COOPERATIVE EXTENSION SERVICE • UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE, LEXINGTON, KY, 40546

4DE-01po

UNIVERSITY OF KENTUCKY College of Agriculture

Unit 1: What is a Watershed?

The Southern Region 4-H_2O Ambassador Program

Educating a new generation of water resource protectors and conservators

Applying knowledge to improve water quality
Southern Regional Water Program
A Partnership of USDA NIFA & Land Grant Colleges and Universities

Introduction

The Southern Region 4-H_2O Ambassador Program addresses key concepts related to watershed education. The program is part of an ongoing effort within the Southern Region to educate and empower youth to conserve and protect our water resources.

A Southern Region 4-H_2O Ambassador is a 4-Her, 8 to 14 years of age, who has successfully completed units 1 through 3 and has been acknowledged by the Southern Region Water Program as having the skills and knowledge to successfully complete a community-based service project. At the completion of the community-based service project, each 4-H_2O Ambassador will be recognized on a local, statewide, and multi-state (regional) basis.

Each unit includes:

Skimming the Surface	Background information to help instructors prepare for activities
Wading In	Hands-on activities
4-H_2O Opportunities	Extensions to particular activities (not required to become an ambassador)
Diving Deeper	Additional activities (not required to become an ambassador)
Sink or Swim	Evaluation options

Table of Contents

UNIT 1

What is a Watershed?

Overview

In this unit, 4-Hers will identify and learn the characteristics of their local watershed. In the process, they will learn about sources of water pollution and their role in keeping water clean.

4-H$_2$Objectives

- Define watershed.
- Name the major watersheds in their state.
- Describe and locate their watershed.
- Define point source and nonpoint source pollution.
- Identify sources of point source and nonpoint source pollution.

Focus Questions

- What is a watershed?
- What are pollutants?
- How do pollutants affect watersheds?
- What watershed do you live in?

4-H Life Skills

- **Head:** Learning to Learn, Critical Thinking, and Keeping Records
- **Heart:** Communication, Cooperation, and Sharing
- **Hands:** Leadership, Responsible Citizenship, Contributions to a Group Effort, and Teamwork
- **Health:** Self-Responsibility

NATIONAL EDUCATION STANDARDS		
Topic	**Section**	**Grade levels**
1. The Nature of Science	C. The Scientific Enterprise	3-5
3. The Nature of Technology	A. Technology and Science	6-8
4. The Physical Setting	B. The Earth	6-8
11. Common Themes	A. Systems	6-8
	B. Models	3-5
	D. Scale	6-8

Skimming the Surface

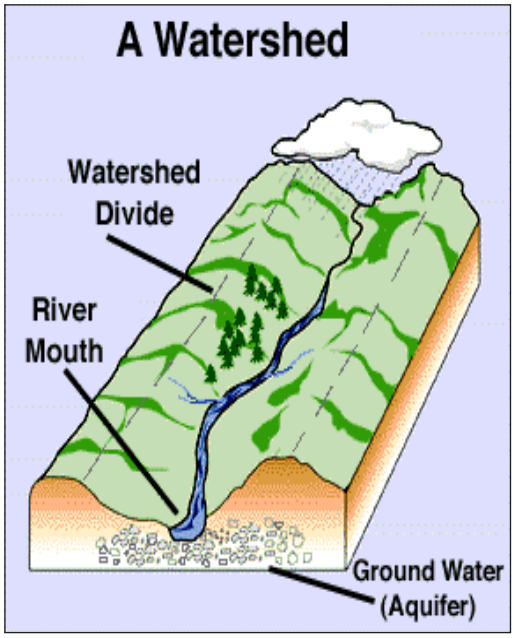
Watersheds

A watershed is the area of land that drains into a lake, river, stream or wetland. You may not realize it, but you are always in a watershed. A watershed is nature's boundary for water. It includes all the land that drains to a single stream, river, lake or body of water. Rainfall and snow melt flow into streams, rivers, wetlands, lakes and eventually to the ocean; or, the water may travel through the soil to become groundwater (Figure 1).

Watersheds may be as small as just a few acres, or as large as several states. The watershed of the Mississippi River is about 1.2 million square miles and contains thousands of smaller watersheds. These smaller watersheds drain to smaller streams that empty into a larger river such as the Ohio River or Missouri River. These larger rivers then empty into the Mississippi River.

The land in a watershed affects how the water flows. If a watershed has lots of hills and mountains, rain runs off quickly. This runoff will reach the stream or body of water soon after the rain falls. If the land in the watershed is mostly flat, rain will run off more slowly and not reach the stream or body of water as fast. The rain may soak into the soil and become groundwater.

Figure 1. A watershed is nature's boundary for water.



Everyone in a watershed can impact water quality. Many of our daily activities at home, work or play have the potential to affect water quality in our watershed. Runoff from lawns, roads and parking lots eventually drains into waterways, carrying with it nutrients, oil, gas, bacteria and other pollutants. Rain can wash fertilizers, pesticides, bacteria and sediment from farming and other activities into creeks and lakes. Industries discharge treated wastewater to rivers and streams. At the same time that we unconsciously pollute our water resources, we rely on clean water for drinking water supplies, as a food source, for recreational activities such as fishing, boating and swimming, and for industrial uses. Aquatic plants and animals as well as terrestrial wildlife depend on clean water for food and habitat. Many people believe that the most effective way to protect water quality is through watershed planning. Watershed planning attempts to address all activities in a watershed that potentially affect water quality.

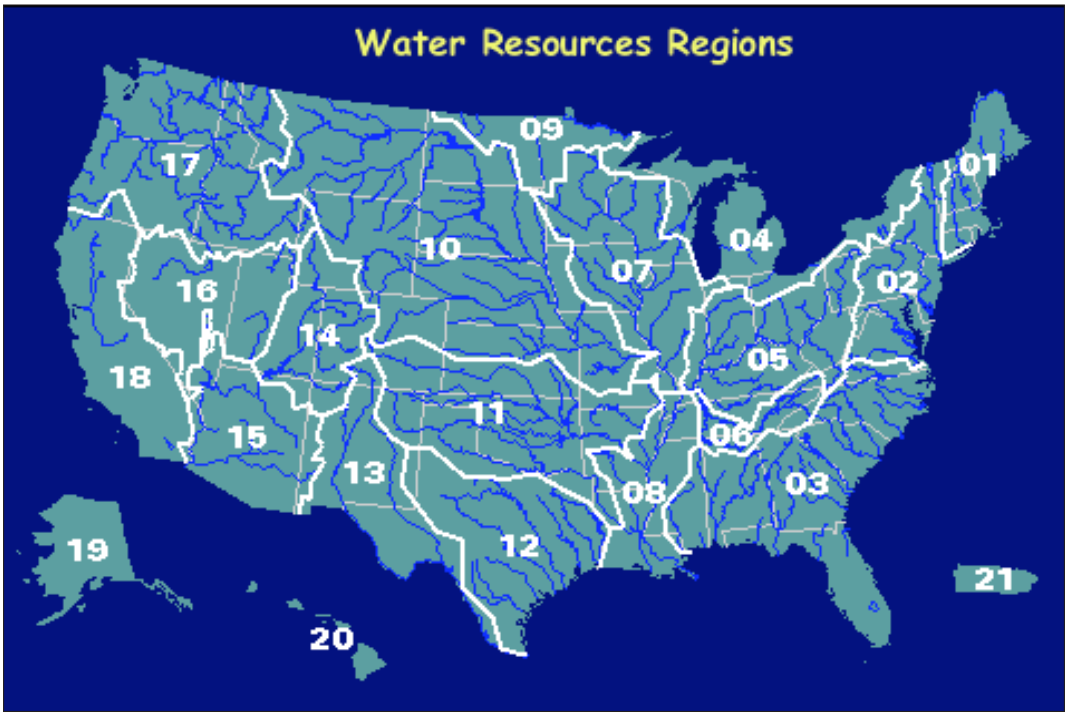
Hydrologic Unit Codes

The Hydrologic Unit Map identifies the location of watersheds. The Water Resources Council developed a hierarchical classification of hydrologic drainage basins in the United States. Each hydrologic unit is identified by a hydrologic unit code (HUC). This unique code is based on the four levels of classification in the hydrologic unit system and consists of two to fourteen digits. Hydrologic units are arranged from smallest (cataloging units) to largest (regions). Hydrologic Unit Maps provide standardized codes and location information to be used by water-resource managers and planners for cataloging and exchanging hydrologic data. The maps are also used to plan water use and to describe land-use activities.

The first level of classification divides the United States into 21 major geographic areas called regions (Figure 2). These geographic areas contain either the drainage area of a major river or the combined drainage areas of a series of rivers. Eighteen of the regions represent the 48 contiguous states. Alaska is represented by region 19. The Hawaiian Islands are region 20, and Puerto Rico and other outlying Caribbean areas comprise region 21.

The second level of classification divides the 21 regions into 222 subregions. A subregion includes the area drained by a river system and its tributaries, a closed basin, or a group of streams forming a coastal drainage area.

Figure 2. Water Resources Regions. Gray lines represent state boundaries; blue lines show major rivers; and white lines indicate the water resources region boundaries.



The third level of classification subdivides many of the subregions into accounting units. These 352 hydrologic accounting units are nested in, or equivalent to, the subregions.

The fourth level of classification is the cataloging unit. A cataloging unit is a geographic area representing part of all of a single drainage basin, a combination of drainage basins, or a distinct hydrologic feature. These units divide the subregions and accounting units into smaller areas. The United States contains 2,150 cataloging units.

The fifth level of classification is the watershed, often the smallest element defined on HUC maps, with basins of approximately 50,000 to 250,000 acres. These areas are often called "11-digit watersheds."

The sixth level of classification, the subwatershed, is not represented in any but the most detailed maps. Subwatersheds are also referred to as "14-digit watersheds."

Table 1. Reading the Hydrologic Unit Code for the Enoree River in South Carolina.

Region	03	South Atlantic Gulf
Subregion	0305	Edisto-Santee
Accounting unit	030501	Santee
Cataloging unit	03050108	Enoree
Watershed	03050108-040	Unnamed watershed
Subwatershed	03050108-040-010	Unnamed subwatershed

Nonpoint Source Pollution

What happens to a drop of water when rain falls? How does the water move as snow melts? When you water your lawn or irrigate farm fields, where does the water go? Some of the water will run across the land surface. Some will soak into the ground. As the water moves, it can pick up things that make it impure. These substances are call pollutants. Pollutants can travel into rivers, lakes, streams or groundwater.

Take a moment to think about the path rain follows. When it reaches the ground, it will either soak into the soil or run along the surface. Rain that lands on a parking lot can pick up motor oil and other pollutants. Rain that lands on a lawn or farm field may carry fertilizer or loose soil with it as it travels. Rain that lands on a bare hillside can wash part of the soil away as it moves. All of these are examples of nonpoint source pollution.

Unlike point source pollution, which can be traced to a single source such as a sewage treatment plant or factory, nonpoint source pollution cannot be traced back to a single starting place. Nonpoint source pollution is the largest water quality problem in the United States today. It is also called runoff pollution. The pollutants are carried in water as it runs off the land.

Runoff can travel directly to rivers, lakes and streams. It may also travel through storm drains. Stormwater is runoff from rain and snowmelt. In cities and towns, a system of drains and pipes is often used to carry stormwater. These systems usually empty into a nearby body of water. Stormwater is not usually routed to a treatment plant.

The most common pollutants carried in runoff are sediment and nutrients. Sediment is soil that is carried in water. The soil can come from farm fields, construction sites, logging sites or any bare land. As the water moves across the land, it picks up part of the soil. This soil travels with the water until it reaches a stream, lake or river.

Nutrients are found in fertilizer, animal manure, pet waste and human waste. Pasture fields and animal feeding lots can be sources of nutrients. Pet waste can be carried in runoff water from lawns. Farm fields, golf courses and lawns may also use fertilizer. Some of the fertilizer can wash away in runoff.

Runoff water may also carry other pollutants. Oil and automotive fluids can wash off streets, roads, parking lots and driveways. Pesticides may be found in runoff from farm fields, lawns and gardens. Toxic chemicals are sometimes washed away when spilled on the ground.

Best management practices are techniques or management strategies that can be used to help prevent water pollution. These practices can help stop soil erosion and keep pollutants out of the water.

Wading In

Paper Wad-ershed Activity

Adapted from Rob Beadel, Arkansas Department of Environmental Quality. Used with permission.

Time: 30 minutes

This activity demonstrates to youth the basic geography of a watershed, how water moves through a watershed, and the impact people have on the quality of our water (Figure 3).

4-H$_2$Objectives

- Define a watershed.
- Identify the elements of a watershed.
- Understand the importance of a watershed in our lives.
- Identify sources of pollution in a watershed.

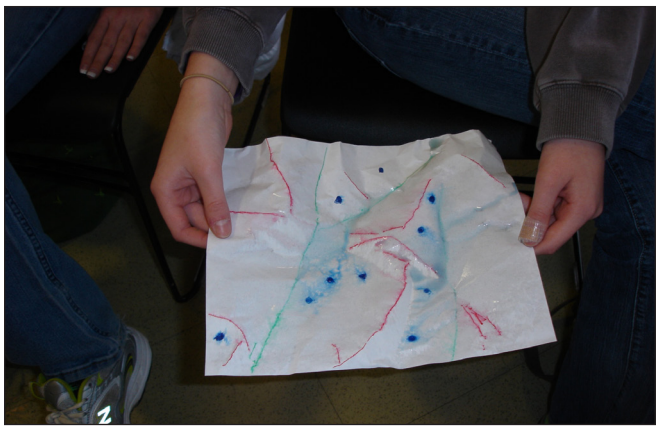
Materials

- White paper, 8.5 x 11 inches, one sheet per individual
- Water soluble markers, 3 different colors per individual (groups of 2-3 students may share if needed)
- Several spray bottles of water
- Paper towels
- Aluminum pans (optional)

Instructions

1. Discuss the definition of a watershed with youth.
2. Discuss the elements of a watershed, such as streams, lakes, ponds, farms, factories, homes, parking lots, etc.
3. Crumble a piece of paper into a ball.
4. Gently open the paper, but don't flatten it out completely. The highest points on the paper now represent mountain tops and the lowest wrinkles represent valleys.
5. Choose one color of the water soluble markers to mark the highest points on the paper (or "map"). These are the mountain ridge lines.
6. Choose a second color to mark the places where different bodies of water might be, such as streams, rivers, ponds, lakes, etc.
7. Use the third marker to mark several places to represent human settlement, such as housing, factories, farms, schools, shopping centers, etc. Label each spot.
8. Use a spray bottle to gently mist each finished map to represent rain falling onto the watershed. (Optional: large aluminum pans can be placed under maps during misting for easier cleanup.)
9. Discuss any observations about how the water travels through the watershed area.
10. Discuss runoff and the effects runoff may have on the quality of water in your watershed.

Figure 3. Example of a Paper Wad-ershed.



Reflection Questions

- What changes did you observe in your map?
- Where does most of the "rain" fall?
- What path does the water follow?
- Where would erosion occur?
- How are the human settlements affected?
- Are any buildings in the path of a raging river or crumbling hillside?
- How does the flow of water through the watershed affect your choice of building sites?
- How does the map demonstrate the idea of a watershed?

4-H$_2$Opportunities

- Look at a topographic map of your town or neighborhood. See if youth can locate ridge lines, streams, rivers, etc. that make up their watershed. Try to determine how heavy rainfall and runoff events might impact certain areas.
- Discuss the issues of land uses (agriculture, construction, etc.) and water quality. Play a simulation game that would illustrate different viewpoints on how we use water.
- Make an outdoor watershed map using a plastic sheet or large sheets of white butcher paper. Use tempura paint instead of markers and a water hose instead of a spray bottle.

4-H Life Skills

- **Head:** Learning to Learn, Critical Thinking, and Keeping Records
- **Heart:** Communication, Cooperation, and Sharing

NATIONAL EDUCATION STANDARDS		
Topic	**Section**	**Grade levels**
1. The Nature of Science	C. The Scientific Enterprise	3-5
3. The Nature of Technology	A. Technology and Science	6-8
4. The Physical Setting	B. The Earth	6-8
11. Common Themes	A. Systems	6-8
	B. Models	3-5
	D. Scale	6-8

Nested Watersheds Activity

Time: 25 minutes

This activity demonstrates to youth the concept that smaller watersheds make up larger watersheds and how pollutants in a smaller watershed can ultimately affect larger watersheds.

4-H_2Objectives

- Define a watershed.
- Understand that smaller watersheds make up larger watersheds.
- Identify sources of nonpoint source and point source pollution in a watershed.
- Identify ways to reduce pollution.

Materials

- Clear stackable bowls that fit inside of one another, 4 in graduated sizes (see Figure 4)
- Industrial-size cans, 3 with both ends cut off
- Food coloring, 3 different colors
- Water to fill each bowl

Instructions

1. Before the activity begins, stack bowls and cans as seen in Figure 4. Add water to almost fill the top three bowls. Fill the largest bowl three quarters full of water. Each bowl represents an individual watershed.

Figure 4. Demonstrating how smaller watersheds form larger watersheds.

2. Discuss concept of watershed with youth.
3. Discuss how each bowl represents an individual watershed. Ask youth if they know what watershed they live in. Discuss how we all live in a watershed and how smaller watersheds form larger watersheds. For example, Sally lives in the Licking River Watershed, which is part of the Ohio River Watershed, which is part of the Mississippi River Watershed. Show a map of local watersheds as a visual.
4. Demonstrate how water flowing in a smaller watershed travels into larger watersheds by adding water to the first (smallest) bowl on top. Allow the water to overflow into the other bowls.
5. Talk about different pollutants that may be present in a watershed (pesticides, fertilizers, oil, automobile fluids, silt, waste products, etc.). Discuss nonpoint source and point source pollution.
6. Illustrate different pollutants in each watershed (or bowl) by adding different colors of food coloring to the first three bowls.
7. Discuss what happens during a rain event. The pollutants in the first watershed (or bowl) will pollute the larger watersheds.
8. Demonstrate a rain event by adding more water to the first watershed (or bowl). Discuss what happens if the second watershed has a rain event and the first watershed does not. Demonstrate this by adding water to the second watershed and not adding water to the first watershed.
9. Discuss how these rain events have affected the larger watersheds (third and forth bowls). Discuss what happened to the different colors that represented different pollutants. Did the colors mix? Relate this to nonpoint source pollution. Discuss how the different colors of food coloring mixed and now cannot be distinguished from one another. Talk about nonpoint source pollution and how it cannot be separated out to one source or starting place.

Reflection Questions

- What pollutants may be present in the watershed you live in?
- How can these pollutants be reduced?

4-H$_2$Opportunities

- Take a walking or driving tour of your watershed. Identify sources of pollution.
- Host a communitywide clean-up event.
- Hand-out educational materials, such as fliers and brochures, to inform others about local watersheds and water quality.

4-H Life Skills

- **Head:** Learning to Learn, Critical Thinking, and Keeping Records
- **Heart:** Communication, Cooperation, and Sharing
- **Hands:** Leadership, Responsible Citizenship, Contributions to a Group Effort, and Teamwork
- **Health:** Self-Responsibility

NATIONAL EDUCATION STANDARDS		
Topic	**Section**	**Grade levels**
4. The Physical Setting	B. The Earth	6-8
11. Common Themes	A. Systems	6-8
	D. Scale	6-8

Edible Watershed

Time: 20 minutes

This activity is used to guide youth in learning about local watersheds. Using edible items, youth create a model of a local watershed (which they can later eat).

4-H$_2$Objectives

- Define a watershed.
- Identify elements in a specific watershed (the watershed you live in, the watershed you go to school in, the watershed the county Extension office is in).

Materials

- Graham crackers
- Peanut butter*
- Chocolate icing
- Green and blue icing
- Mini chocolate chips
- Chocolate chips
- Chocolate candies
- Gummy candies to represent fish, trees, animals, and people
- Various colored sprinkles
- Black licorice
- Fruit leather such as fruit rollups
- Bowls, plates, spoons, knives, napkins
- Map outlining local watersheds (optional)

*Remember to ask if any participants have food allergies. For those with peanut allergies use chocolate icing instead.

Instructions

1. Before activity organize materials (food items) to hand out to youth. Have plenty of paper towels on hand. If possible have a map outlining watersheds in your area.
2. To begin activity, discuss concept of watershed with youth. Choose a local watershed to focus on, such as the watershed that the county Extension office or school is located in. Discuss features of that watershed with youth. Have youth identify different elements in the watershed (buildings, houses, paved areas, roads, water bodies, schools, farms, fields, forested areas, parks, etc.).
3. Discuss possible sources of nonpoint source and point source pollution in that watershed.
4. Explain to youth that they will be constructing a watershed. Have youth construct the local watershed you discussed, or have them construct the watershed they live in.
5. Explain what each item represents and, if possible, have that information available for youth to see (e.g., on chalkboard, flipchart, etc.).
6. Hand out items and have youth begin to construct their edible watersheds.
7. Once youth have constructed their edible watersheds, have them share with the rest of the group. See Reflection Questions below.
8. Once everyone has shared their edible watersheds, allow students to eat their creations!

Table 2. Ideas for making an edible watershed.

Edible Item	Watershed feature
Graham crackers	Bedrock or soil layer
Peanut butter, chocolate icing	Soil layers
Green icing	Grass
Blue icing	Water
Chocolate chips, chocolate candies	Hills and mountains
Gummy candies	Fish, animals, trees, people, buildings, homes, cars
Colored Sprinkles (such as green, blue, red)	Grass, Water, Pesticides, Fertilizers
Black licorice	Roadways
Fruit leather	Paved areas

Reflection Questions

- As youth are sharing their edible watersheds, ask them to identify various sources of pollution within their watersheds.
- Have them discuss possible ways to reduce pollution.

4-H$_2$Opportunities

- Take youth outside to observe features of the watershed.
- Discuss sources of pollution and ways to reduce pollution.

4-H Life Skills

- **Head:** Learning to Learn, Critical Thinking, and Keeping Records
- **Heart:** Communication, Cooperation, and Sharing
- **Hands:** Leadership, Responsible Citizenship, Contributions to a Group Effort, and Teamwork
- **Health:** Self-Responsibility

NATIONAL EDUCATION STANDARDS		
Topic	**Section**	**Grade levels**
4. The Physical Setting	B. The Earth	6-8
11. Common Themes	A. Systems	6-8
	D. Scale	6-8

Diving Deeper

Find Your Watershed Activity

Time: 1 hour

This activity is used to guide youth in learning about the watershed they live in. For younger children, you may consider doing this activity in a large group with adult leaders.

4-H$_2$Objectives

- Identify the watershed you live in.
- Understand hydrologic unit map codes and their importance.

Material

- Internet access

Instructions

1. Have youth locate their watershed on the U.S. Environmental Protection Agency's Surf Your Watershed website: www.epa.gov/surf.
2. Ask youth to name the watershed they live in.
3. Discuss hydrologic unit map codes. Ask youth to identify the 8-digit USGS cataloging unit number for the watershed they live in.
4. Ask youth to identify the counties that make up the watershed they live in.

Reflection Questions

- What watershed do you live in?
- What is a hydrologic unit map code and what is it used for? What is the hydrologic unit map code for the watershed you live?
- What counties make-up the watershed you live in?
- Is the watershed you live in the same watershed that your school is located in?
- How many major watersheds does your state have?

4-H$_2$Opportunities

- Don't have internet access? Go to the local library or print off watershed maps and have 4-Hers locate their watershed using the maps.
- For younger 4-Hers do this activity as a group. Choose one location, such as your county Extension office, and find the watershed for that location.

- Choose an issue or problem in your watershed (urban development, stormwater runoff, pollution, etc.). Invite a local speaker, such as a city or state government employee, Extension specialist, or Natural Resource Conservation Service employee, to discuss that issue.

4-H Life Skills

- **Head:** Learning to Learn, Critical Thinking and, Keeping Records
- **Heart:** Communication, Cooperation, and Sharing

NATIONAL EDUCATION STANDARDS		
Topic	**Section**	**Grade levels**
4. The Physical Setting	B. The Earth	6-8
11. Common Themes	A. Systems	6-8

EnviroScape Activity

The EnviroScape Models are kits featuring a scale model that represents a watershed. The models are valuable in teaching youth about water quality, helping them to visualize how they contribute to water quality problems and how to become part of the solution. EnviroScapes are popular demonstration tools, providing excellent visual illustrations of watershed terms and theory. Various models are available for different types of watersheds. The nonpoint source (NPS) model teaches about what a watershed is, point source and non-point source pollution, and best management practices. Each model has a User's Guide. For more information visit http:\\www.enviroscapes.com.

Sink or Swim

1. Conduct a pre- and post-unit questionnaire with youth. Ask them the following questions before and after the activities to determine if youth's knowledge level changed.
   - What is a watershed?
   - What are some of the elements of a watershed?
   - What is runoff?
   - How does runoff affect the water in a watershed?
   - What is nonpoint source and point source pollution?
   - What watershed do you live in?
2. Develop a K-W-L chart with youth. This chart demonstrates what students **k**now about the subject before the activity, what students **w**ant to know about the subject during the activity, and what students **l**earned about the subject after the activity. Before starting the activity ask youth as a group what they know about watersheds. Once they have told you what they already know, ask them what they want to know about watersheds. Record all answers/comments on large poster board or chalk board to refer back to. This section will help the leader know what areas of the activities to emphasize. The leader may have to adapt the activities to ensure that the youth learn the items they have specified in this section. After the activities discuss what the youth learned. Go back to the first and second questions of the chart and discuss what they knew—Were their statements correct?— and make sure items that youth wanted to know were addressed.

Glossary

Best Management Practice (BMP). Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Erosion. The wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building or logging.

Fertilizer. A natural (e.g., manure) or man-made (e.g., urea) substance used to make the soil more fertile and promote plant growth.

Groundwater. The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs. Because groundwater is a major source of drinking water, concern is growing over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

Habitat. The place where a population (e.g. human, animal, plant, microorganism) lives and its surroundings, both living and non-living.

Landfills. 1. Sanitary landfills are disposal sites for non-hazardous solid wastes spread in layers, compacted to the smallest practical volume, and covered by material applied at the end of each operating day. 2. Secure chemical landfills are disposal sites for hazardous waste, selected and designed to minimize the chance of release of hazardous substances into the environment.

Nutrient. Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in waste water but is also applied to other essential and trace elements.

Nutrient pollution. Contamination of water resources by excessive inputs of nutrients. In surface waters, excess algal production is a major concern.

Nonpoint sources. Diffuse pollution sources (i.e. without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by stormwater. Common nonpoint sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, salt water intrusion, and city streets.

Organism. Any form of animal or plant life.

Pesticide. Substances or mixture thereof intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant or desiccant.

Point source. A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution (pipe, ditch, ship, ore pit, factory smokestack, etc.).

Pollutant. Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals or ecosystems.

Pollution. Generally, the presence of a substance in the environment that because of its chemical composition or quantity prevents the functioning of natural processes and produces undesirable environmental and health effects. Under the Clean Water Act, for example, the term has been defined as the man-made or man-induced alteration of the physical, biological, chemical and radiological integrity of water and other media.

Runoff. That part of precipitation, snow melt or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Sediment. Topsoil, sand, and minerals washed from the land into water, usually after rain or snow melt.

Sewage. The waste and waste water produced by residential and commercial sources and discharged into sewers.

Sewer. A channel or conduit that carries wastewater and stormwater runoff from the source to a treatment plant or receiving stream. "Sanitary" sewers carry household, industrial, and commercial waste. "Storm" sewers carry runoff from rain or snow. "Combined" sewers handle both.

Silt. Sedimentary materials composed of fine or intermediate-sized mineral particles.

Storm sewer. A system of pipes (separate from sanitary sewers) that carries water runoff from buildings and land surfaces.

Topography. The physical features of a surface area including relative elevations and the position of natural and man-made (anthropogenic) features.

Water quality. The chemical, physical and biological condition of a body of water.

Watershed. The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

National Education Standards

1. The Nature of Science

A. The Scientific World View

The results of similar scientific investigations seldom turn out exactly the same. Sometimes this is because of unexpected differences in the things being investigated, sometimes because of unrealized differences in the methods used or in the circumstances in which the investigation is carried out, and sometimes just because of uncertainties in observation. It is not always easy to tell which (Grades 3-5).

B. Scientific Inquiry

Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Investigations can focus on physical, biological and social questions (Grades 3-5).

Results of scientific investigations are seldom exactly the same, but if the differences are large, it is important to try to figure out why. One reason for following directions carefully and for keeping records of one's work is to provide information on what might have caused the differences (Grades 3-5).

C. The Scientific Enterprise

Clear communication is an essential part of doing science. It enables scientist to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world (Grades 3-5).

Accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society (Grades 6-8).

3. The Nature of Technology

A. Technology and Science

Technology enables scientists and other to observe things that are too small or too far away to be seen without them and to study the motion of objects that are moving very rapidly or are hardly moving at all (Grades 3-5).

Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation and communication of information (Grade 6-8).

4. The Physical Setting

B. The Earth

Fresh water, limited in supply, is essential for life and also for most industrial processes. Rivers, lakes, and groundwater can be depleted or polluted, becoming unavailable or unsuitable for life (Grades 6-8).

The benefits of the earth's resources – such as fresh water, air, soil, and trees – can be reduced by using them wastefully or by deliberately or inadvertently destroying them. The atmosphere and the oceans have a limited capacity to absorb wastes and recycle materials naturally. Cleaning up polluted air, water, or soil or restoring depleted soil, forests, or fishing grounds can be very difficult and costly (Grades 6-8).

C. Processes that Shape the Earth

Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed the earth's land, oceans, and atmosphere. Some of these changes have decreased the capacity of the environment to support some life forms (Grades 6-8).

5. The Living Environment

A. Diversity of Life

A great variety of kinds of living things can be sorted into groups in many ways using various features to decide which things belong to which group (Grades 3-5).

Features used for grouping depend on the purpose of the grouping (Grades 3-5).

Interdependence of Life: For any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all (Grades 3-5).

Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful (Grades 3-5).

D. Interdependence of Life

In all environments—freshwater, marine, forest, desert, grassland, mountain, and others—organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter. In any particular environment, the growth and survival of organisms depends on the physical conditions (Grades 6-8).

F. Evolution of Life

Individual organisms with certain traits are more likely to survive and have offspring. Changes in environmental conditions can affect the survival of individual organisms and entire species (Grads 6-8).

9. The Mathematical World

D. Uncertainty

The larger a well-chosen sample is, the more accurately it is likely to represent the whole. But there are many ways of choosing a sample that can make it unrepresentative of the whole (Grades 6-8).

11. Common Themes

A. Systems

In something that consists of many parts, the parts usually influence one another (Grades 3-5).

Thinking about things as systems means looking for how every part relates to others. The output from one part of a system (which can include material, energy, or information) can become the input to other parts. Such feedback can serve to control what goes on in the system as a whole (Grades 6-8).

Any system is usually connected to other systems both internally and externally. Thus a system may be thought of as containing subsystems and as being a subsystem of a larger system (Grades 6-8).

C. Constancy and Change

Physical and biological systems tend to change until they become stable and then remain that way unless their surroundings change (Grades 6-8).

12. Habits of Mind

A. Values and Attitudes

Keep records of their investigations and observations and not change the records later (Grades 3-5).

Offer reasons for their findings and consider reasons suggested by others (Grades 3-5).

Know why it is important in science to keep honest, clear, and accurate records (Grades 6-8).

Source: American Association for the Advancement of Science, *Benchmarks for Science Literacy,* 1993.

References

$4H_2O$ Project (2001). Retrieved October 22, 2010, from http://www.clemson.edu/waterresources/4h2o/gen_inf.htm.

American Association for the Advancement of Science (1993). Benchmarks for Science Literacy. Oxford University Press.

U.S. EPA (2009). Terms of the Environment: Glossary, Abbreviations, and Acronyms. Retrieved October 22, 2010, from http://www.epa.gov/glossary.

U.S. EPA (2010). Surf Your Watershed. Retrieved October 22, 2010, from http://cfpub.epa.gov/surf/locate/index.cfm.

Acknowledgments

Southern Region 4-H_2O Ambassadors Committee

Ashley Osborne, Jann Burks, Amanda Gumbert, Carol Hanley, Stephanie Jenkins, Blake Newton, and Brian Radcliffe (University of Kentucky); Melanie Biersmith (University of Georgia); Lena Beth Carmichael (University of Tennessee); Frank Henning (Region IV EPA–Land Grant Universities Liaison); Rick Wiley (Clemson University); Lenny Rogers (North Carolina State University)

Reviewers

Elizabeth Conway, Kandi Edwards, Brenda Jackson, Octavia Jackson, Terri Kimble, Julie Lawrence, and Dinah Rowe (University of Georgia); Jan Gibson, Rebecca Konopka (University of Kentucky); Julie Jones (Fayette County Public Schools)

This publication was adapted from the *4-H_2O Pontoon Classroom*, a curriculum developed by Clemson University Cooperative Extension. Permission granted for use and modification.

The development of the Southern Region 4-H_2O Ambassador curriculum was funded by the USDA-NIFA Southern Region Water Program.

Issued 2-2011