
	Marion	Sequatchie
Ecoregions:	67f, 67g, 67h, 67i, 68a, 68b, & 68c	
Reference Sites:	2	
Drainage Area:	1,861 square miles	
Tennessee Drainage:	1,214 square miles	
TDEC Stations:	210	
TVA Stations:	28	
Advisories:	3	
High Quality Waters:	70	

About 65 percent of the watershed is in Tennessee with the remainder in Georgia. This watershed includes a major metropolitan area as well as rural areas consisting of small cattle farms and abandoned mines. The majority of the streams have not been assessed. Typical causes of pollution in streams are pathogens, nutrients, low pH, and habitat alteration. Nickajack Reservoir is partially supporting due to PCBs and dioxins. Chickamauga Reservoir is fully supporting.

The watershed has two subecoregion reference sites, Mullens Creek in 68a (Cumberland Plateau) and Ellis Gap Branch in 68c (Plateau Escarpment).

Category Assessment	Stream Miles	Reservoir Acres
Total	1,506.8	45,780
Assessed	466.6	45,770
Category 1	112.7	35,400
Category 2	117.3	0
Category 3	1,040.2	10
Category 4a	13.9	0
Category 4c	1.1	0
Category 5	221.6	10,370



2006 Assessment of Rivers and Streams in Lower Tennessee River Watershed

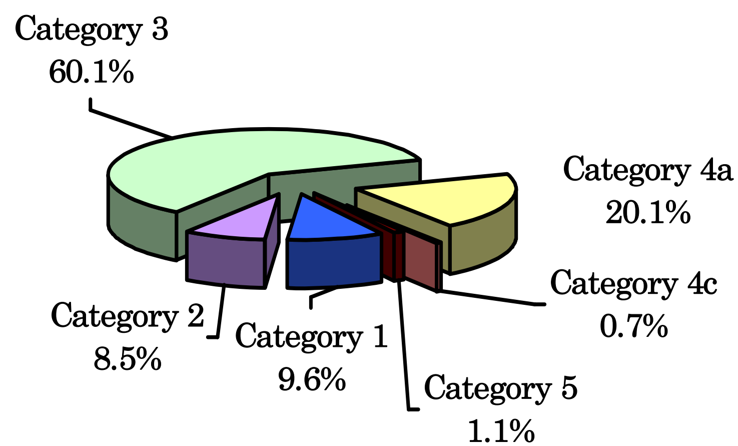
Watershed Name:	**Hiwassee**		
HUC Code:	**TN06020002**		
Watershed Group:	2		
Counties:	Bradley	Monroe	
	Meigs	Polk	
	McMinn		
Ecoregions:	66g, 66e, 67f, 67g, 67h, & 67i		
Reference Sites:	4		
Drainage Area:	2,062 square miles		
Tennessee Drainage:	1,017 square miles		
TDEC Stations:	113		
TVA Stations:	31		
Advisories:	1		
High Quality Waters:	118		

Hiwassee River Watershed

About half of the watershed is in Tennessee with the remainder in North Carolina and Georgia. This is a predominantly rural area of farms, small towns, and national forest. Pathogens, sediment and habitat alteration from livestock grazing and MS4 discharges are frequently cited in impaired stream miles.

A portion of the Hiwassee River is designated as a State Scenic River and is popular for recreational boating and fishing. There are four subecoregion reference sites: Gee Creek in 66e (Southern Sedimentary Ridges), Brymer Creek and Harris Creek in 67g (Southern Shale Valleys), and Blackburn Creek in 67h (Southern Sandstone Ridges).

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	1,666.0	0
Assessed	664.7	0
Category 1	159.7	0
Category 2	140.9	0
Category 3	1,001.3	0
Category 4a	334.9	0
Category 4c	11.4	0
Category 5	17.8	0



2006 Assessment of Rivers and Streams in Hiwassee River Watershed

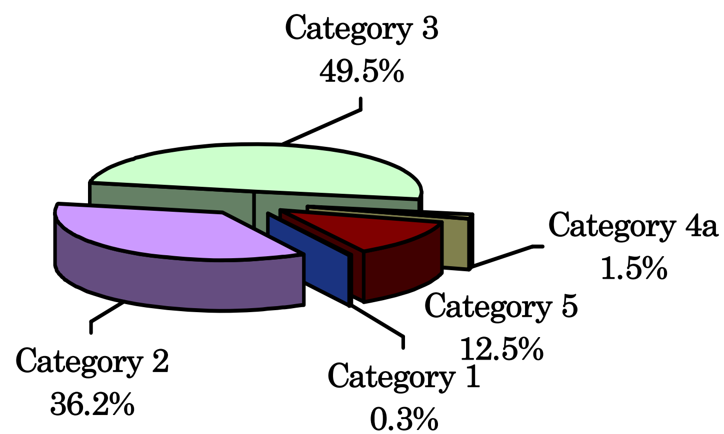
Watershed Name:	**Ocoeee**
HUC Code:	**TN06020003**
Watershed Group:	1
Counties:	Polk
Ecoregions:	66g, 66e, 67f, 67g, & 67i
Reference Sites:	0
Drainage Area:	641 square miles
Tennessee Drainage:	212 square miles
TDEC Stations:	27
TVA Stations:	10
Advisories:	0
High Quality Waters:	87

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	313.5	2,881
Assessed	158.4	2,881
Category 1	0.8	627
Category 2	113.6	0
Category 3	155.1	0
Category 4a	4.8	0
Category 5	39.2	2,254

Ocoee River Watershed

Only 32 percent of the Ocoee River Watershed is in Tennessee with the remainder in North Carolina and Georgia. Three reservoirs were constructed on the Ocoee River between 1911 and 1942 and are currently operated by TVA for the production of electricity. Portions of the river are popular whitewater rafting and kayaking destinations.

The Ocoee River drains the Copper Basin where copper mining and related operations have been carried out since 1850. Most of the impaired stream miles and reservoir acres are a result of this activity. Extensive long term reforestation and clean up activities are being conducted in this watershed.



2006 Assessment of Rivers and Streams in Ocoee River Watershed

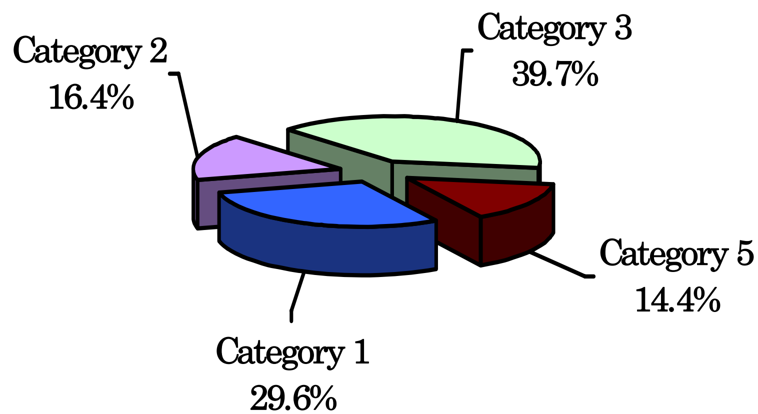
Watershed Name:	**Sequatchie**	
HUC Code:	**TN06020004**	
Watershed Group:	5	
Counties:	Bledsoe	Marion
	Cumberland	Sequatchie
	Grundy	
Ecoregions:	68a, 68b, & 68c	
Reference Sites:	3	
Drainage Area:	586 square miles	
TDEC Stations:	113	
TVA Stations:	12	
Advisories:	0	
High Quality Waters:	14	

Category Assessment	Stream Miles	Reservoir Acres
Total	909.2	0
Assessed	548.6	0
Category 1	268.7	0
Category 2	149.1	0
Category 3	360.6	0
Category 4	0.0	0
Category 5	130.8	0

Sequatchie River Watershed

The entire watershed is in Tennessee. This is primarily a rural area with pasture the dominant land use. Pathogens from livestock grazing cause the most impaired stream miles. Surface mining is also a problem causing elevated iron and manganese and lowering the pH of some streams.

This watershed has three subecoregion reference sites: Crystal Creek, McWilliams Creek and Mill Branch in 68b (Sequatchie Valley). Subregion 68b is entirely within the Sequatchie River watershed in Tennessee. A small portion of the region extends into Alabama that is outside of the Sequatchie watershed.



2006 Assessment of Rivers and Streams in Sequatchie River Watershed

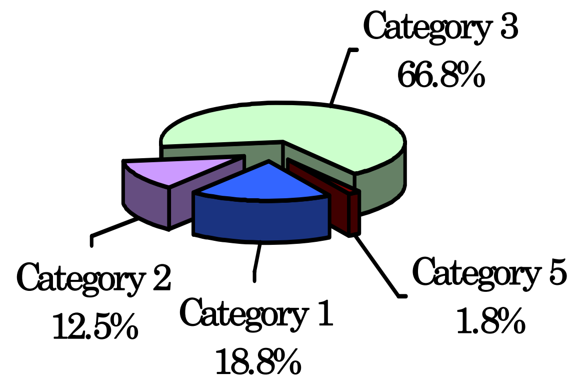
Watershed Name:	**Guntersville**
HUC Code:	**TN06030001**
Watershed Group:	5
Counties:	Franklin Grundy Marion
Ecoregions:	68a, 68b, & 68c
Reference Sites:	1
Drainage Area:	1,995 square miles
Tennessee Drainage:	340 square miles
TDEC Stations:	39
TVA Stations:	4
Advisories:	1
High Quality Waters:	10

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	424.3	1,479
Assessed	140.7	1,479
Category 1	79.9	1,463
Category 2	53.2	16
Category 3	283.6	0
Category 4	0.0	0
Category 5	7.6	0

Guntersville Reservoir Watershed

Only 17 percent of the watershed is in Tennessee with the remainder in Alabama. This is a rural area with small farms and mining. The majority of streams have not been assessed. Pathogens from septic tanks and livestock grazing is the primary pollutant in impaired waters. Guntersville Reservoir is fully supporting.

This watershed has one subecoregion reference site, Crow Creek in 68c (Plateau Escarpment).



2006 Assessment of Rivers and Streams in Guntersville Reservoir Watershed

Watershed Name:	**Wheeler**	
HUC Code:	**TN06030002**	
Watershed Group:	2	
Counties:	Franklin	Lawrence
	Giles	Lincoln
Ecoregions:	68a, 68c, 71f, & 71g	
Reference Sites:	0	
Drainage Area:	2896 square miles	
Tennessee Drainage:	227 square miles	
TDEC Stations:	24	
TVA Stations:	2	
Advisories:	0	
High Quality Waters:	2	

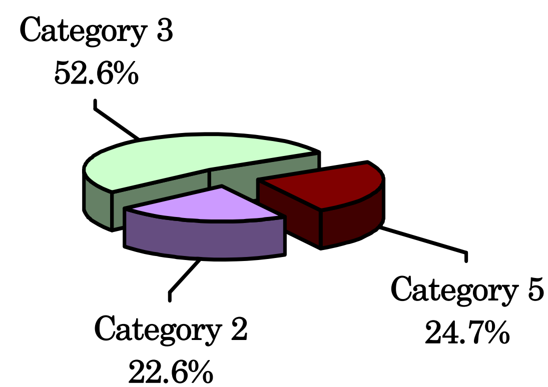
Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	313.3	0
Assessed	148.4	0
Category 1	0.0	0
Category 2	70.9	0
Category 3	164.9	0
Category 4	0.0	0
Category 5	77.5	0

Wheeler Reservoir Watershed

Only eight percent of this watershed is in Tennessee, the rest is in Alabama. Streams in the Tennessee portion of this watershed drain south into Alabama where Wheeler Reservoir is located.

The number of assessed stream miles increased from only 8% in 2002 to 47% in 2006. Both stations were on the Flint River, which is considered impaired by silt and habitat alterations from crop production.

Eighteen additional stations were monitored during the 2006 assessment cycle. Many of the assessed stream miles were shown to be supporting of fish and aquatic life.



2006 Assessment of Rivers and Streams in Wheeler Reservoir Watershed

Upper Elk River Watershed (including Tims Ford and Woods Reservoirs)

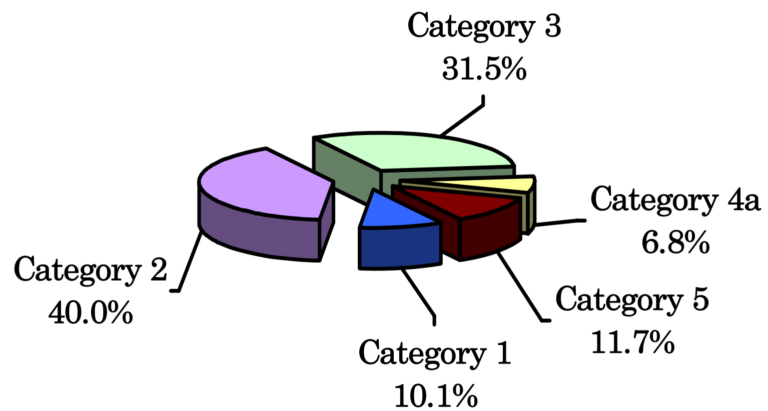
Watershed Name:	**Upper Elk**	
HUC Code:	**TN06030003**	
Watershed Group:	2	
Counties:	Coffee	Lincoln
	Franklin	Marshall
	Giles	Moore
	Grundy	
Ecoregions:	68a, 68c, 71h, & 71g	
Reference Sites:	2	
Drainage Area:	1,260 square miles	
TDEC Stations:	136	
TVA Stations:	35	
Advisories:	1	
High Quality Waters:	25	

Over 99 percent of the watershed is in Tennessee with a small portion in Alabama. TVA completed Tims Ford hydroelectric dam in 1970. The U.S. Air Force completed Woods Reservoir in 1952 to use as a source of cooling water. Both reservoirs are popular recreation areas.

Woods Reservoir is not supporting due to PCBs from contaminated sediments. Tims Ford Reservoir, as well as the majority of assessed streams in the watershed, is fully supporting.

This watershed has two subecoregion reference sites, Mud Creek in 68c (Plateau Escarpment) and Hurricane Creek in 71g (Eastern Highland Rim).

Category Assessment	Stream Miles	Reservoir Acres	Wetland Acres
Total	1,811.8	14,504	1,837
Assessed	1,241.5	14,504	0
Category 1	182.7	10,596	0
Category 2	724.1	0	0
Category 3	570.3	0	1,837
Category 4a	123.1	0	0
Category 5	211.6	3,908	0



2006 Assessment of Rivers and Streams in Upper Elk River Watershed

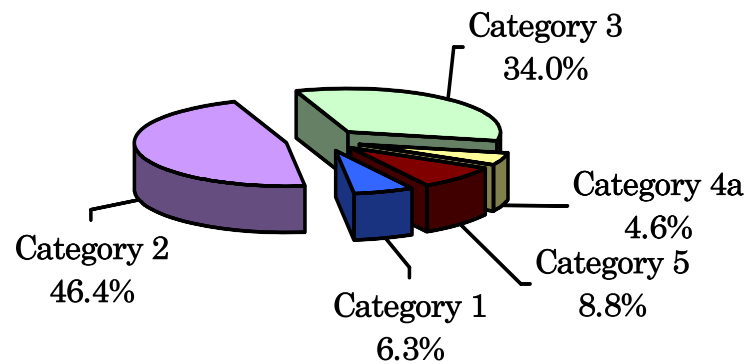
Watershed Name:	**Lower Elk**
HUC Code:	**TN06030004**
Watershed Group:	2
Counties:	Giles
	Lawrence
	Marshall
Ecoregions:	71f & 71h
Reference Sites:	0
Drainage Area:	974 square miles
Tennessee Drainage:	711 square miles
TDEC Stations:	85
TVA Stations:	13
Advisories:	0
High Quality Waters:	2

Category Assessment	Stream Miles	Reservoir Acres
Total	1,116.9	0
Assessed	737.6	0
Category 1	70.7	0
Category 2	518.1	0
Category 3	379.3	0
Category 4a	51.0	0
Category 5	97.8	0

Lower Elk River Watershed

Seventy-three percent of the watershed is in Tennessee with the remainder in Alabama. From Tennessee, the Elk River flows into Wheeler Reservoir on the Tennessee River in Alabama.

The drainage area is primarily agricultural with row crops and pasture prevalent. Most of the assessed streams are fully supporting. Industry, municipal point sources, and livestock are the primary sources of pollution in the impaired stream miles. Pathogens and sediment are the predominant causes.



2006 Assessment of Rivers and Streams in Lower Elk River Watershed

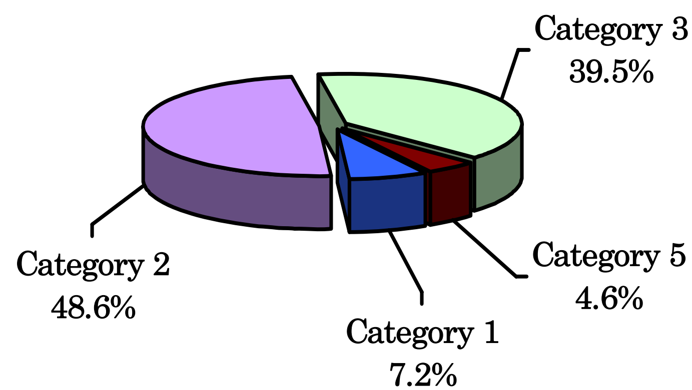
Pickwick Reservoir Watershed

Watershed Name:	**Pickwick**
HUC Code:	**TN06030005**
Watershed Group:	2
Counties:	Hardin Lawrence Wayne
Ecoregions:	65i, 65j, & 71f
Reference Sites:	3
Drainage Area:	2,276 square miles
Tennessee Drainage:	627
TDEC Stations:	88
TVA Stations:	15
Advisories:	0
High Quality Waters:	26

Only 28 percent of the watershed is in Tennessee with the remainder in Mississippi and Alabama. Pickwick Reservoir is a TVA impoundment of the Tennessee River. Most of the assessed waterbodies are fully supporting. Industry, municipal point source, and livestock are the primary pollution sources.

This watershed has three subecoregion reference sites: Pompeys Branch and Dry Creek in 65j (Transition Hills), and Swanegan Branch in 71f (Western Highland Rim).

Category Assessment	Stream Miles	Reservoir Acres
Total	952.0	5,840
Assessed	576.0	5,800
Category 1	68.8	5,800
Category 2	463.0	0
Category 3	376.0	40
Category 4	0.0	0
Category 5	44.2	0



2006 Assessment of Rivers and Streams in Pickwick Reservoir Watershed

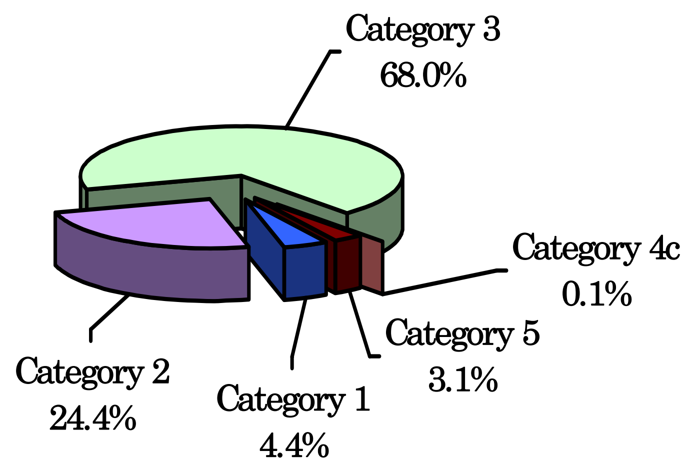
Upper Kentucky Reservoir Watershed

Watershed Name:	**Upper Kentucky**	
HUC Code:	**TN06040001**	
Watershed Group:	3	
Counties:	Benton	Humphreys
	Chester	McNairy
	Decatur	Perry
	Hardin	Wayne
	Henderson	
Ecoregions:	65a, 65e, 65i, 65j, & 71f	
Reference Sites:	4	
Drainage Area:	2,100 square miles	
Tennessee Drainage:	2,055 square miles	
TDEC Stations:	182	
TVA Stations:	47	
TWRA Stations:	2	
Private Sector Stations:	5	
Advisories:	0	
High Quality Waters:	86	

Over 98 percent of the watershed is in Tennessee with a small portion in Mississippi. Between 1963 and 1965, TVA constructed dams on the Beech River and seven tributaries for flood control and recreational use. All of the assessed reservoirs support designated uses. Livestock grazing, sediment and low DO and channelization are the primary pollution sources with silt the most prevalent pollutant in impaired streams.

Four streams are subecoregion reference sites: Wardlow Creek in 65a (Blackland Prairie), Battles Branch in 65i (Fall Line Hills), Right Fork Whites Creek and an unnamed tributary to Right Fork Whites Creek in 65j (Transition Hills).

Category Assessment	Stream Miles	Reservoir Acres
Total	3,398.2	20,763
Assessed	1,088.2	17,500
Category 1	150.8	17,500
Category 2	829.3	0
Category 3	2,310.0	3,263
Category 4c	2.9	0
Category 5	105.2	0



2006 Assessment of Rivers and Streams in Upper Kentucky Reservoir Watershed

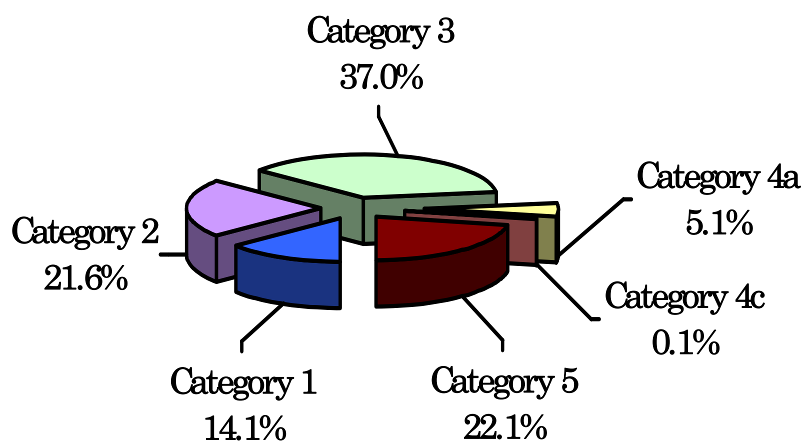
Watershed Name:	**Upper Duck**	
HUC Code:	**TN06040002**	
Watershed Group:	3	
Counties:	Bedford	Maury
	Coffee	Rutherford
	Marshall	Williamson
Ecoregions:	71g, 71h, & 71i	
Reference Sites:	2	
Drainage Area:	1,553 square miles	
TDEC Stations:	288	
TVA Stations:	25	
Advisories:	2	
High Quality Waters:	35	

Upper Duck River Watershed (including Normandy Reservoir)

The entire watershed is in Tennessee. Normandy Dam, built for flood control, is TVA's largest non-power generating dam. Over 1,000 stream miles have been assessed. Pathogens, nutrients, silt, and habitat alteration from agricultural activities and MS4 discharges impair the most stream miles. Normandy Reservoir is fully supporting.

A portion of the Duck River is designated as a State Scenic River. The river also provides habitat for several endangered species. There are two subecoregion reference sites, Flat and Little Flat Creeks in 71i (Inner Nashville Basin).

Category Assessment	Stream Miles	Reservoir Acres
Total	1,606.1	3,260
Assessed	1,012.5	3,260
Category 1	227.2	3,260
Category 2	346.9	0
Category 3	593.6	0
Category 4a	81.8	0
Category 4c	2.2	0
Category 5	354.4	0



2006 Assessment of Rivers and Streams in Upper Duck River Watershed

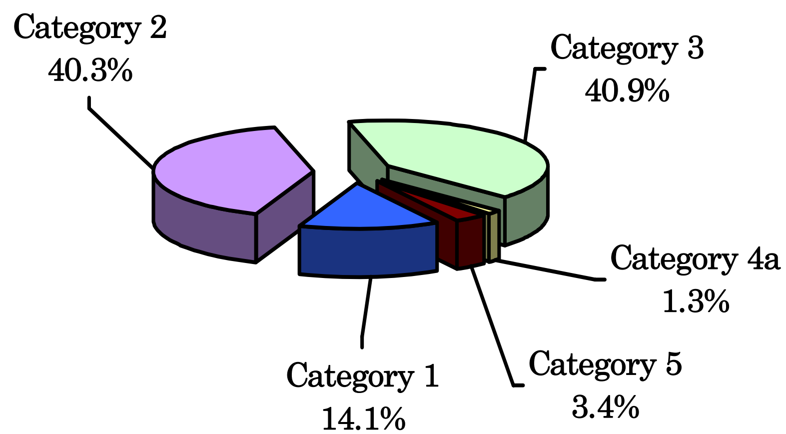
Watershed Name:	**Lower Duck**	
HUC Code:	**TN06040003**	
Watershed Group:	3	
Counties:	Dickson	Lewis
	Hickman	Maury
	Humphreys	Perry
	Lawrence	Williamson
Ecoregions:	71f & 71h	
Reference Sites:	3	
Drainage Area:	736 square miles	
TDEC Stations:	223	
TVA Stations:	34	
TWRA Stations:	1	
Private Sector Stations:	4	
Advisories:	0	
High Quality Waters:	55	

Category Assessment	Stream Miles	Reservoir Acres
Total	2,511.6	1,013
Assessed	1,484.5	0
Category 1	355.3	0
Category 2	1,011.2	0
Category 3	1,027.1	1,013
Category 4a	33.2	0
Category 5	84.7	0

Lower Duck River Watershed

The entire watershed is in Tennessee. The area is primarily agricultural with some small towns and industry. Point source discharges (industrial and municipal), MS4 discharges, abandoned mines, site development and CAFOs are sources of impairment. The primary causes of pollution are sediment, pathogens, nutrients, and habitat alteration.

This watershed has three subecoregion reference sites: Wolf Creek, Little Swan Creek and Hurricane Creek in 71f (Western Highland Rim).



2006 Assessment of Rivers and Streams in Lower Duck River Watershed

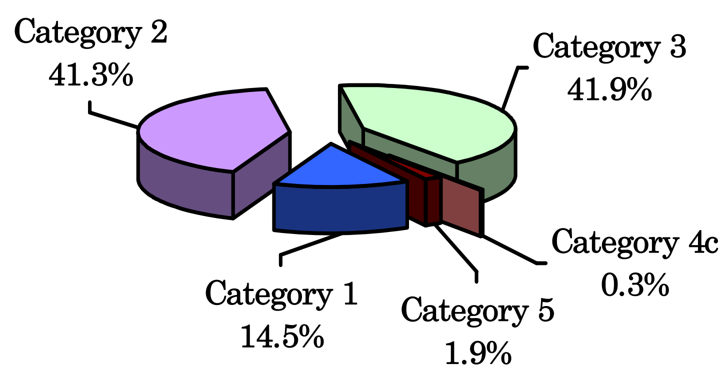
Watershed Name:	**Buffalo**	
HUC Code:	**TN06040004**	
Watershed Group:	3	
Counties:	Hickman	Lewis
	Humphreys	Perry
	Lawrence	Wayne
Ecoregions:	65j & 71f	
Reference Sites:	1	
Drainage Area:	1,823 square miles	
TDEC Stations:	98	
TVA Stations:	16	
TWRA Stations:	2	
Advisories:	0	
High Quality Waters:	33	

Buffalo River Watershed

The entire watershed is in southern middle Tennessee. The Buffalo River flows into the Duck River just upstream of its confluence with the Tennessee River. Over half of the watershed has been assessed. Water quality is good with the majority of assessed stream miles fully supporting fish and aquatic life.

The Tennessee General Assembly has designated portions of the Buffalo River as a State Scenic River. It is popular for canoeing and supports several commercial operators. This watershed also has one subecoregion reference site, Brush Creek in 71f (Western Highland Rim).

Category Assessment	Stream Miles	Reservoir Acres
Total	1,224.1	349
Assessed	710.7	0
Category 1	177.6	0
Category 2	505.6	0
Category 3	513.4	349
Category 4c	4.0	0
Category 5	23.5	0



2006 Assessment of Rivers and Streams in Buffalo River Watershed

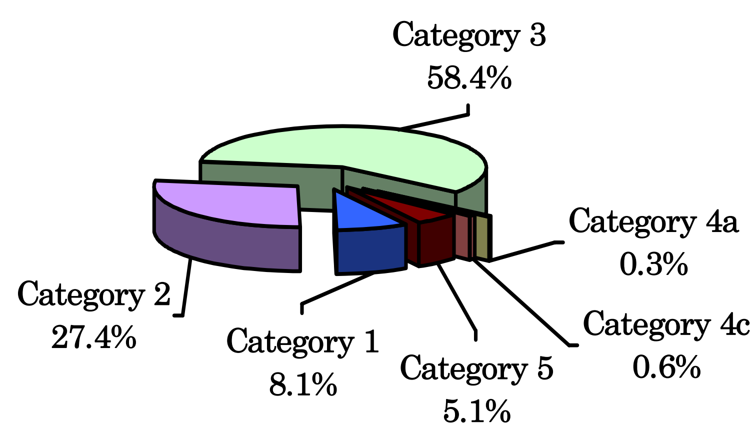
Watershed Name:	**Lower Kentucky**
HUC Code:	**TN06040005**
Watershed Group:	3
Counties:	Benton, Houston, Carroll, Humphreys, Henderson, Stewart, Henry
Ecoregions:	65e, 71f, & 74b
Reference Sites:	1
Drainage Area:	1,824 square miles
Tennessee Drainage:	1,469 square miles
TDEC Stations:	137
TVA Stations:	28
TWRA Stations:	5
Advisories:	0
High Quality Waters:	82

Category Assessment	Stream Miles	Reservoir Acres
Total	2,112.0	100,004
Assessed	879.2	100,004
Category 1	170.8	100,000
Category 2	579.6	0
Category 3	1,232.8	0
Category 4a	7.3	0
Category 4c	13.6	
Category 5	107.9	4

Lower Kentucky Reservoir Watershed

About 80 percent of the watershed is in Tennessee with the remainder, including Kentucky Dam, in Kentucky. This is a geographically diverse watershed, which crosses three Level III ecoregions. It is a relatively rural area with agriculture, upstream impoundments and channelization impairing the most stream miles. The lower portion of the Kentucky Reservoir is fully supporting except for the West Sandy Embayment area, which is impaired due to sediment and low DO from upstream impoundments and septic systems.

This watershed has one high quality stream that is a subecoregion reference site, Blunt Creek in 65e (Southeastern Plains and Hills).



2006 Assessment of Rivers and Streams in Lower Kentucky Reservoir Watershed

Watershed Name:	**Clarks**
HUC Code:	**TN06040006**
Watershed Group:	3
County:	Henry
Ecoregions:	65e & 74b
Reference Sites:	0
Drainage Area:	704 square miles
Tennessee Drainage:	23 square miles
TDEC Stations:	5
Advisories:	0
High Quality Waters:	0

Category Assessment	Stream Miles	Reservoir Acres
Total	29.4	0
Assessed	14.8	0
Category 1	0.0	0
Category 2	0.0	0
Category 3	14.6	0
Category 4	0.0	0
Category 5	14.8	0

Clarks River Watershed

About 3 percent of the watershed is in Tennessee with the remainder in Kentucky. Clarks River flows into the Tennessee River in Kentucky. This watershed primarily drains a rural area. The watershed was not previously assessed due to the small size of the watershed in Tennessee. During 2005, the state began a project with Kentucky to develop cooperative water quality improvement projects between Tennessee and Kentucky. Five stations are monitored as part of that project. Physical substrate habitat alterations from non-irrigated crop production impair all assessed stream miles.

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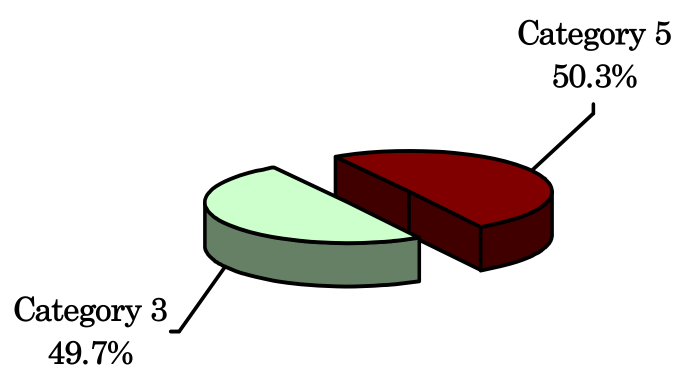


2006 Assessment of Rivers and Streams in Clarks River Watershed

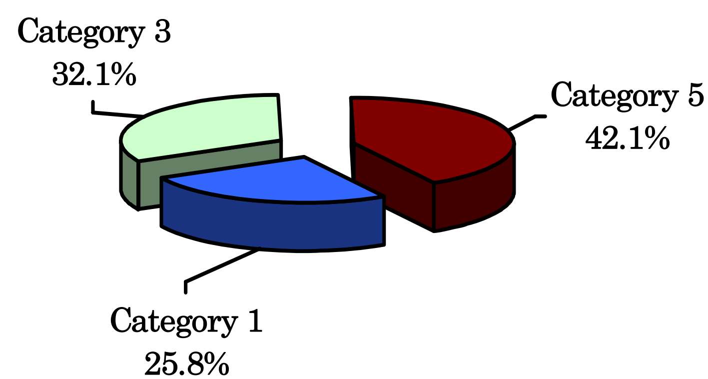
Watershed Name:	**Mississippi**	
HUC Code:	**TN08010100**	
Watershed Group:	5	
Counties:	Dyer	Shelby
	Lake	Tipton
	Lauderdale	
Ecoregions:	73a & 74a	
Reference Sites:	3	
Tennessee Drainage:	497 square miles	
TDEC Stations:	37	
Mo. ONR Station:	1	
Volunteer Stations:	14	
Advisories:	2	
High Quality Waters:	43	

Category Assessment	Stream Miles	Reservoir Acres
Total	515.9	125
Assessed	350.2	125
Category 1	133.1	0
Category 2	0.0	0
Category 3	165.7	0
Category 4	0.0	0
Category 5	217.1	125

Mississippi River Watershed

The portion of the river bordering Tennessee is defined as the Lower Mississippi-Memphis segment by USGS. The mainstem Mississippi River is considered impaired by a variety of pollutants. Agricultural activities and sources in other states are the principal pollution sources upstream of Shelby County. The river near Memphis is not supporting recreational uses due to contaminated sediment.

This watershed has three subecoregion reference sites: Cold Creek and Middle Fork of the Forked Deer River in 73a (Northern Mississippi Alluvial Plain) and Sugar Creek in 74a (Bluff Hills).



2006 Assessment of Rivers and Streams in Mississippi River Watershed

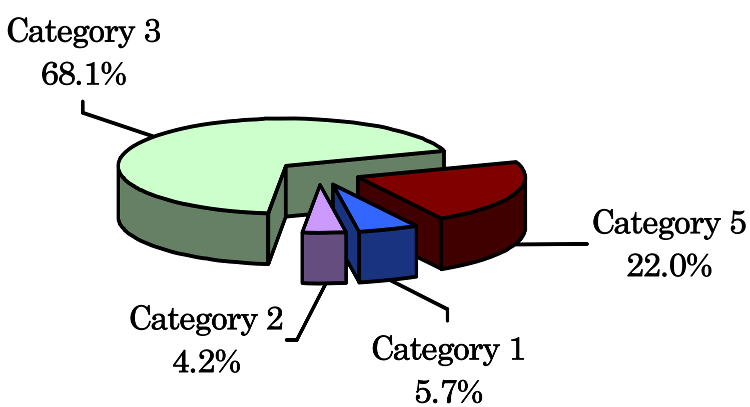
Lower Obion River Watershed (including Reelfoot Lake)

Watershed Name:	**Lower Obion**	
HUC Code:	**TN08010202**	
Watershed Group:	5	
Counties:	Dyer	Lake
	Gibson	Obion
	Henry	Weakley
Ecoregions:	65e, 73a, 74a, & 74b	
Reference Sites:	4	
Drainage Area:	1,311 square miles	
Tennessee Drainage:	1,171 square miles	
TDEC Stations:	142	
Advisories:	0	
High Quality Waters:	35	

About 89 percent of the Lower Obion River Watershed is in Tennessee with the remainder in Kentucky. Row crops including corn, cotton, and soybeans are widespread. Crop runoff and channelization are the significant pollution sources resulting in sedimentation and physical substrate alterations. Reelfoot Lake is impaired due to accelerated eutrophication.

Reelfoot, the largest natural lake in Tennessee, is an ONRW due to recreational, scenic, and unique ecological values. There are four subecoregion reference sites: Bayou du Chien in 73a (Northern Mississippi Alluvial Plain), Pawpaw Creek in 74a (Bluff Hills), and Terrapin and Powell Creeks in 74b (Loess Plains).

Category Assessment	Stream Miles	Reservoir Acres
Total	1,744.4	15,550
Assessed	556.5	15,550
Category 1	100.0	0
Category 2	73.4	0
Category 3	1,187.9	0
Category 4	0.0	0
Category 5	383.1	15,550



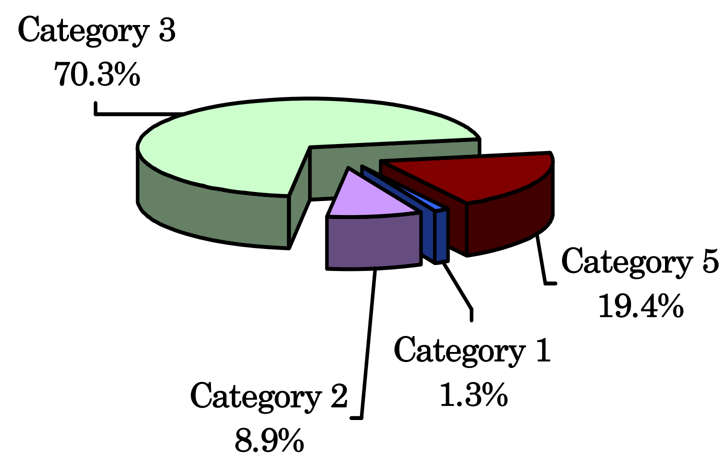
2006 Assessment of Rivers and Streams in Lower Obion River Watershed

Watershed Name:	**South Fork Obion**		
HUC Code:	**TN08010203**		
Watershed Group:	5		
Counties:	Carroll	Henry	
	Gibson	Obion	
	Henderson	Weakley	
Ecoregions:	65e & 74b		
Reference Sites:	0		
Drainage Area:	1,150 square miles		
TDEC Stations:	146		
TWRA Stations:	1		
Advisories:	0		
High Quality Waters:	14		

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	1,840.5	0
Assessed	546.0	0
Category 1	24.2	0
Category 2	164.1	0
Category 3	1,294.5	0
Category 4	0.0	0
Category 5	357.7	0

South Fork Obion River Watershed

The entire watershed is in Tennessee. Like many west Tennessee streams, the South and Rutherford Forks of the Obion River have been extensively channelized, causing silt and habitat problems. Runoff from row crops is another significant pollution source.



2006 Assessment of Rivers and Streams in South Fork Obion River Watershed

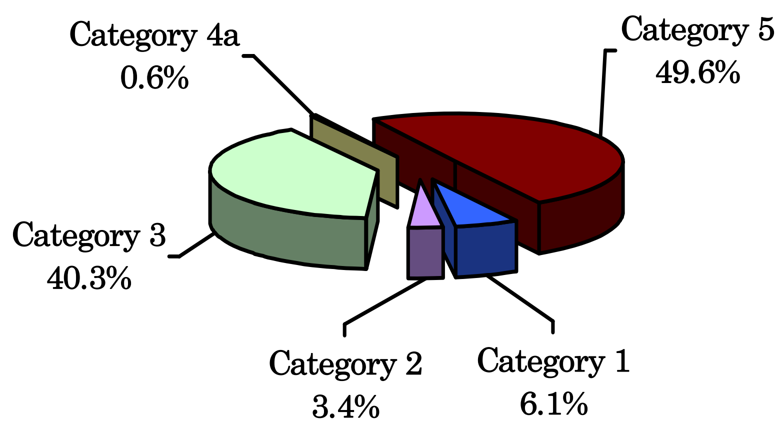
Watershed Name:	**North Fork Forked Deer**	
HUC Code:	**TN08010204**	
Watershed Group:	2	
Counties:	Carroll	Gibson
	Crockett	Henderson
	Dyer	Madison
Ecoregions:	65e, 74a, & 74b	
Reference Site:	1	
Drainage Area:	962 square miles	
TDEC Stations:	110	
TWRA Station:	1	
Advisories:	0	
High Quality Waters:	14	

Category Assessment	Stream Miles	Reservoir Acres
Total	1,697.8	87
Assessed	1,014.2	87
Category 1	103.9	0
Category 2	57.9	0
Category 3	683.6	0
Category 4a	9.5	0
Category 5	842.9	87

North Fork Forked Deer River Watershed
(including Middle Fork Forked Deer River)

The entire watershed is in Tennessee. Like other streams in the western portion of the state, many of the streams and rivers in this watershed have been extensively channelized. Row crops, especially cotton, are the principle land use. Most of the assessed streams in this watershed are considered impaired by channelization, crop run-off and MS4 discharges. Silt, nutrients, and habitat alteration are the primary pollutants. Humboldt Lake is impaired by livestock grazing and crop production.

There is one subecoregion reference site, Griffin Creek in 65e (Southeastern Plains and Hills).



2006 Assessment of Rivers and Streams in North Fork Forked Deer River Watershed

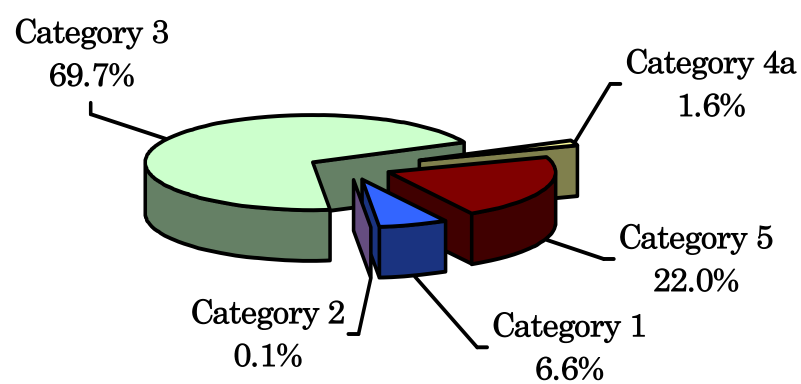
Watershed Name:	**South Fork Forked Deer**	
HUC Code:	**TN08010205**	
Watershed Group:	1	
Counties:	Chester	Henderson
	Crockett	Lauderdale
	Dyer	Madison
	Haywood	McNairy
Ecoregions:	65e, 73a, 74a, & 74b	
Reference Site:	1	
Drainage Area:	1,062 square miles	
TDEC Stations:	44	
Advisories:	0	
High Quality Waters:	8	

Category Assessment	Stream Miles	Reservoir Acres
Total	1,829.2	570
Assessed	554.4	0
Category 1	119.9	0
Category 2	2.3	0
Category 3	1,274.8	570
Category 4a	29.0	0
Category 5	403.2	0

South Fork Forked Deer River Watershed

The entire watershed is in Tennessee. As is common in the western portion of the state, streams and rivers in this watershed have been extensively channelized. Many of the streams in this watershed have not been assessed. Seventy-eight percent of assessed stream miles are impaired mainly due to channelization crop production, quarries, and MS4 discharges. Silt, pathogens, and habitat alteration are the most prevalent pollutants.

There is one subecoregion reference site, Harris Creek in 65e (Southern Plains and Hills).



2006 Assessment of Rivers and Streams in South Fork Forked Deer River Watershed

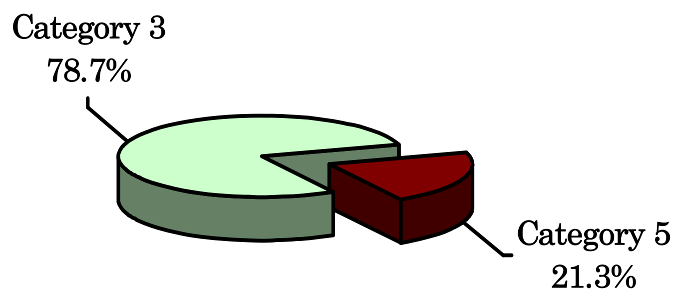
Watershed Name:	**Forked Deer**
HUC Code:	**TN08010206**
Watershed Group:	2
Counties:	Dyer Lauderdale
Ecoregions:	73a & 74a
Reference Sites:	0
Drainage Area:	70 square miles
TDEC Stations:	0
Advisories:	0
High Quality Waters:	0

Category Assessment	Stream Miles	Reservoir Acres
Total	70.0	0
Assessed	14.9	0
Category 1	0.0	0
Category 2	0.0	0
Category 3	55.1	0
Category 4	0.0	0
Category 5	14.9	0

Forked Deer River Watershed

This entire small watershed is in Tennessee. The Forked Deer River now flows into the Obion River. Before the earthquakes of 1812, the Forked Deer River had a direct channel that flowed further south to the Mississippi River.

Only the main stem of the Forked Deer River has been assessed. The Forked Deer River is impaired due to silt and habitat alterations from channelization.



2006 Assessment of Rivers and Streams in Forked Deer River Watershed

Upper Hatchie River Watershed

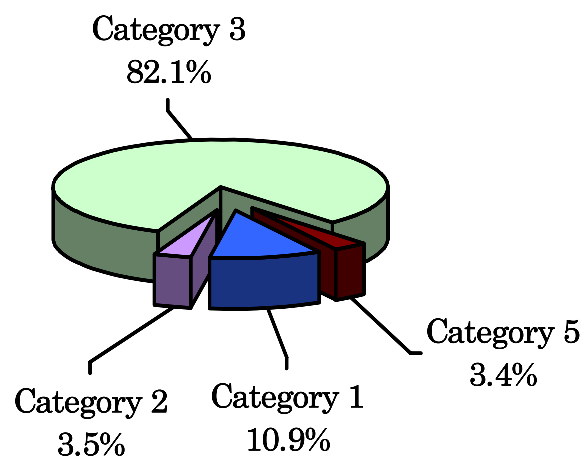
Watershed Name:	**Upper Hatchie**
HUC Code:	**TN08010207**
Watershed Group:	4
Counties:	Chester Hardeman McNairy
Ecoregions:	65a, 65b, & 65e
Reference Sites:	2
Drainage Area:	1,139 square miles
Tennessee Drainage:	431 square miles
TDEC Stations:	72
Advisories:	0
High Quality Waters:	8

Thirty-seven percent of the watershed is in Tennessee with the remainder in Mississippi. This is a rural watershed with small farms the principal land use.

Due to a lack of recent data, the majority of this watershed has not been assessed. Cypress Creek and Tuscumbia River are the only assessed streams. Silt from channelization and crop production is the primary pollutant in Cypress Creek. Nine miles of the Tuscumbia River in Tennessee are impaired by channelization in Mississippi.

There are two streams used as subecoregion reference sites: Unnamed Tributary to Muddy Creek in 65a (Blackland Prairie) and Cypress Creek in 65b (Flatwood/Alluvial Prairie Margins).

Category Assessment	Stream Miles	Reservoir Acres
Total	752.5	0
Assessed	134.4	0
Category 1	82.2	0
Category 2	26.6	0
Category 3	618.1	0
Category 4	0.0	0
Category 5	25.6	0



2006 Assessment of Rivers and Streams in Upper Hatchie River Watershed

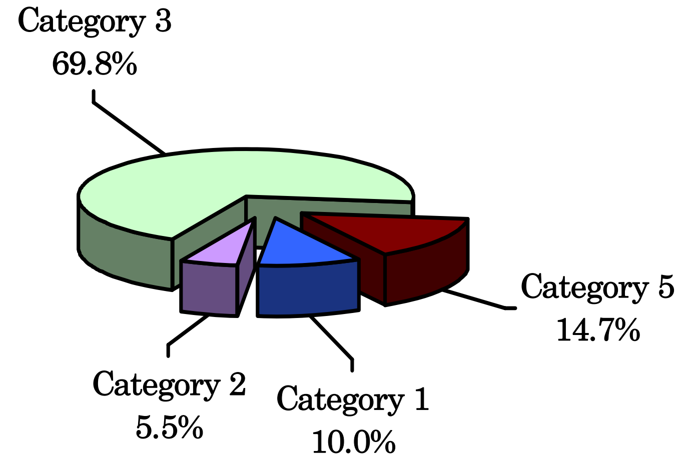
Watershed Name:	**Lower Hatchie**
HUC Code:	**TN08010208**
Watershed Group:	4
Counties:	Chester, Lauderdale, Fayette, Madison, Hardeman, Tipton, Haywood
Ecoregions:	65b, 65e, 73a, 74a, & 74b
Reference Sites:	2
Drainage Area:	1,461 square miles
Tennessee Drainage:	1,446 square miles
TDEC Stations:	165
TWRA Station:	1
Advisories:	0
High Quality Waters:	35

Lower Hatchie River Watershed

About 99 percent of the watershed is in Tennessee with the remainder in Mississippi. The mainstem Hatchie is the last unchannelized river of its type in the lower Mississippi Valley. The river drains a series of wetlands including bottomland hardwoods. Silt and habitat alteration are problems due to channelization of many tributaries. Elevated nutrients and low DO are also common pollutants primarily from crop production. Cane Creek, Hyde Creek, and Nelson Creek are impaired by industrial pollution and collection system failure.

A portion of the Hatchie River is designated as a State Scenic River. There are two subecoregion reference sites, Marshall and West Fork Spring Creeks in 65e (Southeastern Plains and Hills).

Category Assessment	**Stream Miles**	**Reservoir Acres**
Total	2,530.8	0
Assessed	764.0	0
Category 1	252.0	0
Category 2	139.2	0
Category 3	1,766.8	0
Category 4	0.0	0
Category 5	372.8	0



2006 Assessment of Rivers and Streams in Lower Hatchie River Watershed

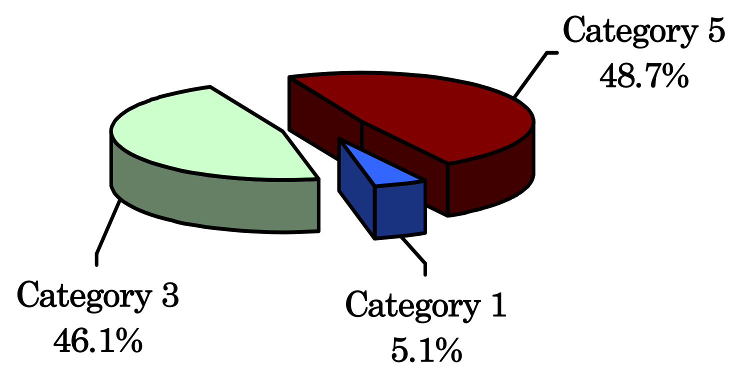
Watershed Name:	**Loosahatchie**
HUC Code:	**TN08010209**
Watershed Group:	2
Counties:	Fayette Shelby Hardeman Tipton Haywood
Ecoregions:	65e, 73a, 74a, & 74b
Reference Sites:	0
Drainage Area:	738 square miles
TDEC Stations:	57
TWRA Stations:	2
Advisories:	0
High Quality Waters:	0

Category Assessment	Stream Miles	Reservoir Acres
Total	1,436.2	81
Assessed	773.5	0
Category 1	73.4	0
Category 2	0.0	0
Category 3	662.7	81
Category 4	0.0	0
Category 5	700.1	0

Loosahatchie River Watershed

The entire watershed is in Tennessee. The Loosahatchie River flows into the Mississippi River near Memphis, Tennessee.

Silt deposits and habitat alterations are problems since the river and many of its tributaries have been extensively channelized. Crop production, land development and MS4 discharges are also common sources of pollution. Many streams have low DO and elevated pathogens. The river has a fish consumption advisory from the mouth to Highway 14 due to chlordane and other toxic organics that have accumulated in fish tissue from contaminated sediments.



2006 Assessment of Rivers and Streams in Loosahatchie River Watershed

Watershed Name:	**Wolf**
HUC Code:	**TN08010210**
Watershed Group:	3
Counties:	Fayette Hardeman Shelby
Ecoregions:	65e, 73a, & 74b
Reference Sites:	1
Drainage Area:	805 square miles
Tennessee Drainage:	567 square miles
TDEC Stations:	73
Advisories:	1
High Quality Waters:	6

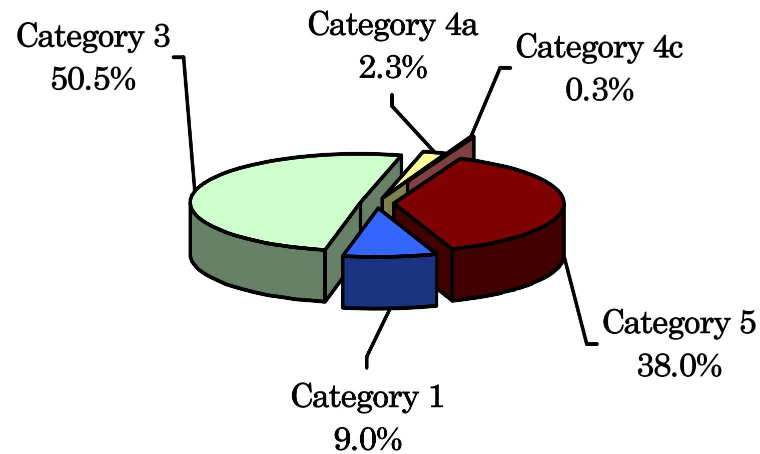
Category Assessment	Stream Miles	Reservoir Acres
Total	1,026.2	177
Assessed	508.0	0
Category 1	91.9	0
Category 2	0.0	0
Category 3	518.2	177
Category 4a	23.1	0
Category 4c	3.1	
Category 5	389.9	0

Wolf River Watershed

Over 70 percent of the Wolf River watershed is in Tennessee with the remainder in Mississippi. The Wolf River flows into the Mississippi River near Memphis.

Agriculture activities and channelization impact the many stream miles with MS4 discharges and RCRA hazardous waste sites as major contributors in the downstream portion. The Wolf River has a fish tissue advisory from the mouth to Highway 23 due to chlordane and other toxic organics that have accumulated in fish tissue.

There is one subecoregion reference site, Wolf River near the Mississippi state line in 74b (Loess Plains).



2006 Assessment of Rivers and Streams in Wolf River Watershed

Watershed Name:	**Nonconnah**
HUC Code:	**TN08010211**
Watershed Group:	1
Counties:	Fayette Shelby
Ecoregions:	73a, 74a, & 74b
Reference Sites:	0
Drainage Area:	283 square miles
Tennessee Drainage:	190 square miles
TDEC Stations:	23
Municipal Stations:	15
Advisories:	1
High Quality Waters:	2

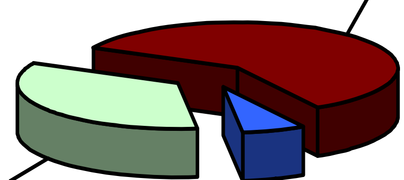
Nonconnah Creek Watershed

Sixty-seven percent of the watershed is in Tennessee with the remainder in Mississippi. Nonconnah Creek flows into McKellar Lake before entering the Mississippi River.

The watershed is heavily urbanized. MS4 discharges and channelization impair the greatest number of stream miles. Elevated pathogens, low DO and habitat alteration are the most common pollutants.

Nonconnah Creek has a fish tissue advisory from the mouth to Horn Lake Road Bridge due to chlordane and other toxic organic substances which have accumulated in fish flesh.

Category Assessment	Stream Miles	Reservoir Acres
Total	260.6	0
Assessed	171	0
Category 1	16.4	0
Category 2	0.0	0
Category 3	89.6	0
Category 4	0.0	0
Category 5	154.6	0



2004 Assessment of Rivers and Streams in Nonconnah Creek Watershed