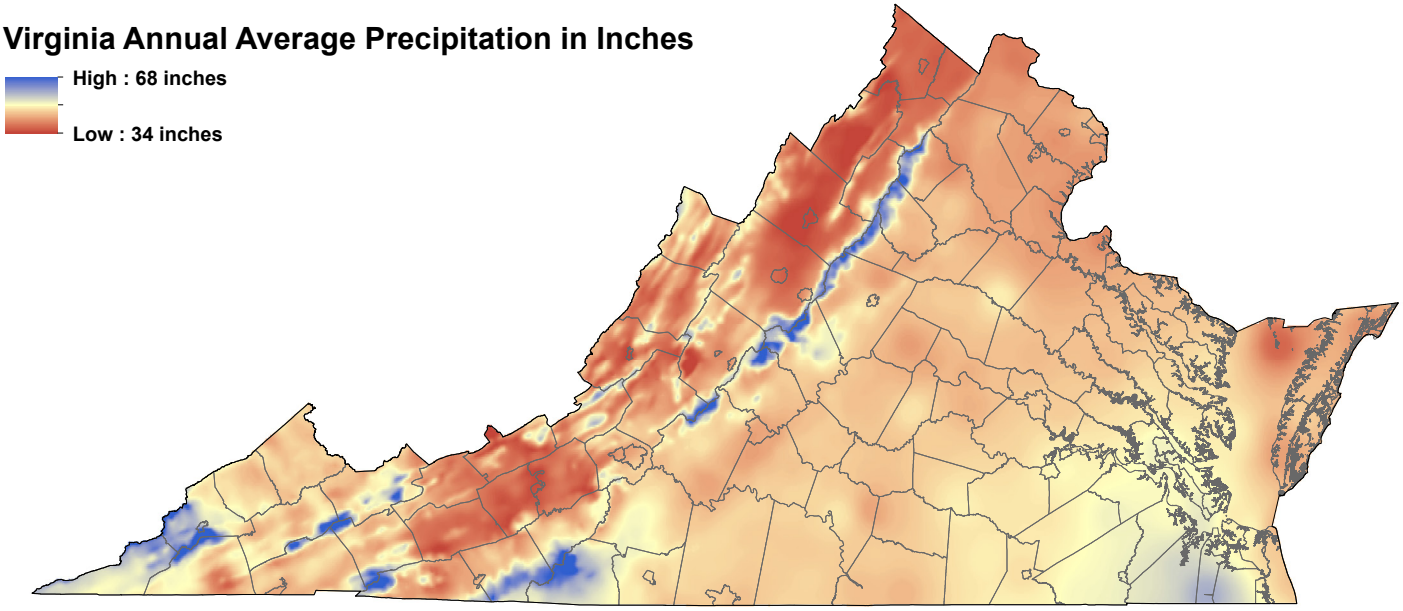
Virginia's Water Resources

Water is vital to Virginia's well-being, as it is to communities across the globe. Water supports virtually every human endeavor, from farming and forestry to generating electric power and all types of manufacturing processes.

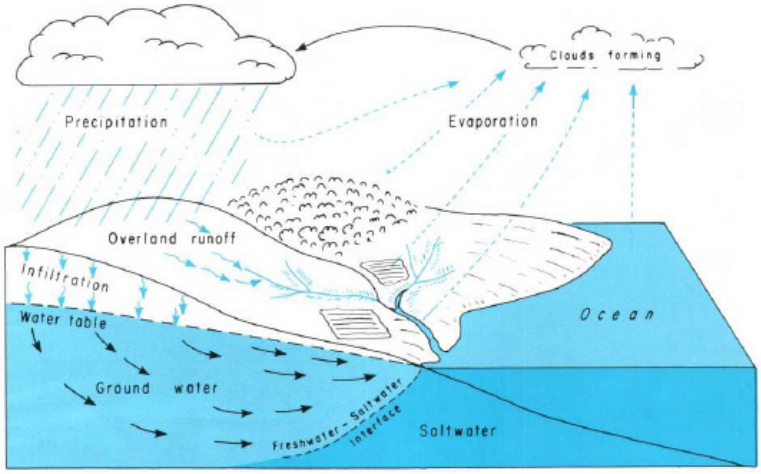
Water sustains humans as well as the habitat for millions of plants and animals that share the planet with us. Each Virginia resident uses about 75 gallons of water per day for personal and domestic needs. When agricultural, business, municipal and industrial uses are added to the equation, the amount of water used in Virginia is more than 500 gallons per day per person.

Where is Virginia's Water?



In Virginia, the average annual rainfall ranges from 34 to 68 inches (based on 30-year records). The state's rainfall is distributed evenly throughout the year without distinct wet and dry periods. This abundance – approximately 87,200 million gallons per day – supplies Virginia's surface and ground water. Precipitation replenishes surface waters, some of which filters into the soil and continues down through cracks and crevices to replenish groundwater.

Hydrologic Cycle



Virginia's Water Budget

INFLOW:

Precipitation: 43 inches/year (87,172 MGD)

Surface water: 1 inch/year (2,974 MGD)

Inflow Total: 44 inches/year (90,146 MGD)

OUTFLOW:

Evapotranspiration: 32 inches/year (65,146 MGD)

Surface water: 12 inches/year (25,000 MGD)

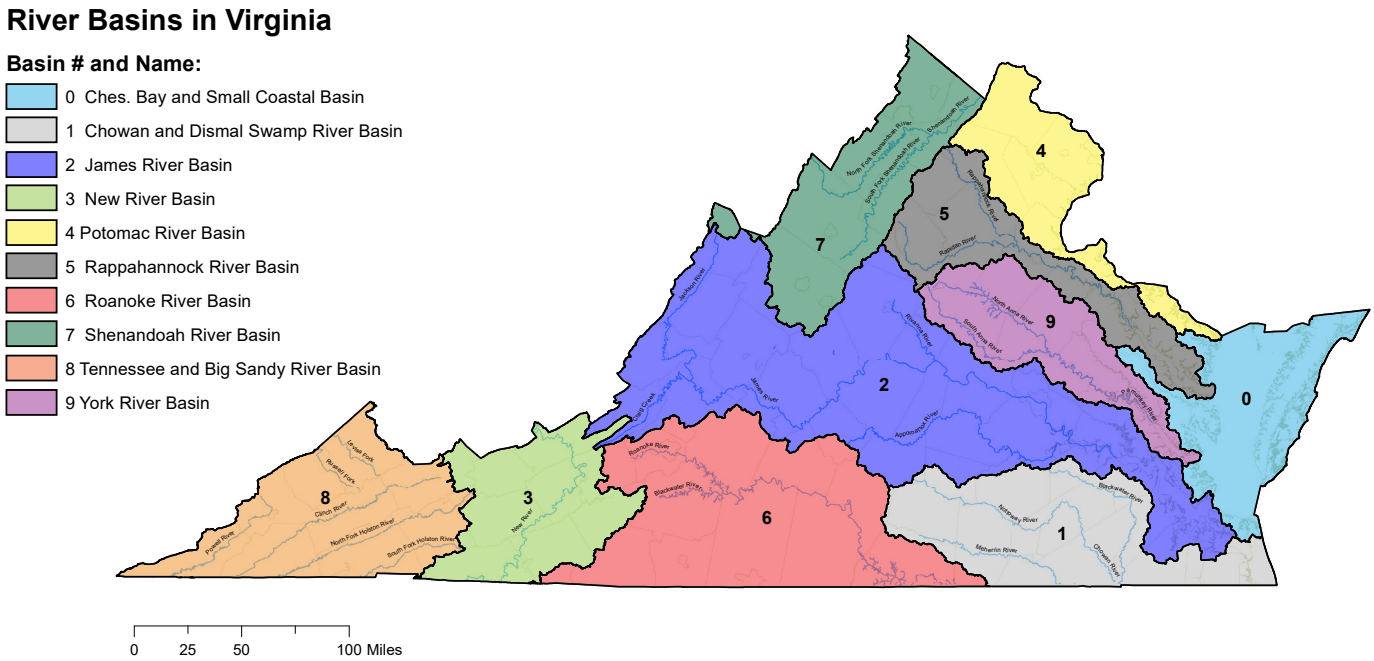
Outflow Total: 44 inches/year (90,146 MGD)

All water on Earth is found in one of the three parts of the hydrologic cycle: the atmosphere, the land surface, and the subsurface. A water budget shows water exchanged in the cycle and is the basis for water resources planning.

River Basins

Virginia has nine major river basins. While most of the state drains into the Chesapeake Bay, water from some basins – such as the Tennessee, Big Sandy and New Rivers – ends up in the Gulf of Mexico. Rivers in the Roanoke and Chowan basins flow into the Albemarle Sound in North Carolina. The Albemarle Sound is part of the Albemarle-Pamlico Estuary System, the second largest estuarine system in the United States.

It was along the banks of the James River that English colonists settled in the early 1600s, establishing Tidewater Virginia as the "Cradle of the Republic." The James and her sister rivers – the York, Rappahannock and Potomac rivers – drain nearly two-thirds of Virginia's land mass before reaching the Chesapeake Bay.



Virginia's Water Budget Analysis

The Commonwealth's western rivers – the ancient New River and the Tennessee Big Sandy – course through rugged mountain valleys, benefiting generations of Virginia farmers, miners, trout fishermen and white-water rafters. The Roanoke and Chowan rivers meander through Virginia's Southside, sustaining peanut and tobacco farms, textile industries, and lakeside vacationers.

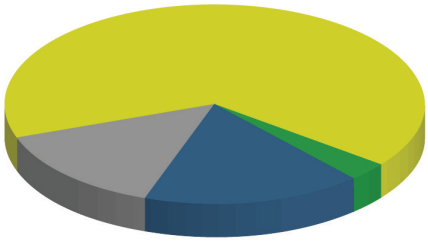
Rivers carry enormous amounts of water, especially during floods, when peak flows can reach 40 to 80 times their average volumes. During such events, rivers also transport enormous amounts of sediment and pollution, and are known to unleash tremendous force upon human resources.

In June 1972, Hurricane Agnes deposited more than six inches of rain over many parts of Virginia (a record amount in one day for Lynchburg and the National Airport in Washington, D.C.). The soil was already saturated and when heavy rains hit, the result was rapid runoff and disastrous flooding. Water levels in the James River in Richmond reached a peak of 36.5 feet, the highest recorded level in more than 200 years. Average stream flow at the station is 6,796 cubic feet per second (CFS); during Agnes, it peaked at 313,000 CFS. Water supply, sewage treatment, and electric and gas plants were flooded. Throughout the state, 1,400 homes, roads and bridges were destroyed, and 13 people killed, amounting to $325 million in damage.

Protecting Water Resources

Protecting our water is the responsibility of all Virginians, including state government. Virginia was one of the first states in the nation to embrace this responsibility. In 1946, the Commonwealth enacted the Virginia Water Control Law to combat water pollution (two years before the adoption of the first Federal Water Pollution Control Act by Congress). Over the past 30 years, resource managers have made great strides to address water-related concerns, like ensuring adequate future supplies for consumers, farmers, industries and recreationists.

Who consumes water?



- Electric Power Industry (66%)
- Farm/domestic Use (3%)
- Public Utilities (17%)
- Industry/Mining (14%)

The goal sounds simple enough, but may prove challenging – i.e., to provide the right quantity of satisfactory quality water where and when it is needed. For example, power plants supplying electricity and factories supplying goods use vast amounts of water.

Demand for water is expected to increase 30 percent by 2040. Surface and ground water resources are already limited in areas where demand is high. The result can create conflicts among local governments that are not neatly aligned along river basin lines. In some regions where conflicts have become acute (such as the Eastern Shore), designated Ground Water Management Areas have been established and large water withdrawals (more than 10,000 gallons per day) require special permits.

Drought conditions in 2002 prompted state water managers to evaluate Virginia's water supply. To ensure proper use of the state's limited surface and ground water, all Virginia localities are now required to follow water supply plans.

Water quality is another concern, as practically everything we do in our daily lives has an impact. Whenever we take a shower, wash a dish or flush a toilet, the wastewater likely passes through a sewage treatment plant that eventually discharges into a local river. All of these actions become part of what we call "point source" pollution, or pollution that is traceable. Mining, forestry, farming and construction are all examples of soil-disturbing activities that can lead to erosion and, ultimately, soil running into nearby water bodies. All have the capacity to add nutrients, sediments, toxics, minerals, or acids to lakes and streams. This type of pollution is called "nonpoint source" pollution, meaning it emanates from sources difficult to pinpoint.

What is a Watershed?

A watershed is a land area that channels all of the water into it into a larger single body of water. Some watersheds drain into others. Most of Virginia is in the Chesapeake Bay watershed. However, water in the Tennessee, New, and Big Sandy River watersheds travels to the Mississippi River all the way to the Gulf of Mexico!

The Virginia Department of Environmental Quality (DEQ) has issued thousands of discharge permits to businesses, municipalities and individual homeowners. The documents set pollution limits that specify how clean a permit holder's wastewater must be before it is discharged into a stream or river. The vast majority of permit holders consistently meet their permit limits, ensuring that users downstream (people, plants and animals) receive the water in good condition. In addition, Virginia has spent hundreds of millions of dollars over the past decade to build or upgrade its sewage treatment plants across the state to remove even more pollutants. These efforts have had an enormous positive impact on water quality.

Surface water is the kind we can easily see, like streams, lakes, reservoirs, springs and wetlands.

- Rivers: 49,000 miles of streams in nine major river basins
- Lakes: 450 public and private covering 322,000 acres
- Springs: 1,600 (100 of them yield more than 450 gallons per minute)
- Wetlands: 1,000,000 acres (tidal and non-tidal)

Groundwater is found beneath the soil mantle in rock fractures and sediment formations. Large units that yield water to wells are called aquifers. The annual recharge to the groundwater system from precipitation ranges from eight inches in western Virginia to 10 inches in the Coastal Plain. About 1.7 million Virginians, or 22 percent, depend entirely on wells for drinking water.

Contamination can occur from the following:

- **Sediments –** soil erosion
- **Urban and suburban stormwater flows –** storm events
- **Phosphates and nitrates –** agricultural sources
- **Improperly treated sewage –** overflows during storm events, or from failing septic systems
- **Industrial wastes –** such as acids, oils and grease from factories and other industrial facilities
- **Acids and leachates –** abandoned mines and dumps
- **Encroaching salt water –** the ocean leaking into groundwater
- **Herbicides and pesticides –** water and sediments running off the land

In 1997, the Virginia General Assembly passed the Water Improvement Act to help fund innovative technologies and programs to further improve water quality. Evidence is mounting that we're making progress.

The 2018 statewide water quality assessment showed that most Virginia waterways – 94 percent of all streams monitored – are in good shape and meet or exceed water quality standards. Bald eagles, ospreys and pelicans have returned to fish in Virginia waters. In the Chesapeake Bay, striped bass have made a dramatic comeback, underwater grasses have increased 60 percent since 1984 and phosphorus levels have been reduced by 19 percent since 1985. The amount of toxic chemicals released by industries into the Bay watershed has declined 55 percent since 1988.

Challenges remain, however. DEQ's water quality studies found that the vast majority of water pollution problems in the Commonwealth are caused by nonpoint sources of pollution.

A DEQ biologist measures water pH, conductivity (salt content) and speed to determine water quality.

Stormwater Management

One type of nonpoint source pollution is stormwater runoff, the water that flows over land and into natural or manmade water sources during and after precipitation. Stormwater can pick up pollution as it flows over land, from multiple places like lawns and parking lots. Stormwater from construction sites, municipal storm sewers and industrial facilities is regulated as a point source of pollution, because it has the same effect as a direct discharge into a waterbody. Unmanaged, stormwater can cause erosion and flooding, and can also contain contaminants, like bacteria, sediment and nutrients.

DEQ is responsible developing and issuing stormwater permits. These permits help enforce federal regulations via the Stormwater Act and the Virginia Stormwater Management Program, which DEQ uses to manage stormwater quality and quantity.

DEQ and other state agencies are working with local governments, industries, volunteer groups, and citizens to implement best management practices that address nonpoint source and other water pollution issues. Today, DEQ maintains a network of more than 1,100 monitoring stations that regularly sample and analyze streams, rivers, lakes and bays across the state.

DEQ monitors 17,000 miles of free-flowing streams. The agency also regularly surveys stream life – the aquatic organisms living in the water – and takes samples of bottom sediments and fish tissue to test for toxins. Together with data from other state agencies and active citizen monitoring groups, DEQ has a comprehensive database of water quality information, the basis for making continued improvements and informed decisions.

The agency also carries out plans that protect the Commonwealth's waters. Virginia's Watershed Implementation Plan guides state agencies on how to reduce the amount of pollution that goes into the Bay. Specific clean-up goals to reduce nitrogen and sediment are detailed in the Chesapeake Bay Total Maximum Daily Load (TMDL). The TMDL is a "pollution diet," or clean-up plan for a body of water. The TMDL limits the amount of pollution allowed to ensure there are no adverse effects on human and aquatic health.

How to "Lighten Your Footsteps" on Land:

- Pick up trash in your neighborhood.
- Never pour chemicals down the drain.
- Read instructions on labels to learn where to dispose of chemicals and motor oil.
- Pick up after your dog.
- Rethink using toxic cleaning chemicals, pesticides and fertilizers.

Don't Pollute!

A common culprit of water pollution is fecal coliform bacteria, a type of bacteria commonly found in human and animal waste. Waste can wash from your back yard into storm drains and end up in our lakes, rivers and streams. The bacteria can get into shellfish and cause people who eat the shellfish to get sick. A day's waste from a large dog can contain enough fecal coliform bacteria to close 15 acres of commercial shellfish beds. So, do your part and scoop the poop!

Additional Resources

- Virginia Department of Environmental Quality
- Virginia Department of Conservation & Recreation
- Virginia Association of Soil and Water Conservation Districts
- Virginia Water Radio
- Virginia Save Our Streams
- Project WET

Fundamental Learnings Related to Water Resources

- All life processes, from the level of a cell to that of an ecosystem, require water. Both the quantity and quality of water are important. Habitats with abundant plants and animals are areas with clean water in good supply.
- Water is found in the atmosphere, on the surface and underground. The water cycle is central to life on Earth and connects Earth systems.
- Water is a natural resource that must be managed. The amount of available freshwater is limited (99 percent of the Earth's water is saline) and must support multiple users. Clean, sustainable water supplies are vital. When supplies fail to meet demands, conflicts arise.
- Aquatic environments are subject to much use and abuse by people. Water pollution occurs when chemicals, nutrients or sediments are placed into water faster than they can be removed by natural processes. Water pollution can often be traced to runoff in the watershed.
- While water is useful as a cleaning agent ("the universal solvent") and as a means for disposing of soluble waste, the capacity for water to dilute pollutants is limited.

What's Your Watershed Address?

Easy ways to demonstrate how water flows through a watershed

Grade Levels: 3-6

Science SOLs:
3.9, 4.8, 6.11

Materials:

- A map of your local area showing streams (topographic is good but not essential)
- Paper and markers
- Paint trays (1-2)
- Aluminum foil or a white shower curtain
- Rocks or blocks
- A powdered "pollutant," such as soil, salt, cinnamon, powdered drink mix or cocoa
- Sponges and small toys

Objective:
Students will be able to predict where water will flow in water¬sheds, describe drainage patterns in watersheds, and identify sources of pollution.

Vocabulary Words:
erosion
groundwater
hydrologic cycle
nonpoint source pollution
nutrients
pollutants
runoff
water pollution
watershed

Watershed Background

A watershed, also called a drainage basin, is a geographic area in which water, sediments, dissolved minerals and other pollutants, including trash, drain into a common body of water. While we all reside in one, many of us do not even know its name. There are nine distinct watersheds or river basins that lie within the state of Virginia. They are from south-west to north-east: The Tennessee-Big Sandy, the New, the Roanoke, the Chowan, the James, the Potomac-Shenandoah, the Rappahannock and the York. The James River is the largest watershed. It includes all or parts of 39 counties and 18 cities and drains one-fourth of the state's land area into the Chesapeake Bay.

Discuss the concept of a watershed and how water travels over and through the land. Students may wonder where water goes after it flows down the street during a heavy rainstorm. Make the connection between people living in the watershed and the impacts that they have upon water quality; specifically, non-point source pollution. Provide some examples of how the actions and behaviors of individuals (including pets and their owners) and businesses in your area affect the water quality of your local watershed and the body of water into which the watershed drains, such as the Chesapeake Bay. Don't forget to include sewage treatment plants, homes, commercial developments, and factories.

This image shows the dividing line and drainage basin for a small tributary of the James River in Nelson County. When it rains here, water (and pollution!) travels about 175 miles down the James River to the Chesapeake Bay.

Discuss the speed at which water flows and how moving water changes the land. You can refer to the branches on a tree, or the veins in a leaf, or the human nervous system to describe how bodies of water "branch out" with smaller branches analogous to streams branching into larger ones, such as rivers, and so forth. Explain that watersheds can be open or closed depending on where the water drains. In closed systems, there is no outlet for the water, so it leaves the system naturally by evaporation or by seeping into the ground (becoming groundwater). In open watershed systems, such as those found in Virginia, water eventually flows into outlet rivers or a bay and, ultimately, the sea.

Activities

There are numerous ways that students can build a model of a watershed, ranging from individually constructed models made of paper to larger scale models created by using a shower curtain or tarp. Here are some easy ways to demonstrate topography and the action of water flowing through a watershed:

Students use crumpled paper or foil to create a miniature watershed model: Crumple a piece of foil or paper into a tight ball. Gently open it up, but don't flatten it out completely. The highest points on the foil or shower curtain represent the mountain tops and the lowest wrinkles, the valleys. Choose one color of water

soluble marker and use it to mark the highest points on the map. These points are the mountain ridge lines. Choose a second color and mark the places where different bodies of water might be: creeks, rivers, and lakes. With a third color, mark four or five places to represent human settlements: housing tracts, factories, shopping centers, office buildings, schools, etc. Try sprinkling a powdered material, such as cinnamon, red pepper, or cocoa powder, to demonstrate how pollutants flow through the watershed. Use spray bottles to lightly spray the topographic watershed maps. The spray represents water falling into the watershed.

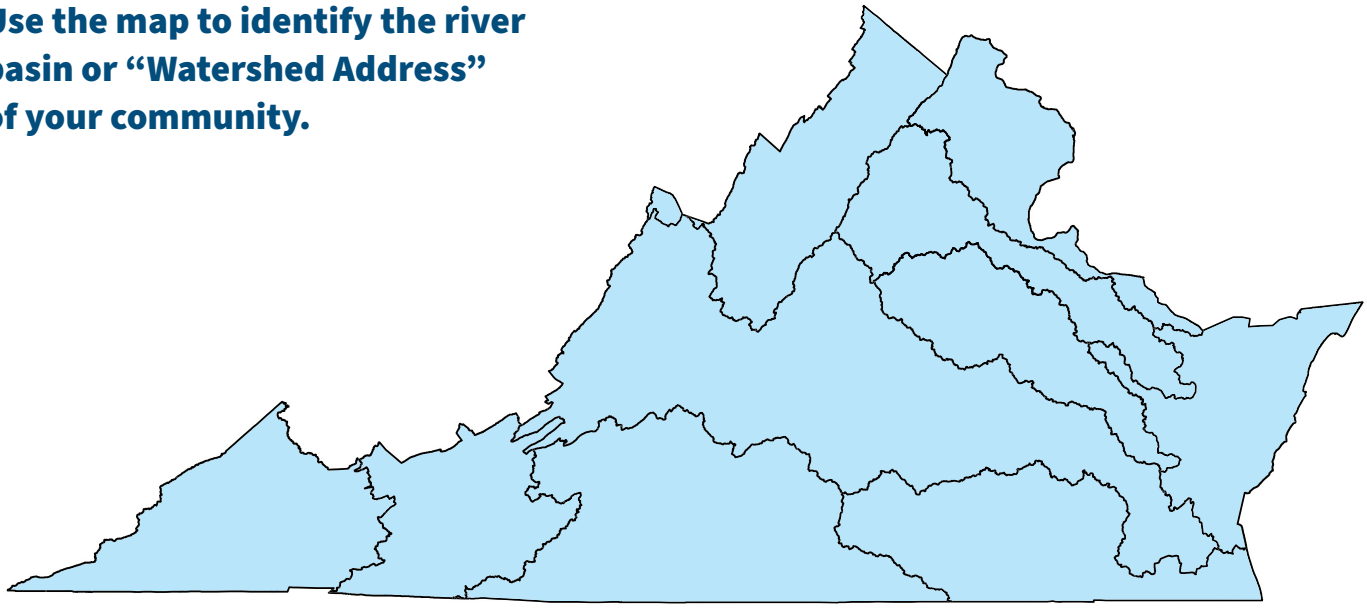
Or, you can use a paint tray to create a slightly larger model: Place small rocks or other objects on the tray, and cover the tray with aluminum foil or a white garbage bag. Use spray bottles to represent rain. Sprinkle powdered materials such as cinnamon, Kool Aid, or cocoa powder to represent how pollutants flow through the watershed. Place sponges at the bottom of the watershed to represent wetlands that help clean the water. To show how wetlands help to hold and clean water, you could conduct a test (either using two paint trays or one paint tray with two different scenarios) to see which watershed drains more quickly and how much water reaches the end of the tray. In either case, measure the water before you spray it into the watershed and again, afterwards. You could also time the contest.

Investigative questions

Investigate how the water travels through the system.

- What changes do you observe in the “paper” watershed maps?
- Where does erosion occur?
- What happens to human settlements? Are any buildings in the way of a raging river or crumbling hillside?
- How does the flow of water through the watershed affect choices for building sites?
- What happens to the “pollutants? Where do they end up?
- What factors may lead to increased pollutants such as run-off from sediments, industrial wastes, phosphates and nitrates from agricultural sources, sewage, and residential runoff including pesticides.
- What are some ways to reduce or prevent these “non-point” source pollutants?

Use the map to identify the river basin or "Watershed Address" of your community.



RIver Basins in Virginia

1 - Potomac

2 - Rappahannock

3 - York

4 - James

5 - Roanoke

6 - New

7 - Tennessee/Big Sandy

8 - Chowan

9 - Coastal Rivers/Eastern Shore