Eco-Meet 2021
WATERSHEDS
Phinizy Center for Water Sciences

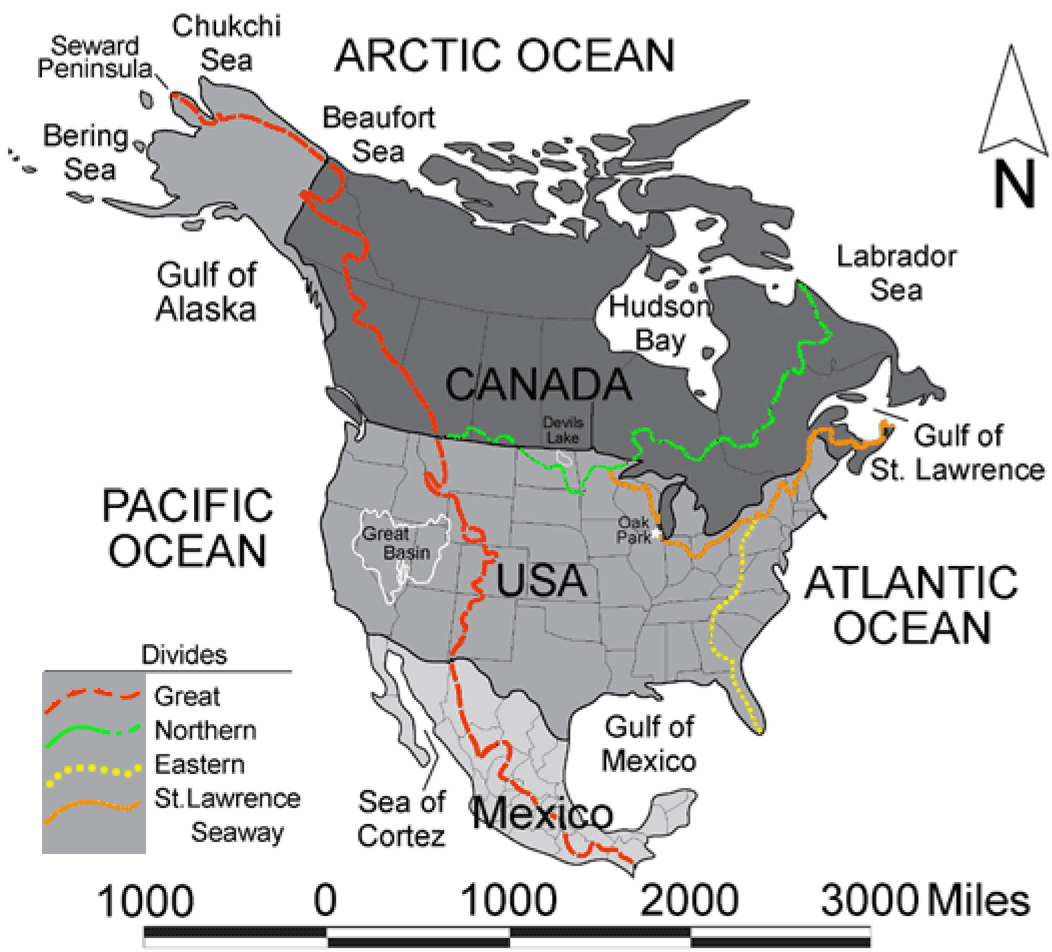
ON WATERSHEDS:
WATERSHED DEFINITION

- Georgia Adopt-A-Stream defines a watershed as a system. A watershed is the land area from which water, sediment, and dissolved materials drain to a common point along a stream, wetland, lake or river. For each watershed, there is a drainage system that conveys rainfall to its outlet. Its boundaries are marked by the highest points of land around the water body.
- A watershed is a region that drains into a particular water body. They are also known as water basins or river basins.
- Within large watersheds there are many smaller ones, and within those smaller watersheds are even smaller ones. For example, the watershed of Little Spirit Creek is part of the bigger watershed for Spirit Creek, which is part of the larger watershed for the Savannah River, which in turn flows into the Atlantic Ocean.
- A broader definition by George Wingate, Bureau of Land Management says a watershed is more than the physical landscape that is defined by ridges with one outlet for water to flow. Watersheds support a variety of resources, uses, activities, and values where everything is linked in such a way that eventually all things are affected by everything else. Most importantly, it contains the history of all that went before us and the spirit of all to come.

WATERSHED BOUNDARIES

- The boundaries of watersheds are determined by **topography** unlike man-defined boundaries such as between countries, states, counties, political voting districts, and school zoning districts.
- The greatest watershed boundary in the Americas is the **Continental Divide,** also known as the Great Divide. This divide separates the waters that flow to the Pacific Ocean from those waters that flow to the Atlantic Ocean and those waters that flow to the Atlantic via Gulf of Mexico and Caribbean Sea. The Continental Divide starts at Cape Prince of Wales in Alaska and runs south along the crest of the **Rocky Mountains**, continues south along the crest of the **Sierra Madre Occidental**, and the **Andes** and ends in northwest South America.
- The Triple Divide separates the water of three of North America's largest rivers. **The Triple Divide,** located in Glacier National Park where the Great and Northern Divides meet, forms the boundaries of three major watersheds: the

Saskatchewan and its tributaries which flow into the Hudson Bay and to the Arctic Ocean, the tributary streams of the Mississippi and Missouri rivers which flow to the Gulf of Mexico, and the tributaries of the Columbia River which flow to the Pacific Ocean. Where a single drop of rain falls at this divide determines whether it will eventually end up in the Arctic Ocean, Pacific Ocean, or Gulf of Mexico.



US Department of Interior

MAJOR WATERSHEDS IN GEORGIA AND SOUTH CAROLINA

- Georgia has 14 major river basins (watersheds) which include 70,150 miles of river and draining 102 million acres. They include the **Tennessee, Coosa, Tallapoosa, Chattahoochee, Flint, Ocmulgee, Oconee, Savannah, Ogeechee, Altamaha, Satilla, Suwannee, Ochlockonee, and St. Mary's**. These watersheds are subdivided into 52 smaller watersheds.
    - With the exception of the Savannah, Tennessee, and Coosa rivers, all **headwaters** (definition on page 8) for the river basins are entirely within Georgia.
    - The **Eastern Continental Divide** separates which Georgia watersheds drain to the Gulf of Mexico and which watersheds drain to the Atlantic. Georgia's western watersheds, which include the Tennessee, Coosa, Tallapoosa, Chattahoochee, Flint, Ochlockonee, and Suwannee, drain to the Gulf of Mexico.
    - Georgia's eastern watersheds, which include the Savannah, Oconee, Ocmulgee, Altamaha, Satilla, Ogeechee, and St. Mary's, drain to the Atlantic Ocean.
    - Georgia's largest watershed, the Altamaha, is also the second largest watershed on the east coast. The Altamaha Watershed drains approximately ¼ of the state's water and releases approximately 100,000 gallons per second into the Atlantic. This river is completely undammed.
- South Carolina can be divided into 4 major river basins which include 30,000 miles of rivers and streams draining 20 million acres. They include the **Savannah, Santee, Pee Dee**, and **ACE** (**A**shley-Cooper, **C**ombahee-Coosawhatchie, and **E**disto).
    - All watersheds in South Carolina drain to the Atlantic Ocean.
    - The ACE Basin is South Carolina's only major river basin which lies completely in South Carolina. The other 3 basins drain parts of North Carolina and Georgia.
    - The South Carolina's Savannah Basin is further divided into smaller watersheds including the Tugaloo, Chatlooga, Seneca, Keonee, Upper Savannah, Stevens (Stevens Creek which runs through Edgefield), Middle Savannah, and Lower Savannah.
    - The Santee Basin is further divided into smaller watersheds including Tyger, Enoree, Saluda, Broad, Catawba, Wateree, Congaree, Santee, and Lake Marion.
    - The Pee Dee Basin is further divided into smaller watersheds including Black, Lynches, Pee Dee, Little Pee Dee, Lumber, Waccamaw, and Coastal Sampit.

- The ACE Basin is further divided into smaller watersheds including North Fork Edisto, South Fork Edisto, Edisto, Salkehatchie, Combahee, Coastal Ashley, and Cooper.

- The majority of Georgia's and South Carolina's watersheds derived their names from Native American river names.
- **There are no natural lakes in either Georgia or South Carolina.** All lakes in these states are created by damming a river or stream.
- A map for both Georgia's and South Carolina's major watersheds is located at the end of this study package.

ON TOPOGRAPHY:

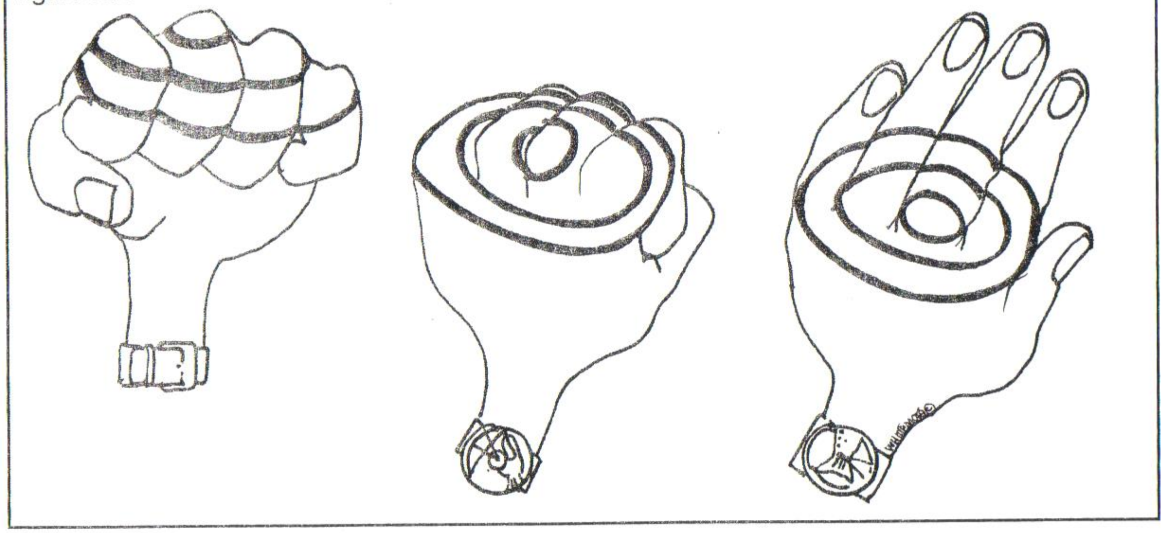
TOPOGRAPHY DEFINITION

- Topography is defined as the three-dimensional shape of the land surface. It determines the boundary of all watersheds. The topographic boundaries of a watershed are the highest points surrounding a stream or river. If a drop of water falls on one side of the highest point, it eventually drains into that watershed's stream. If the drop lands on the other side of the highest point, it drains into the stream or river of a neighboring watershed.

CONTOUR LINES

- Contour lines are lines used on a two-dimensional map to show topography. All points along any contour line are at the same elevation. The closer the lines are, the steeper the slope. Wide spaces between lines represent gently sloping land or valleys. Circular contour lines which increase in elevation to the inner circle represent hills.

figure 2.2



20 The Streamkeeper's Field Guide

- The following exercise and figures 2.2 & 2.3 come directly from 'Streamkeeper's Field Guide' and provides a better understanding of contour lines. Maps are flat, but the areas they represent are filled with hills, valleys, mountains, and plains. Contour lines represent points of equal elevation. The lines allow mapmakers to show the "lay of the land" very clearly. The following exercise will help those of you who have a hard time seeing in three dimensions on a flat map. It is taken from the 1990 Boy Scout Handbook, which also has great tips on other vital mapping skills. To understand how contour lines work, make a fist with one hand. A fist has width, length, and height, just like land. With a water soluble pen or magic marker, draw a level circle around your highest knuckle. Draw a second circle just below that one. Start a third line a little lower. Notice that to stay level, the pen may trace around another knuckle before the third circle is closed. Continue to draw circles, each one beneath the last. Lines will wander in and out of the 'valley' between your fingers, over the 'broad slope' on the back of your hand and across the 'steep cliffs' above your thumb. After all the lines are drawn, spread your hand flat. Now it has only width and length, just like a map. But by looking at the contour lines you can still imagine the shape of your fist. Small circles show the tops of your knuckles. Lines that are close together indicate steep areas. Lines farther apart show more gentle slopes of your hand. The contour lines of a map represent terrain in the same way. Small circles are tops of hills. Where the lines are far apart, the ground slopes gently. Where they are close together, a hillside is steep.

- Understanding how the contour lines represent valleys and ridges may be the most challenging thing about reading topo maps. Contour lines that represent a valley or depression usually are V or U shaped, with the tips of the V's pointing toward higher elevations. Lines that show a ridge are also shaped like V's or U's, but the tips point toward lower elevations. Water flows through the valleys perpendicular to contour lines.

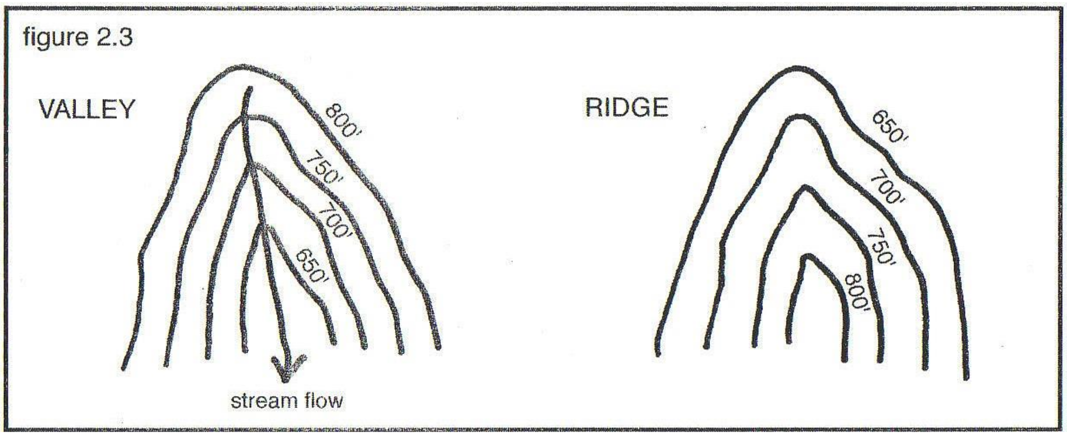
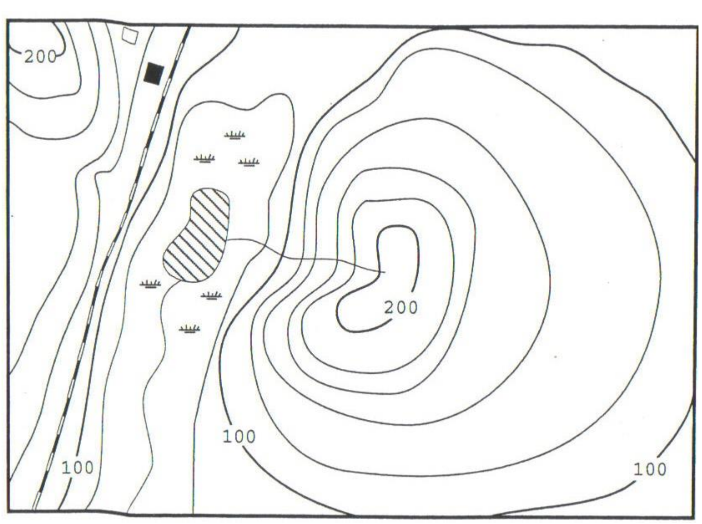


figure 2.3

- Reading topo maps takes practice. Contour lines on the topo maps will be at standard intervals and a map key should state the distance between the intervals. Common intervals are 10ft, 20ft, and 100ft. Look at the topo map labeled Figure A (from A World in Our Backyard). The hill is indicated by circles with the inner circle (top of the hill) at 200ft. There are 5 more circles to reach the bottom of the hill which is at 100ft. To calculate the contour intervals, subtract the top of the hill from the bottom (200 – 100) and divide by 5 (the number of contour lines to reach the next marked contour). These contour lines are 20ft apart. The line above 100ft represents 120ft, the next line 140ft, the next 160ft, the next 180ft, and the top line is 200ft.

FIGURE A



- Streams are marked as blue lines on topography maps. To determine which way the stream flows, look at the contour lines. Water always flows to a point of lower elevation.
- Marking the boundary of a watershed on a topography map can be tricky. First locate the stream and the direction of water flow. Follow the stream to the headwaters. At the headwaters, locate the highest point of elevation above the stream (which is often the top of the hill shown as a circle). Mark that spot with an X. Now come down the stream. Find the high elevation points on both sides of the stream and mark them with an X. Draw a line connecting the high points (X's) by following ridges and crossing contour lines at right angles. This line represents the boundary of the watershed. (See Cooper River Watershed Map at the end of the study package)
- Topography maps are included at the back of this study package. Be prepared to answer basic topography questions from maps at the Eco-Meet testing station.

ON STREAM ORDER:

STREAM CLASSIFICATION

- Systems which consist of relatively slow moving water such as lakes, ponds, and wetlands, are known as **lentic systems.** Systems which consist of relatively fast moving water such as rivers and streams, are called **lotic systems.**
- Streams are also classified by size. Small streams that only flow at certain times of the year are known as **intermittent** streams. They are marked on topo maps as dashed blue lines. If they are not marked, you would expect to find them where the "V's" are sharpest and pointing to the higher elevation. Streams that carry water all year and have no **tributaries** (another stream flowing into the stream) are known as **first order streams.** When two first order streams come together a **second order stream** is formed**.** When two second order streams come together a **third order stream** is formed**.** Note that it takes two second order streams to make a third order stream. In many cases a first order stream will join a second order stream; the stream remains a second order stream. A **fourth order stream** is only formed when two third order streams join. Once again, when a second order stream or first order stream joins a third order stream the stream remains a third order stream. The stream ordering continues in this order with the larger order stream usually being the larger waterways.

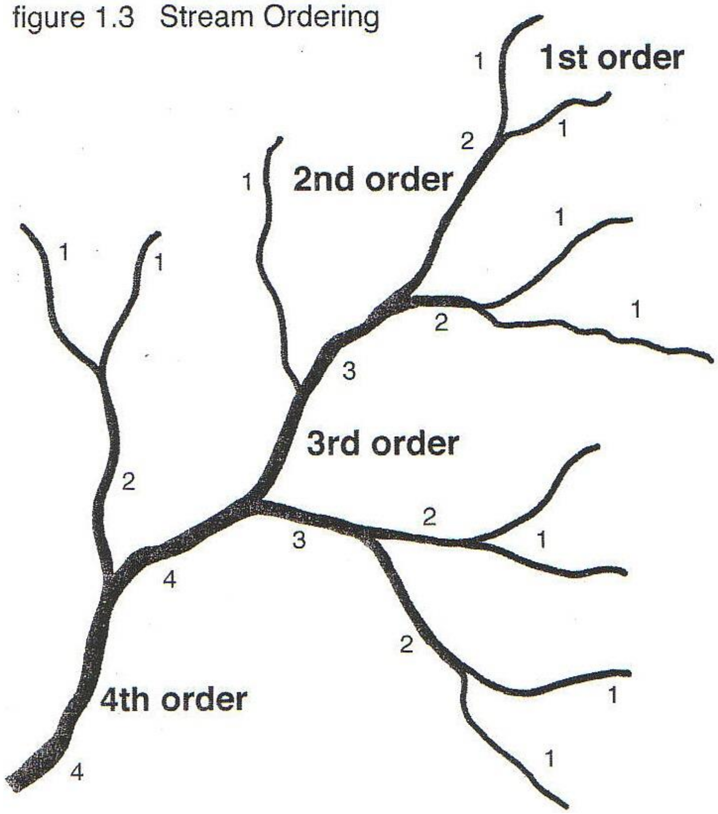


figure 1.3 Stream Ordering

- The origins of streams are known as **headwaters.** Streams originate from a variety of sources such as snow melt, surface runoff, lake outlets, and springs (an area where ground water comes to the surface). Some maybe **intermittent,** flowing only part of the time such as during the wet seasons and others are **perennial**, having water year-round.
- The outlet of a stream, where the stream empties into another water body such as an estuary, lake, or larger stream, is known as the **mouth.** Rivers can be divided into three or more sections. The **upper river reach** is made up of the headwaters, intermittent streams, and first and second order streams. The **middle river reach** have tributaries entering which add flow. This area of the river is usually bigger, deeper and made up of third and forth order streams. The **lower river reach** progresses downstream towards the river mouth. More tributaries enter and add more flow, making it deeper and wider.

ON THE HYDROLOGIC CYCLE & LAND TYPES/ USES:

THE HYDROLOGIC CYCLE AFFECTS ON WATERSHEDS

- More than 97% of the water on Earth is contained in the oceans. 2.5 % is stored on land with approximately 79% of that as ice (glaciers), 20% in the groundwater and only 1% on the surface. In other words the earth's surface water (streams, lakes and wetlands) makes up **less than 0.02%** of the water on Earth!

- Through the hydrologic cycle, precipitation brings water to the watershed as rain or snow. Some of this water will not stay long as it is intercepted by plants and returned to the atmosphere by **transpiration** and **evaporation** (**evapotranspiration**). Of the water that does reach the ground, some of it will enter the pore space in the soil through a process known as **infiltration** and become part of the **groundwater**. The water remaining on the surface eventually enters the streams and lakes by a process known as **surface runoff.**
- Water infiltrating the soil can take different paths. It can be absorbed by plant roots and eventually returned to the atmosphere by evapotranspiration. It can percolate down to the aquifers (area of groundwater that can store and transmit significant amounts of waters). Or it can move laterally through the soil to points of lower topography by a process known as **subsurface runoff.** Subsurface runoff is an important source of water in the watershed as the water eventually reappears at the surface through **seeps** and **springs** and flows to the stream. This process may take hundreds of years but it provides an important water source during periods when there is little rain or surface runoff. Groundwater and surface water are part of the same watershed system with the difference being where the water is located at any particular time.
- Land type, vegetation, and soil all have an impact on surface runoff.

LAND TYPE / LAND USE AFFECTS ON SURFACE RUNOFF

- The terrestrial (land) component of the watershed has a tremendous affect on the watershed from the type of soil to the steepness of the topography and from the vegetative cover to the urban development.
- The steeper the topography of the land, the faster surface runoff will flow to the stream. In a heavy rain, fast flowing surface runoff may have little chance for soil infiltration. The surface runoff has the opportunity to 'collect' materials as it travels to the stream. Some of the materials collected include leaf litter, soil, twigs and limbs, grass cuttings and other organic material, but can also include motor oils & gas, trash, fertilizers, animal waste, pesticides, and sewage spills. A steep terrain that is bare (little to no trees or other vegetation) can send these materials cascading down to the stream.
- Some soils are more permeable than others and therefore allow more surface water to infiltrate to the groundwater. The space between soil particles is known as **pore space** and the size of the pore space affects the **permeability** (ability to flow through) of the soil. Soils with bigger pore space tend to have higher permeability rates as water flows through large holes faster. **Clay** soils have

extremely small pore space creating slow permeability rates. In a heavy rain, precipitation falling to the ground on a clay-based soil may have a higher percentage of surface runoff. **Sandy** soils tend to have higher permeability rates as the sand particles create large pore space in the soil.

- Soil compaction can also lead to slow infiltration rates which tend to increase surface runoff. Soil compaction can be caused by extended use of heavy equipment on the land such as farm equipment or construction equipment.
- The type of bedrock also can make a difference in the watershed. If the bedrock in a watershed is composed of minerals with high concentrations of ions such as limestone, sandstone, magnesite, gypsum, or dolomite, it is more easily eroded by surface water. This eroded material can cause a buildup of sediment in the streams. If on the other hand the bedrock is composed of igneous rocks such as granite and basalt, it is not easily eroded.
- The amount of vegetative cover also has an affect on surface runoff. Typically, the more vegetative cover the less chance for surface runoff. Plants slow the flow of water across the landscape and thus allow for more infiltration to the soil. Accumulating leaf litter on the ground helps absorb water and can decrease surface runoff as well. Native grasslands tend to have 10% less surface runoff than forests and forests tend to have 10% less surface runoff than agricultural land. Wetlands have the least amount of surface runoff and have an amazing ability to store water, slowly releasing it to a stream. Wetlands located along streams act as buffers by intercepting surface runoff from adjacent land types.
- Urban land use has made considerable contributions to increased surface runoff. Buildings and pavement produce **impermeable** surfaces (areas where water cannot pass through) which have close to 100% surface runoff in storm events. Watershed managers use land use maps to predict stream flow in the watersheds. Land Use maps are broken down into different uses including:
    - **URBAN** which includes residential, parks, and businesses. Urban areas in watersheds produce high amounts of surface runoff due to buildings, sidewalks, driveways, parking lots, and manicured lawns. Some urban areas create as much as 90% surface runoff in storm events. This can create flooding as well as many undesirable pollutants in our streams.
    - **AGRICULTURE** which includes pasture, cropland such as corn, soybean, and cotton, poultry farms, and even bare fields. Agriculture does not tend to have as high levels of surface runoff as urban, but bare crop land or eroded pasture can have significant impacts on our streams. Also, soil compaction from extended years of heavy farm equipment can add to surface runoff.

- **INDUSTRY** which include factories that produce commodities such as automobiles, pharmaceuticals, packaged foods, electronics, clothes, and much more. These areas tend to create large impermeable surfaces but are often buffered by large areas of natural land types such as forest and wetlands.
- **TRANSPORATION SYSTEMS** which include our roads and highways as well railroads, bike trails and airports. These areas are largely made up of impermeable surfaces.
- **PUBLIC LANDS** which include wildlife refuges, parks, national and state forests, and monuments. These land types are more natural with little surface runoff, however the buildings and parking areas associated with these sites can impact the streams.
- **NATURAL AREAS** which include wetlands, forests, grasslands, water bodies such as lakes, streams, and rivers, deserts, and estuaries. These land use types tend to have the least amount of impact to our streams due to the low amount of surface runoff produced.

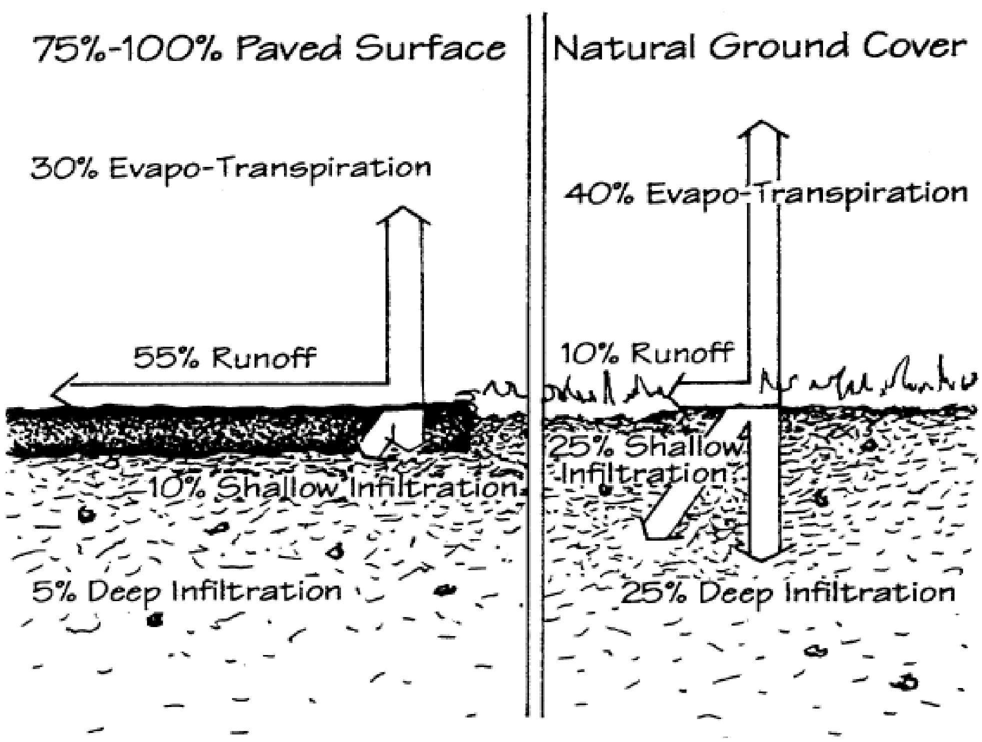


Figure 1.7 Depending on the amount of impervious surface in a watershed, the annual volume of storm water runoff can increase by up to 16 times that of natural areas*
*Schueler, Thomas, 1995 *Site Planning for Urban Stream Protection*, Washington: Metropolitan Washington Council of Governments.

ON POLLUTION IN THE WATERSHED:

TYPES OF POLLUTION

- Water Pollution is broken into two types, **Point Source Pollution** and **Nonpoint Source Pollution.** Overall nonpoint source tends to be the harder source to control.
- **Point Source Pollution** is pollution that is discharged from, and can be traced back to, an identifiable point or source such as factory discharge pipes, storm drains, sewage ditches, channels, tunnels, and various types of containers. Point source pollution can be monitored and managed. Standards can be set for the discharge and fines and other disciplines can be set if these standards are broken. The discharge can be moved to a treatment facility.
- **Nonpoint Source Pollution** is pollution that cannot be traced to a single source but is made up of many sources. It is pollution discharged by widespread surface runoff containing pollutants that do not originate from one specific location. Examples of nonpoint source pollution include sediment, fertilizers, herbicides, road salts, petroleum products, and pet waste. This type of pollution is much harder to control and manage. Despite the large concern over toxic substances, the leading nonpoint source pollution problems in our watersheds are sediment, nutrients, and fecal bacteria (that bacteria discharged from the waste of warm-blooded animals).
- Common types of nonpoint source pollution include sediment, pathogens, and nutrients. Nutrients are essential to all life but too many nutrients in an ecosystem can be harmful. Nutrients are added to a stream from decomposing organic matter, pet waste and sewage, as well as fertilizers that are made of ammonia, nitrates, and phosphorous. These pollutants enter the waterways from agricultural land, animal feeding operations, construction sites, and other areas of disturbance. (see page 14 on BOD for more information on nutrients and organic materials). Other common pollutants are pesticides, herbicides, pathogens, oil, toxic chemicals, and heavy metals.

MAJOR SOURCES OF NONPOINT SOURCE POLLUTION

- **Sediment** which enters the stream from soil erosion can come from sources such as uncontrolled construction activities, sites with exposed soil such as bare farmland, clear cuts, mining, dirt roads, and enlarged stream banks. Excessive sediment in the stream can smother fish spawning sites, clog fish and macroinvertebrate gills, fill in stream channels, raise temperature in the stream, block sunlight from submerged vegetation, and bring with it harmful bacteria, metals, and nutrients.
- **Pathogens** from human and animal waste enter the stream from sewer leaks, unmaintained septic tanks, pet waste, pastures, and stockyards. Untreated waste

can release harmful fecal bacteria and viruses into the stream such as cholera and hepatitis A. Swimming in these streams can cause serious outbreaks. The presence of **Fecal coliform** and **E. coli** (bacteria found in fecal matter) are used to indicate the potential for pathogens in the water.

- **Pesticides, herbicides and fungicides** enter our streams by way of surface runoff from lawns, gardens, farms, golf courses and other manicured lands, and from improper disposal. These chemicals are designed to limit the growth of or kill life forms and can do much damage to the native flora and fauna once they enter the stream.
- **Fertilizers** enter the stream in the same manner as pesticides; from lawns, gardens, farms, and golf courses. Fertilizers contain nitrogen, ammonia, and phosphorous and can cause excess nutrient loads in the stream. An increase in nutrients can cause algal blooms which can choke the stream and consume all the free oxygen in the water.
- **Inorganic compounds** often come from mining and manufacturing industries, oil field operations, and agriculture. They include tire residue, weathered paint, road salts, plastics, and mineral substances. They commonly dissolve in water and interfere with natural stream purification as well as destroy fish and other aquatic life.
- **Organic contaminants** entering the stream typically originate from domestic sewage treatment plants, food-processing plants, paper mills, grass and leaf clippings, and animal waste. Decomposition of added organic waste in the stream increases the bacterial populations. High levels of bacteria in the stream can deplete the oxygen in the water (see page 14 on BOD for more information). An overload of organic material also increases the nutrient load in the stream creating conditions similar to high levels of fertilizers in the stream.
- **Oil and other petroleum products** which enter the stream are often caused by automotive leaks and spills on paved parking areas or improper disposal of used oil and automotive products into storm drains, as well as from boats, marinas and oil rigs and refineries. Oil spills can kill aquatic life (birds, fish, macroinvertebrates, and vegetation).
- **Heated Water** enters the stream from such sources as power plants, paved surface runoff, and deep dam releases. Hot water holds very little oxygen and dumping heated water into streams can cause fish kills due to lack of oxygen. A large paved parking lot can create a great amount of heated surface runoff after a summer thunderstorm. That water could impair a nearby stream if it is not collected first. Power plants use large quantities of water in their steam turbines. The heated water is often returned to the stream.

SOLUTIONS TO NONPOINT SOURCE POLLUTION

- **Preventing erosion** is an excellent solution to nonpoint source pollution. Some steps to erosion control include:
    - Placing straw or other cover over newly seeded areas
    - Placing sod or grass seed, or growing plants on slopes
    - Planting crops with the contour of slopes or on terraces
    - Covering gardens during winter months
    - Installing silt or sediment fences at construction sites
    - Maintaining vegetative buffer zones along streams.
- **Retention Ponds** are man-made ponds built to capture surface runoff. They are used to collect and store surface runoff that may have contaminants such as from impervious roads and parking lots, large residential areas, shopping malls, dog parks, pastures, and stockyards.
- **Public Education** encourages citizens to make good decisions including things like: reading labels and following directions when applying and disposing of fertilizers, pesticides, and other chemicals, using non-chemical substitutes, composting, using native plants in landscaping, and picking up after pets.
- Solutions can also include routine **maintenance and repair** on automobile oil and fuel leaks, septic systems, and urban sewer liners.
- Other solutions include using non-chemical deicers (sand and ash) on roads, sidewalks, and driveways as well as labeling storm drains to inform citizens that storm drains lead to our streams.

WATERSHED MANAGEMENT

- Federal laws and state regulations for water quality standards have been set since the Clean Water Act of 1972. Many states depend on Water Management Districts and Watershed Managers to regulate the watersheds. Watershed laws focus on water allocation as well as discharge to the streams. Discharge to the stream is often regulated in regard to BOD and TMDL.
- **Biochemical Oxygen Demand (BOD)** is a measure of the demand for oxygen in the water (stream). BOD is a combined measurement of oxygen used:
    - By microorganisms in decomposition (respiration)
    - By the use of oxygen for chemical reactions such as oxidation of sulfides, iron, and ammonia
    - For respiration of aquatic life including plants and animals

  High levels of organic matter – debris that comes from living or once living plants and animals – in the stream can deplete the oxygen levels in the stream. Oxygen consumed in the decomposition of organic matter robs other aquatic organisms of the oxygen they need to live.

- Natural sources of organic matter in the stream include plant decay, leaf litter, woody debris from fallen trees, and aquatic animal waste. A stream without this organic matter is unhealthy as this substance supplies the nutrients needed for aquatic life. However, increased organic matter from urban impact including pet wastes, fertilizers, grass clippings, yard leaves, agricultural runoff, and wastewater treatment plant effluent can overload the stream with excess BOD.
- **Total Maximum Daily Load (TMDL)** is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards as addressed in the Clean Water Act. TMDL is generally a measure of BOD contributed from both point source and non-point source pollution. The combined BOD levels can not be higher than the set TMDL levels without consequences. Solutions include limiting the amount of discharge for wastewater treatment facilities or factories, not permitting a new discharger such as a new factory or residential neighborhood, and targeting non-point source pollution problems. **Everyone who lives in the watershed is responsible.**

ON URBAN & NATURAL IMPACTS IN THE WATERSHED:

NATURAL IMPACTS TO OUR WATERSHEDS

- Natural ecological changes are constant events in most watersheds. From the movement of glaciers, the rise and fall of sea levels, climate-related changes such as drought, flood, storms, and fire, and even effects of plants and animals, the watershed is constantly changing. The human impact to the watershed can make a natural change much more dramatic. For instance a heavy rain falling in a natural watershed may only cause slight swelling in the stream. The same rainfall in an urban watershed with many impervious surfaces may cause a major flood in the stream.
- **Beavers** are known for their ability to alter their watershed. They build dams that can turn a small stream into a large pond. These ponded areas can drown trees and slow the flow of water downstream. In some cases beaver damage to the watershed can be harmful but in most cases it creates much needed wetland habitat.
- **Floods** due to large rain events or spring snow melt can reshape the stream carving out new banks and depositing new sandbars. The floodwaters often carry with them heavy organic loads from the watershed as decaying matter is carried to the stream. Natural buffer zones along the stream as well as wetlands help to prevent some of the impact of floods but often in urban watersheds these buffers and wetlands have been altered.

- **Hurricanes** can also change watersheds as they bring high winds and heavy rainfall. Downed trees due to the winds can cause soil erosion as well as higher organic loads to the stream.
- **Drought,** especially in the headwaters, can cause limited stream flow. This can be a problem for fish migration. Drought becomes a major problem in an urban watershed as the water in our rivers is the source of drinking water, power production, factory influent and effluent, as well as recreation.
- **Fires** can destroy vegetation in the watershed leaving exposed soil. A heavy rain after a fire and before the chance for a new vegetative cover to form can cause soil erosion.

URBAN IMPACTS TO OUR WATERSHEDS

- The urban impacts to our watersheds have become severe as our population continues to grow and we place more demands on our rivers. Besides the surface runoff problems with impervious surfaces and pollution problems addressed earlier in this package, channelizing and damming our streams have major impacts in our watersheds.
- **Channelizing** alters the course of the stream to make it flow straight. It is accomplished by removing woody debris and other large objects and straightening the banks. Channelization has been used to support transportation and industry, carry wastewater, and quickly move water downstream to help prevent flooding. More often than not, channelizing creates worse problems than it solves by causing erosion, downstream flooding, and less ability to dissipate and absorb the force and volume of flow. One of the largest channelization efforts in US history is the Kissimmee River in South Florida. The Kissimmee River, also known as the “river of grass”, originally drifted 103 miles through floodplains meandering at a slow pace from Lake Kissimmee to Lake Okeechobee. A heavy hurricane season in 1947 brought pressure to control flooding along the river. During the 1960’s the US Army Corps of Engineers begin dredging canals and were able to reduce the Kissimmee River to a mere canal of 56 miles, 30 feet deep, and 300 feet wide. Close to 35,000 acres of wetlands were lost, which resulted in a decline in water quality, a 90% decline in waterfowl, a loss of habitat for endangered species, as well as a loss of fish species. Restoration work began in the early 1990s focusing on 22 miles of the middle third of the channelized river. When complete the 22 mile section will be restored to 43 miles of meandering river and 27,000 acres of wetlands.
- **Damming** a stream changes the flow of water in the stream channel by slowing it, detaining it or re-routing it. Dams are built to supply hydroelectric energy, reservoirs for drinking water, create lakes for recreation or water for farming, manage for fish and other wildlife, and flood control. Dams not only change the

flow of water in the stream with limited flows downstream, but they block fish migration and change downstream habitat. There are current efforts in America to undam many of our rivers including the last dam on the Savannah River at Lock and Dam in Augusta, Georgia.

- **Inter-basin Transfers** occur when water is removed from one watershed and sent to another. This ends up creating changes in both watersheds from not enough water in one to too much in the other. During the recent droughts in the upstate of Georgia (2007 & 2008), Atlanta came close to running out of water. Inter-basin transfers were considered as a solution and they were looking at the Savannah River as a possible water supply for the Atlanta area. One of the earliest inter-basin transfers started in the 1790's in South Carolina. A navigable diversion canal known as the Santee Canal allowed transportation to the upcountry of South Carolina from Charleston by connecting the Santee River to the Cooper River. This canal was heavily used for 50 years. During the Depression, the Santee Cooper Power Utility was formed. They built a dam for hydroelectric power. This dam created Lake Marion and Lake Moultrie. The Santee Canal flows between these two lakes. Building the dam diverted much of the freshwater flow from the Catawba River, Wateree River, and Congaree River that form the Santee River to the predominantly coastal Cooper River. This created problems for both rivers. With limited fresh water flow, the Santee River became more saline. The Cooper River, receiving an increased sediment load from upstream cities on the Catawba and Congaree River, began filling in Charleston Harbor (a major port). This lead to increased dredging costs. In 1980 the US Army Corp of Engineers built a diversion canal to send some of the fresh water back to the Santee River.

ON SHARING WATERSHEDS & WATERSHED DISPUTES:

SHARING THE WATERSHED

- Watershed boundaries are established by topography and often this means many urban areas share the same watershed. Those living at the mouth of the watershed are highly impacted by activities at the headwaters as everything flows downstream. Water removed from the stream can cause low flow rates downstream. Downstream users relying on higher flow rates could face problems due to the upstream water use. Even a cow pasture on a stream can impair the water quality for the town downstream of the pasture.
- As our population increases there are increased demands on our streams and with increased demands there are increased battles to the rights of the water. Many lawsuits have been filed against watershed stakeholders (those who have a stake in the use of the stream). Stakeholders include groups such as residents,

industries, farmers, communities, and recreation facilities. Water allocation laws have been set to delegate withdrawals from the streams (who and how much). Permits are also required to make a water withdrawal from most streams.

- One such ongoing battle is between Savannah, GA and Augusta, GA. The city of Savannah is in the process of dredging the lower Savannah River to create a deep water port. In the process they are experiencing poor water quality due to low oxygen levels. This may be partially due to higher levels of salt water and deeper water levels but elevated BOD levels can also be blamed. Much of the BOD blame is focused upstream at Augusta. Continuous research has been done on the river to look for solutions and for the root of the problems. Much of this research has been conducted by Southeastern Natural Sciences Academy's Research group.

STATES THAT SHARE WATERSHEDS

- Just as in cities that share watersheds, everyone downstream is affected by upstream activities. If the stream (watershed) crosses state lines even more problems arise. There are many ongoing battles between states on allocation rights, inter-basin transfers, and water use.
- In June of 2007, South Carolina sued North Carolina over water use on the Catawba River, a river that is shared by both states. North Carolina allocated 10 million gallons of water per day to be withdrawn from the Catawba for use in Concord and Kannapolis (both cities in North Carolina). The permit also allowed the cities to return the water to another watershed (inter-basin transfer). The states reached an agreement in 2010 by pledging to work together to regulate withdrawals and conserve water in times of drought.
- Alabama, Florida, and Georgia have clashed since the early 1940's over the waters of the Apalachicola River, Chattahoochee River, and Flint River which form the ACF river basin. In the 1940's Congress authorized the building of Buford Dam on the Chattahoochee River which created Lake Lanier, a large reservoir for Atlanta. Point of interest: Atlanta is one of the largest cities ever built in proportion to the watershed that supports it; in other words, the watershed that Atlanta is in has a very limited supply of water for supporting a population of over 3 million. The Chattahoochee River flows through Atlanta and on to Alabama where it becomes the divide between Alabama and Georgia until it flows into Florida and joins the Flint River to become the Apalachicola River. In 1989 the US Army Corps of Engineers recommended reallocating 20% of the water supply to remain in Lake Lanier to sustain Atlanta's growth. Both Alabama and Florida sued the Corps to protect its interest in the waters of

the ACF basin. Some of the problems include increased hydropower cost, reduced dilution for TMDL, the loss of ability to recruit industry in the basin, and the health of the Apalachicola Bay oyster beds and seafood industry. The battle is ongoing and was heightened during recent drought conditions in the Atlanta area. In 2013, Florida filed yet another lawsuit against Georgia for their retention of the water. In other words, Florida believes Atlanta is not sending enough water downstream for a healthy oyster habitat in the Apalachicola Bay.

COUNTRIES THAT SHARE WATERSHEDS

- Watershed disputes can become heated even between two farmers but as the shareholders increase so do the problems. If the battle between two or three states such as in the ACF basin is not enough of a problem, battles between countries can be a nightmare.
- The Colorado River flows 1,450 miles from Colorado to northwestern Mexico draining an area of 246,000 square miles from parts of Wyoming, Utah, Colorado, Nevada, California, Arizona, and New Mexico. It serves as the primary source of drinking water, irrigation, and hydroelectric power. Water from the river is transported far from its source to supply several urban areas, including Denver, Los Angeles, Phoenix, and Tucson. The All-American Canal diverts water from the Colorado River to California's Imperial Valley, a natural desert that has been converted into a productive agricultural region. Because the waters of the Colorado River are used for so many purposes across such a wide area, there have been constant disputes about its use between states, and even between the United States and Mexico. The Mexican Treaty of 1944 was established to ensure that Mexico receives a specific amount of water from the Colorado River on a regular basis. Since the Mexican Treaty there has been numerous battles many of which are still in dispute.

WATERSHED VALUES:

WHY IS WATERSHED QUALITY IMPORTANT?

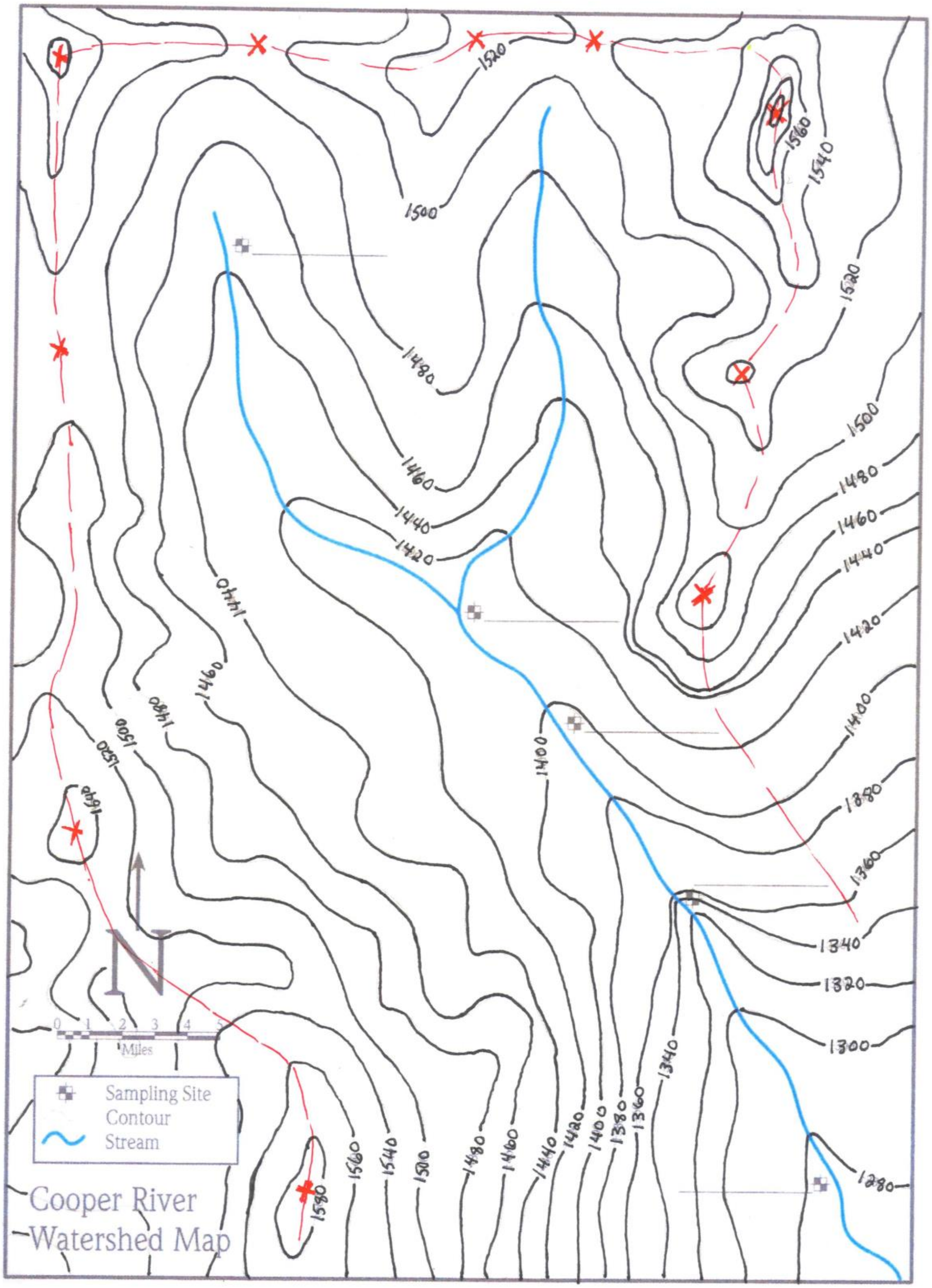
- Everyone living or working in the watershed depends on it for **drinking water**.
- Watersheds provide farmers with water for **irrigation**, which affects crops produced in a watershed, which in turn affects the local economy.
- Businesses rely on watersheds to provide water for **industrial processes**.
- People rely on the quality of their watershed for **recreational activities**, such as fishing, swimming, and boating.
- Healthy watersheds are necessary to provide **habitat** for plants and animals.
- Clean water is vital to **biodiversity**, which promotes stable and sustainable wildlife populations.

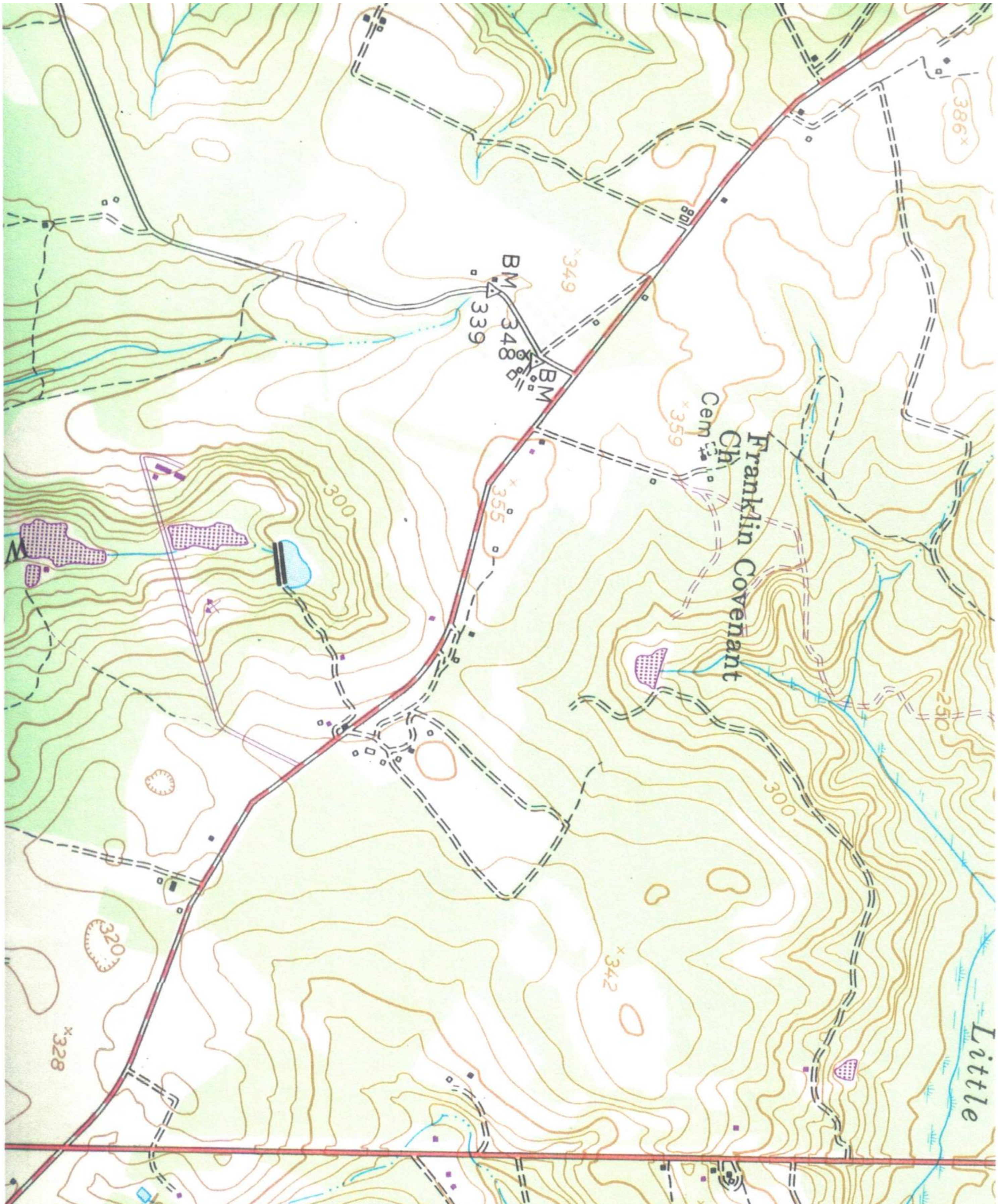
RESOURCES:

The following resources were used to create this study package. Much of the study packet information came directly from these sources. The questions asked in the Eco-Meet watershed session given by the *Southeastern Natural Sciences Academy / Phinizy Swamp Nature Park* will be based on the study material provided, including the attached maps, charts, and figures. To understand and learn more about watersheds, look in the following resources.

- <u>The Adopt-A-Stream Foundation Streamkeeper's Field Guide – Watershed inventory and stream monitoring methods</u> by Tom Murdoch and Martha Cheo with Katie O'Laughlin
- <u>A World in Our Backyard</u> from the New England Interstate Water Pollution Control Commission
- <u>Healthy Water Healthy People</u> Water Quality Educators Guide produced by The Watercourse, Hach Scientific Foundation, and International Project WET
- <u>Watersheds A Practical Handbook for Healthy Water</u> by Clive Dobson and Gregor Gilpin Beck, A Firefly Book
- <u>Project WET Curriculum & Activity Guide</u> by The Watercourse and Council For Environmental Education
- <u>Project WILD Aquatic Curriculum & Activity Guide</u> by the Council For Environmental Education and Western Association of Fish and Wildlife Agencies

COOPER RIVER WATERSHED MAP from HEALTHY WATER HEALTHY PEOPLE WATER QUALITY EDUCATORS GUIDE

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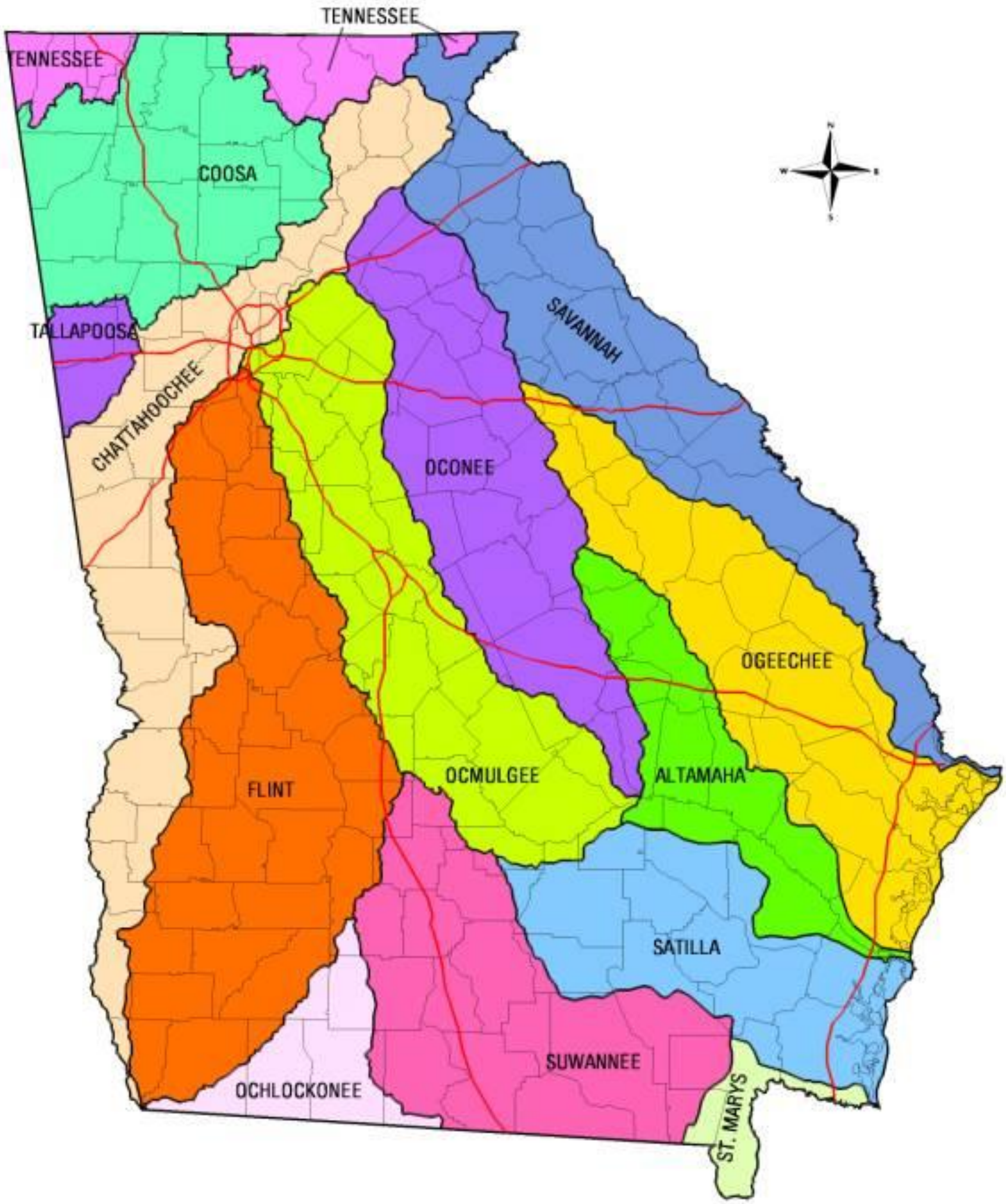
EPD 14 River Basins



Map by the Geologic Survey Branch, Environmental Protection Division

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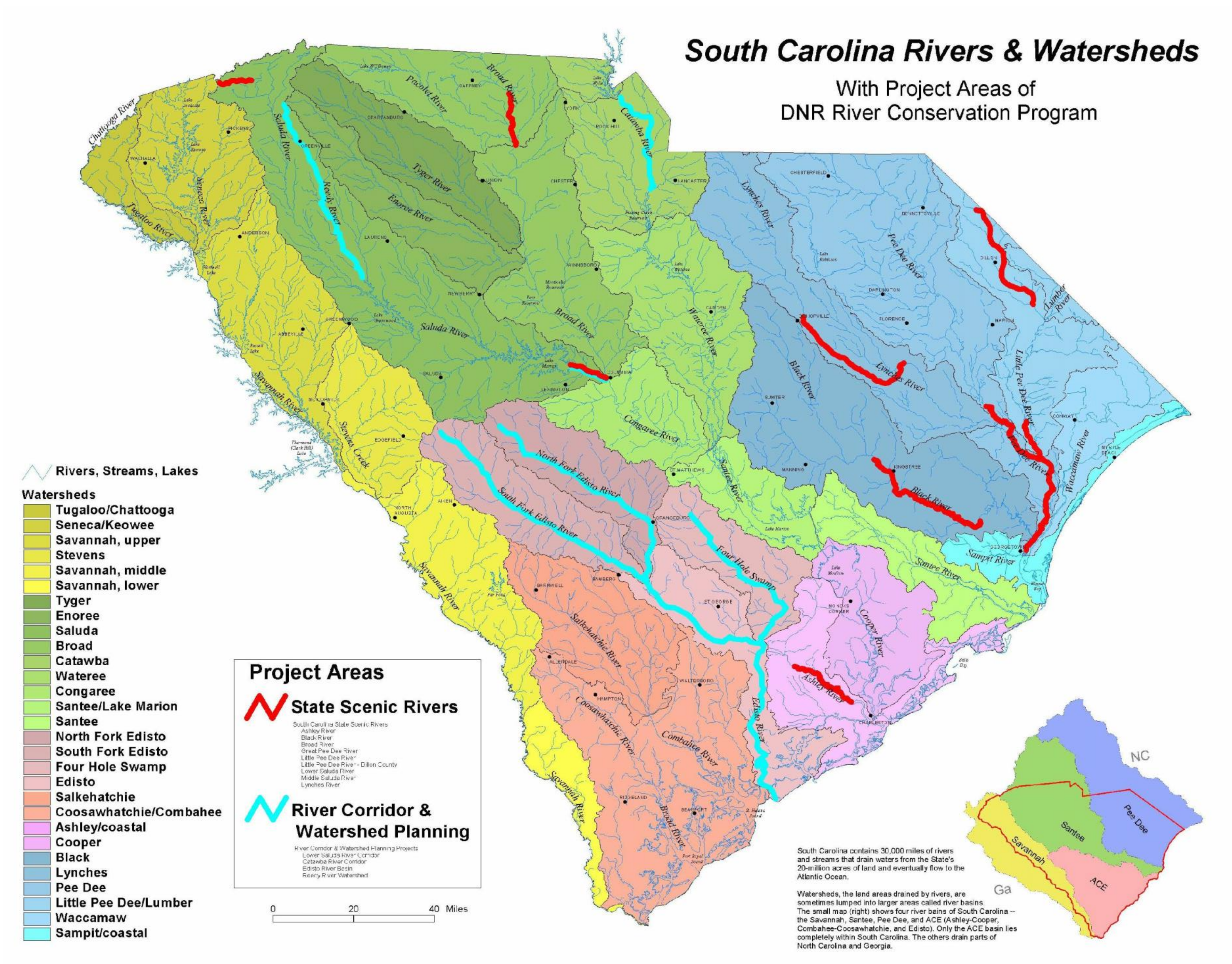
South Carolina Rivers & Watersheds
With Project Areas of
DNR River Conservation Program
Rivers, Streams, Lakes
Watersheds
Tugaloo/Chattooga
Seneca/Keowee
Savannah, upper
Stevens
Savannah, middle
Savannah, lower
Tyger
Enoree
Saluda
Broad
Catawba
Wateree
Congaree
Santee/Lake Marion
Santee
North Fork Edisto
South Fork Edisto
Four Hole Swamp
Edisto
Salkehatchie
Coosawhatchie/Combahee
Ashley/coastal
Cooper
Black
Lynches
Pee Dee
Little Pee Dee/Lumber
Waccamaw
Sampit/coastal
Project Areas
State Scenic Rivers
South Carolina State Scenic Rivers
Ashley River
Black River
Broad River
Great Pee Dee River
Little Pee Dee River
Little Pee Dee River - Dillon County
Lower Saluda River
Middle Saluda River
Lynches River
River Corridor & Watershed Planning
River Corridor & Watershed Planning Projects
Lower Saluda River Corridor
Catawba River Corridor
Edisto River Basin
Reedy River Watershed
0 20 40 Miles
Chattooga River
Tugaloo River
Seneca River
Saluda River
Reedy River
Tyger River
Enoree River
Pacolet River
Broad River
Catawba River
Savannah River
Stevens Creek
Congaree River
Wateree River
Lynches River
Pee Dee River
Black River
Little Pee Dee River
Lumber River
Waccamaw River
Sampit River
Santee River
North Fork Edisto River
South Fork Edisto River
Four Hole Swamp
Salkehatchie River
Coosawhatchie River
Combahee River
Broad River
Edisto River
Ashley River
Cooper River
South Carolina contains 30,000 miles of rivers and streams that drain waters from the State's 20-million acres of land and eventually flow to the Atlantic Ocean.
Watersheds, the land areas drained by rivers, are sometimes lumped into larger areas called river basins. The small map (right) shows four river bains of South Carolina -- the Savannah, Santee, Pee Dee, and ACE (Ashley-Cooper, Combahee-Coosawhatchie, and Edisto). Only the ACE basin lies completely within South Carolina. The others drain parts of North Carolina and Georgia.
NC
Ga
Savannah
Santee
Pee Dee
ACE