Program Title: Watersheds: Mountains to the Bay

Suggested Grade Level: 6th

Maximum Group Size Per Day: 45 students (plus chaperones) per site

Overview

Fresh water is a precious, non-renewable resource that is essential for life. People depend on it for drinking, transportation, livelihoods, and recreation. Water also provides habitat for many plants and animals. The manner in which this resource is protected has a direct impact upon the natural and human communities. Shenandoah National Park lies at the headwaters for three of Virginia's watersheds. Through direct investigation, data collection, and observation of a mountain stream, students will connect local water sources with larger watersheds and better understand the dynamics of stream life and the extensive impacts of water management and usage. As human and environmental impacts are evaluated, stewardship behaviors that support a healthy world will be explored and practiced.

Objectives

Following the park and classroom activities, the students will be able to

1. define the following terms: watershed, headwaters, macroinvertebrate, abiotic, pH, dissolved oxygen, point and non-point source pollution;
2. describe the composition of a watershed and identify the Virginia regional watershed in which they live;
3. determine the water quality of the streams in Shenandoah National Park based on scientific investigation and the study of macroinvertebrate communities;
4. predict the impacts on the health of a watershed ecosystem from natural events and human activities;
5. assess Shenandoah National Park's role in protecting water resources and evaluate the effect of human behaviors on watersheds.

Virginia Science Standards of Learning Addressed

Strand: Living systems

6.7 The student will investigate and understand the natural processes and human interactions that affect watershed systems. Key concepts include

- a. the health of ecosystems and the abiotic factors of a watershed:
- b. the location and structure of Virginia's regional watershed systems;
- c. divides, tributaries, river systems, and river and stream processes;
- f. major conservation, health, and safety issues associated with watersheds;
- g. water monitoring and analysis using field equipment including hand-held technology.

Background Information

When rain or snowmelt saturates the ground, the excess water becomes runoff that eventually collects in a stream channel, lake, reservoir, or other body of water. The collection area from where all this water drains is called the *drainage basin* or *watershed*. High elevation areas called *divides* or *ridgelines* separate watersheds.

The Virginia Department of Game and Inland Fisheries defines 12 major watersheds in Virginia: Big Sandy, Chowan, Clinch, Eastern Shore, Holston, James, New, PeeDee, Potomac-Shenandoah, Rappahannock, Roanoke, and York. In addition there are 497 sub-watersheds, made up of small creeks and streams that flow into larger ones before merging into the major rivers. Five of the major watersheds (60% of Virginia) are part of the larger Chesapeake Bay watershed, which covers 64,000 square miles in six states. Shenandoah National Park, located along the crest of the Blue Ridge Mountains, is at the headwaters of three of these watersheds, the Potomac-Shenandoah, Rappahannock, and James. All the streams that flow out of the park pass through numerous farms, towns, and cities, eventually reaching the Chesapeake Bay and the Atlantic Ocean.

The quality or health of a body of water can be measured by investigating the water chemistry and the types of organisms living in the water. Oxygen content, pH, and mineral content are typical *abiotic* (non-living) factors that affect water chemistry. *pH* measures the relative acidity and alkalinity of a substance. pH levels range from 0 (highly *acidic*) to 14 (extremely *alkaline*), with 7 being the neutral rating given to distilled water. Most plants and animals prefer a balanced or almost neutral pH level. *Dissolved oxygen* (DO) is a measure of the water's oxygen content in parts per million (ppm). A DO reading of 5-15 ppm provides ideal conditions for most aquatic organisms and generally indicates a healthy body of water.

Macroinvertebrates are the tiny invertebrate (without backbones) animals that are found in aquatic ecosystems. Examples include such animals as crayfish, mussels, aquatic snails, aquatic worms, and the aquatic larvae of insects such as mayflies, stoneflies, caddisflies, and dragonflies. Many macroinvertebrates require clean, highly oxygenated water to survive. The presence (or absence) of specific macroinvertebrates can indicate the relative health of the water habitat.

Water *pollution* is caused when harmful chemical or waste materials are discharged or deposited into the water. *Point source pollution* can be traced to a single source such as a factory or sewage treatment plant while *non-point source pollution* comes from a variety of sources or over a wide area such as runoff from farmland or city streets. Acid rain, fertilizer runoff, human and animal waste, chemicals, and sediments from erosion can dramatically affect the natural balance of watersheds and alter the water chemistry. Many animals are pollution "sensitive" and are unable to survive when the water conditions change. Irresponsible human actions can have significant impact on the fresh water supply that plants, animals, and people depend on for survival.

Fortunately, many types of water pollution can be cleaned up by using natural or man-made filtering systems. People can reduce or eliminate the sources of pollutants that are released into the environment. Healthy wetlands and *riparian buffer zones* along the riverbanks are crucial to provide natural filters for some contaminants. Pollution control systems, new technology, energy conservation, and responsible personal habits can contribute to clean water and a healthy environment for the future.

Visiting a National Park

The mission of the National Park Service is to preserve and protect the natural and cultural resources of the nation for all people to enjoy. It is important for today's park visitors to practice good stewardship ethics and behaviors in order to pass these unique natural and historical treasures on to future generations in an *unimpaired* condition.

We recommend following **Leave No Trace** (LNT) principles when going on a field trip. There are seven LNT principles:

- Plan Ahead and Prepare
- Travel (and Camp) on Durable Surfaces
- Dispose of Waste Properly
- Leave What You Find
- Minimize Campfire Impacts
- Respect Wildlife
- Be Considerate of Other Visitors

Following these principles and park rules will help make your park visit a safe, successful learning experience while also caring for park resources.

Vocabulary

- **abiotic –** non-living components of an ecosystem which include water supply, topography, landforms, geology, soils, sunlight, and air quality/oxygen availability
- **acidic –** values of less than 7 on the pH scale
- **acid rain** – all forms of precipitation that have an acidity lower than normal rainfall (pH 5.6)
- **alkaline-** values greater than 7 on the pH scale, the amount of carbonate and bicarbonate in a substance
- **contamination** – the introduction of a substance to a water supply that reduces the usefulness of the water to humans and other living organisms
- **dissolved oxygen** – the amount of oxygen in the water available to organisms that have special adaptive features (gills), measured in parts per million (ppm)
- **drainage basin** – the collection area from where water drains; a watershed
- **downriver** – toward or near the mouth of a river; in the direction of the current
- **ecosystem** – a combination of individual habitats where life needs are met
- **groundwater** – water that infiltrates into the earth and is stored in the soil and rock below the earth's surface
- **headwater** - the headstreams and the beginning of a large stream or river

- **macroinvertebrate** – invertebrate animal (without backbones) large enough to be observed without the aid of a microscope or other magnification
- **non-point source pollution** – pollution that cannot be traced to a specific point, because it comes from a multitude of sources or wide area
- **pH** - a measure that indicates the relative acidity or alkalinity of a substance**.** The pH scale ranges from 0 – 14, where 7 is neutral, values less than 7 are acidic, and values greater than 7 are basic or alkaline
- **point source pollution** - pollution that can be traced to a single point source
- **pollution** – an alteration in the character or quality of the environment that causes it to be less suited for life
- **ridgeline** - the crest of a mountain; a divide; an area of higher elevation that separates watersheds
- **riparian** – located or living along or near a stream, river, or body of water
- **riparian buffer** – an area of trees and shrubs located adjacent to streams, lakes, ponds, and wetlands. This intercepts sediment, nutrients, pesticides, and other materials in surface runoff and reduces nutrients and other pollutants in shallow subsurface water flow. Woody vegetation in buffers provides shelter for wildlife, lowers water temperatures through shade, and reduces bank erosion.
- **runoff** - water that drains or flows off the surface of the land
- **tributary** - a stream that flows into a larger stream or body of water
- **topography** - the representation of surface features of a region on maps or charts
- **watershed** – the land area that water flows across or through on its way to a stream, lake, wetland, or other body of water.
- **wetlands -** any land area that tends to be regularly wet or flooded

Materials
Clear tank of water, samples of litter, and new toilet seat; pan with 3” sides, aluminum foil, food coloring; maps (land-use, residential, physical, and topographic); pH test kit or red cabbage juice, distilled water, vinegar, and milk of magnesia; stream insect and crustacean identification sheet, journals or portfolios; native vegetation

Pre-Visit Activities

Prior to beginning the Watersheds unit study, have the students take the Watersheds **Pre-Visit Assessment**. Record the class scores on the **Pre-Visit/Post-Visit Score Sheet**. Begin the unit study. Incorporate as many of the following pre-visit activities as possible into your lesson plan to prepare the students for the stream study during the park field trip. For more fun watershed activities see *Good Character, Good Stewards: Caring for the World Around Us* at
http://www.nps.gov/shen/forteachers/upload/edu_steward_watersheds.pdf

1. Motivational Activity

For this activity, ask students in advance to bring a small item of disposable “litter” to school. In addition, the teacher should provide a tray of items such as dish soap, apple core, candy wrappers, cooking oil, motor oil, plastic, etc. Have a new toilet seat cover ready for the culminating effect.

Display a clear plastic tub of clear, clean water in a prominent spot. The water will represent your classroom's "clean park stream." Provide a paper cup and invite a student to drink from the "pure" water. Share ideas of how clean water might be used for recreation, habitat for animals, a place for peaceful reflection, reservoirs used to supply drinking water, and home use.

Ask students one at a time to create a short "pollution scenario" followed by disposal into the water of one of the litter items or liquids. (It's effective to include dish soap and oil into the mix.) As each student comes to the tank, he/she should tell his/her part of the story, e.g., "I was picnicking with my parents and finished my apple. I decided to throw it into the stream. I thought, 'No one will know.'"

When everyone has contributed, place the toilet seat on the tank and compare the now polluted water with a sewer or garbage dump. See if a volunteer would now like to drink the water. Have students share how they would feel about using it for other purposes. Keep the tank in a visible spot during the study of watersheds. Examine it occasionally for changes in the pollution. Does the pollution dissipate? Search the internet to determine how long each item will last and if it will decompose. Discuss ways and values of keeping our waterways clean.

2. Vocabulary Activity Suggestions

a. Make a "watershed word wall" of cards with the definitions on back. Use these for creative writing, games, and activities to practice the meanings.

b. Play "WATER BINGO" (game card and teacher page attached) to practice vocabulary. Have students fill in blocks with vocabulary words then use a bean to cover squares as you call words or definitions (variation of Bingo).

c. Play "Waterfall," a spelldown where the teacher dictates a word from the vocabulary list and a student must give the correct definition. Optionally, the teacher may dictate a definition and a student must give and spell correctly the word to stay in the "waterfall."

3. Create a Classroom Watershed

Fit a piece of foil inside a large pan, placing blocks under one end to represent a mountain. Crumple the foil to make dips and gullies and to create stream and river beds. Leave an open area at the lower end to indicate the Chesapeake Bay. Slightly elevate the mountain end of the pan.

Use a watering can to pour "rain" on the "mountain." Have students observe how the water runs off the mountain into the "streams and rivers." Notice the topography that determines the perimeter of the "watershed" and that the "rivers" eventually run into the "Chesapeake Bay."

Create pollution by adding a drop of food coloring close to one of the streams. Brainstorm ideas for the cause of this pollution, e.g., someone is changing motor oil and

dumping the used oil onto the land. Sprinkle more water into the mountains and watch how the “pollution” is carried into tributaries and eventually into the Bay.

Expand this activity by placing grass, dirt, and rocks on the “land area” to observe the effects of natural filtering on the pollution. Contrast this with “pollution” on a flat, “paved area” to see how quickly and directly it might enter the water system.

4. Mapping Watersheds

Have students use maps to determine the watersheds of Virginia, determine the tributaries and routes, and identify the body of waters into which each ultimately flows - the Chesapeake Bay, the Atlantic Ocean, or the Gulf of Mexico. Utilize maps showing various types of land use to hypothesize the types of pollution that may impact the waterway along its journey and to learn about point and non-point pollution sources. Discuss and locate the 3 watersheds that originate in Shenandoah National Park. Ask students to find and trace the watershed in which their homes and school are located. See http://www.dgif.virginia.gov/education/sol/watersheds.asp

5. Testing Water Samples

The quality or health of a body of water can be measured by investigating the water chemistry and the types of organisms living in the water. Oxygen content, pH, and mineral content are typical *abiotic* (non-living) factors that affect water chemistry. pH measures the relative acidity and alkalinity of a sample. Healthy streams that support a variety of living organisms generally have a pH range of 6.5-7.5

a. Measure the pH of three water samples. Use a purchased pH paper, a test kit with pre-made indicator solution and a color-coded chart, or make some red cabbage indicator (see below) to determine the pH of the following sample mixtures:

    1. 1 part water and 1 part vinegar (acidic),
    2. 1 part water and 1 part milk of magnesia (alkaline)
    3. all distilled water (pH=7)

    The vinegar and magnesia represent “pollution” that can significantly change the pH in a water source and impact the capability to support living organisms.

    *Directions for use of red cabbage indicator: Cook red cabbage until it is tender. Strain the juice into a jar. Add a few drops of the cabbage juice to each water sample to test the pH. The juice will turn bright pink when exposed to an acid (0-6 pH) and green or blue when exposed to an alkaline (8-14 pH).
    http://www.mr-damon.com/experiments/6svt/ph_cabbage.htm
    http://chemistry.about.com/library/weekly/aa012803a.htm

b. Have the students predict the pH level that they expect to find in a Shenandoah National Park stream and explain why. Record this prediction and compare with actual results following the park stream study.

6. What's A Macroinvertebrate?

Macroinvertebrates are the tiny invertebrates (animals without backbones) which are found in aquatic ecosystems. Macroinvertebrates are influenced by the amount and type(s) of pollution in the water and respond differently to various pollutants.

a. Have the students become familiar with common macroinvertebrates by using a stream insect and crustacean identification sheet.
http://www.barnard.columbia.edu/iue/ForestCurricula/StreamInsectCrustaceanIDKey.htm

b. Have the students brainstorm types of pollution that might be found in waterways. For each pollution example given, determine if it is a point source or non-point source pollutant. Examples of point source are waste from a factory, raw sewage from a home or city, and garbage (tires, batteries, trash) dumped in stream. Non-point sources include fertilizers from farm runoff, oil and chemicals from parking lots and streets, acid rain, and sediments. Describe how each would affect the water quality. Have the students use the macroinvertebrate categories on the following chart to hypothesize how each group might be affected by the different types or combinations of pollution.

POLLUTION SENSITIVE (found in good quality water)	**SOMEWHAT POLLUTION TOLERANT** (can survive in fair quality water)	**POLLUTION TOLERANT** (can survive in poor quality water)
caddisfly larva	**crayfish**	**leech**
mayfly larva	**beetle larva**	**midge fly larva**
stonefly larva	**damselfly larva**	**blackfly larva**
riffle beetle	**alderfly larva**	**snails**
water penny	**fishfly larva**	**aquatic worms**
dobsonfly larva	**scud**	**rat-tailed maggot**
gilled snail	**watersnipe fly larva**	
	crane fly larva	
	dragon fly larva	
	sowbug	

c. Have the students predict which category of macroinvertebrates they would expect to find in a Shenandoah National Park stream and explain why. Record this prediction and compare with actual results following the park stream study.

7. Language and Art Activities

Have students create a journal, portfolio, poster, story, diorama, poem, or mural to document their water-related activities. Be sure they document ways in which water is valued and how it can be protected. These can ultimately be shared with other classes, presented at parent meetings, or displayed in the school library.

8. Leave No Trace Principle: Suggested Activities for "Respect Wildlife"

To prepare for your field trip to Shenandoah National Park, share with your students the mission of the National Park Service. Explain that the mission is to protect and preserve

the natural and cultural treasures of the nation for present and future visitors to enjoy. Lead them to understand that they can help protect the beauty and natural resources of Shenandoah National Park by using good environmental stewardship practices.

a. Introduce the L*eave No Trace* principle of "Respect Wildlife." Discuss the importance of respecting wildlife and preserving our resources. Remind them:
   - observe wildlife from a safe distance, do not follow or approach them
   - never feed wild animals. Feeding wildlife damages their health, alters natural behaviors, and exposes them to predators and other dangers.
   - protect wildlife and your food by storing rations and trash securely
   - avoid wildlife during sensitive times: mating, resting, raising young, or winter

   Explain that the mountain streams in Shenandoah are fragile environments which provide habitat for many fish and macroinvertebrates. Remind the students that they will be searching for animals in a park stream. Students should respect these creatures and tread softly, be gentle, and carefully return the animals to the stream after they finish the stream study.

b. Have students imagine that they had a guest in their house who left spoiled food around, put trash on the floor, left dirty dishes in the sink, walked on the carpet with dirty shoes, broke furniture, and took all the food when they left. How would they feel about their "guest"? Explain that when they visit the national park they are the guests and that they have the responsibility to treat the plants and animals that live there with respect.

   Next, have each student pick a wild animal and describe in personification how the animal would feel if it were shown disrespect by humans. Have them role play what an animal would say if it could speak its mind, e.g., a bear that had all its berries eaten, a deer that is chased through the meadow, a crawfish that is placed in a container with no water. By respecting wildlife and being considerate of others, the students can help preserve both the integrity of the national park's resources and the experience of other visitors.

c. Review all 7 Leave No Trace principles. Separate the scenario cards on the "Leave No Trace Ethics Activity" form (attached). Choose and read aloud 3 cards and place them on the floor as "ethics stations."

   Have each student choose the scenario that is personally the MOST offensive and disturbing, then position him/herself at that station. Ask each student to explain the reason for his/her choice. Collect the cards, keeping the most frequently chosen scenario in a separate stack. Using 3 new cards, repeat the activity for as many rounds as time and enthusiasm allow (at least 3). In conclusion, place the cards most frequently chosen in each round at new stations. Have each person choose the very most offensive, giving reasons why, e.g., permanently impacting an area, affecting others' experiences, willfully changing a resource.

d. Discuss and practice proper field trip behavior and exploration skills with students before their park visit. Have them brainstorm a list of rules they think will help keep plants, animals, and themselves safe. Review the need for good stewardship behaviors when exploring a stream. This is a particularly fragile ecosystem and wet rocks can be slippery! Respect other visitors who may be nearby enjoying the tranquility and sounds of a mountain stream.

9. Begin final preparation and planning for the class field trip to Shenandoah National Park. Review appropriate dress. **Remind the students that they will be going into a mountain stream to collect samples. The rocks and stream bed will be uneven and slippery. Extra care and attention is required.** Long pants that can be rolled up are suggested along with closed shoes with tread (no open sandals) that can be worn in the water. We recommend that students bring an extra pair of shoes and socks to change into after the program. These can be left on the bus. Have students write letters to their parents informing them about the time and date, appropriate dress, personal needs, and behaviors expected for the field trip.

Shenandoah National Park Field Trip

The in-park program will generally take a minimum of 2 hours. Plan for adequate travel time from your school to meet the ranger(s) at the scheduled time and location in the park. For an effective learning experience, please remember the following:

- Bring enough competent chaperones to assist on the field trip. The park requires 1 adult for every 10 students.
- Review appropriate dress and behavior for the field trip and remind students they will still be in school while at the park. The rocks and stream bed will be uneven and slippery. **Extra care and attention is required.** Bring extra shoes and socks.
- Before arriving at the park, have the students divided into groups of 15 or fewer and assign chaperones to groups. Provide nametags for all participants, including adults.
- Provide a snack break prior to the in-park program.
- Be prepared to present a short, 5-minute introduction at the program site in the park to bridge the classroom lessons with the park experience. Assist rangers as needed.
- Plan for lunch. School groups are welcome to picnic in the park after the program. Picnic areas offer picnic tables and restrooms, but there are no shelters for inclement weather.

Post-Visit Activities

Following your field trip to Shenandoah National Park, incorporate as many of the following post-visit activities as possible into your lesson plan to conclude the unit of study. Give the students the Watersheds **Post-Visit Assessment.** Record the class scores on the **Pre-Visit/Post-Visit Score Sheet**. Complete the **Program Evaluation Form.** Return the program evaluation, pre/post-visit score sheet, and any other student work to:

Shenandoah National Park
3655 US Hwy 211 East
Luray, VA 22835
Attention: Education Office

1. Scenario Activities
Have students form three teams with a designated leader and recorder for each team. Give each team one of the watershed scenarios (attached). Have the leader read the Water Fact, Historical Information, and Challenge scenario, then have each team discuss the scenario and prepare a written response for each question. When the teams have completed their work, allow class time for reporting results and sharing team discussions. Acceptable answers should be reasonable and thoroughly explained.

2. Stream Comparisons
As follow-up to the park field trip, test a stream outside of Shenandoah National Park and compare results with those found in the park. If possible, choose a tributary to a park stream. Use a variety of maps (physical, land-use, topographic) to trace the watershed back to its source and try to determine the reasons for any differences in test results. Have students determine the factors that might have caused the differences. What along the way might have influenced and changed the pH, dissolved oxygen levels, and types of macroinvertebrates living in the water?

If your class returns for a watersheds program year after year, have the students create an ongoing graph to compare current statistics and macroinvertebrates with those found in past (and future) years. Watch for any changes and discuss possible causes such as storms with debris, greater or lesser air pollution and acid rain, drastic change in temperature, increased animal feces, increased or decreased visitation to the park.

3. Riparian Buffer Zone for Local Stream
If your school has a stream or river nearby, have the students look for impacts to the water from the community, school activities, and student behaviors. What factors affect the course of the stream and those who depend on it? Look for evidence of damage to the stream banks and causes for the damage. How will this impact the water quality?

Have the class research the importance of riparian buffer zones along waterways. A riparian buffer zone provides shade and food for fish, habitat for local wildlife, reduces erosion, filters pollution and runoff, and creates a more pleasant area for enjoyment and recreation. After class research and goal-setting discussions, obtain approval of the school and land owners to plant appropriate vegetation along an impacted stream to create/restore a riparian buffer zone.

4. "Adopt a Stream"
Adopt a stream near the school or in the community. Hold a stream cleanup day and help keep the stream clean during the school year. Sign your class (or school!) up for the Adopt-A-Stream Program at http://www.dcr.virginia.gov/soil_&_water/adopt.shtml

5. Environmental Club
Establish an environmental club at school that meets on a regular basis to research issues, write letters, take "clean-up field trips," canoe a river to map visible pollutants, and educate peers and citizens via posters, presentations, and personal behaviors.

6. Portfolio Activity

Use the attached **Watersheds Portfolio Page** for an end-of-the-unit portfolio activity. You may use this as a unit final evaluation, confirmation of student learning, or portfolio page. Below is a suggested rubric. Provide each student with a copy of the worksheet and encourage creative writing and thoughtful input. If possible, send copies of the completed worksheets, artwork, and writing to the Shenandoah National Park Education Office.

NUMBER		Points possible	Student totals
#1 – 2 (20 points each)	Facts And Knowledge - with explanations	40	
#3 – 4 (20 points each)	Expression of Behaviors	40	
#5 (20 points)	Environmental writing	20	
	Total points	100	

Unit Assessment

1. Observe and document behavior, participation, and understanding exhibited in the classroom and in conversations.

2. Evaluate each individual's responsibility and contribution to the word wall. Suggested criteria for evaluation: 20 + words = A, 15+ words = B, 10+ words = C.

3. Create a rubric to evaluate the watershed map. Criteria would include correct labeling, following directions, and effort.

4. Determine the level of understanding expressed in discussions and writings about the value water has in the development of surrounding areas.

5. Use the completed portfolio or journal entries as criteria for assessment of understanding, responsibility, effort, and content standards.

Going Further

1. Storm Drain Stenciling

In what ways does runoff from streets and parking lots affect our streams? Storm drains were designed to be the fastest and most efficient way of getting rainwater off streets and parking lots. Unfortunately, the water that flows into the storm drain carries trash and sediment from the street, nutrients in the form of fertilizers, and toxics in the form of pesticides, household cleaners, gasoline, and motor oil. Water in storm drains throughout Virginia often ends up in a local stream or river, and eventually, the Chesapeake Bay or the Atlantic Ocean.

Get permission from the city council, public works office, or other appropriate agency to do stenciling near storm drains. Stencil a message of "dump no waste….drains to river"

on the pavement next to storm drains throughout the city. You might design an aquatic figure above the message. Stenciling storm drains in your community may discourage people from putting harmful things and trash in the drains. See http://www.cbf.org/site/PageServer?pagename=action_outdoors_stencil

2. Compare and Analyze Statistics

You might like to have your class use the *Virginia Save Our Streams* (VASOS) website to research stream monitoring data gathered by citizens. Students could compare the VASOS statistics with those found in Shenandoah National Park. Hypothesize why there would be differences and have students predict future stream conditions in both areas. See http://www.vasos.org/pages/aboutus.html

3. Class Canoe Trip

Take a class canoe trip down a tributary of one of the watersheds leading from Shenandoah National Park. Along the way, observe and map the types of land use bordering the river. Discuss possible sources of pollution.

You might provide a trash bag for each canoe and encourage the students to gather trash along the way. This can later be examined and charted to determine what kind of litter is most frequently disposed of in the river and possible sources (industrial, individual, or commercial). To learn more and compare the Top Ten Litter items found in Virginia waterways, see http://www.longwood.edu/cleanva/toptenva.htm.

4. Design A Public Parking Area

Design a commercial parking lot with “islands” of nature to absorb and filter the runoff. Have a contest for the best design. Attend a city planning meeting or invite the city manager to the school to present ideas and request legislation that would require these runoff filter areas.

5. Can You Tell Toxic Products?

Have students research to find which products can safely be poured down the drain. Have them make and post a list of these products, along with those that are organic (made from plants and other natural elements) and biodegradable (easily dissolved into harmless elements).

References and additional activities:

Science Enhanced Scope and Sequence – Grade 6, Investigating Watersheds, Virginia Department of Education, 2007. pp. 171-216.
http://www.doe.virginia.gov/VDOE/EnhancedSandS/scigrade6.pdf

Adopt-A-Stream Program (AAS), Virginia Department of Conservation and Recreation, http://www.dcr.virginia.gov/soil_&_water/adopt.shtml

Chesapeake Bay Foundation http://www.cbf.org
Watershed issues http://www.cbf.org/site/PageServer?pagename=exp_sub_state
For teachers http://www.cbf.org/site/PageServer?pagename=lrn_sub_teachers
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Branching Out, 129-132.
A Drop in the Bucket, 238-241.

Save our Streams (SOS)
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Izaak Walton League http://www.iwla.org/index.php?id=19

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http://www.purewaterforum.org/fishkill/

Taking Action, An Educator's Guide to Involving Students in Environmental Action Projects, Council for Environmental Education. 1995 Edition.
http://www.projectwild.org/TakingAction.htm

University Of Virginia, Shenandoah Watershed Assessment Study (SWAS) and Virginia Trout Stream Sensitivity Study (VTSSS), http://swas.evsc.virginia.edu/

U.S. Geological Survey
Water Resources http://water.usgs.gov/
Real-Time Water Data for Virginia http://waterdata.usgs.gov/va/nwis/rt

Virginia Department of Environmental Quality (DEQ)
Water Programs http://www.deq.state.va.us/water/
What's in my backyard mapping system of impaired streams
http://gisweb.deq.virginia.gov/deqims/viewer.htm

Virginia Department of Game and Inland Fisheries
Virginia Watersheds http://www.dgif.virginia.gov/education/sol/watersheds.asp

Virginia's Natural Resource Education Guide, Virginia Naturally,
Water Resources http://www.vanaturally.com/vanaturally/guide/water.html

Watersheds Pre-Visit Activity
"Water" Bingo

Directions: Write a Watersheds term from the vocabulary list in each blank space. Cover the word when it is called (as you would in BINGO). You have won "WATER" if you cover the squares in the format pre-established by the teacher (line down, line across, diagonal, or "postage stamp" – all 4 squares covered in any corner, 4 corners, or full board).

W	A	T	E	R
		FREE RAIN DROP		

Watersheds Pre-Visit Activity
"Water" Bingo - Teacher Page

Use this table as a master copy of vocabulary words to call. Mark off each word when it is used. Have students prove their winning format by calling their list back.
To create words for a "draw-from-bowl," color-code the backs of each column to differentiate various columns before cutting them out. i.e.: blue = W, red = A, etc.

W	A	T	E	R
abiotic	abiotic	abiotic	abiotic	abiotic
acidic	acidic	acidic	acidic	acidic
acid rain	acid rain	acid rain	acid rain	acid rain
contamination	contamination	contamination	contamination	contamination
dissolved oxygen	dissolved oxygen	dissolved oxygen	dissolved oxygen	dissolved oxygen
drainage basin	drainage basin	drainage basin	drainage basin	drainage basin
downriver	downriver	downriver	downriver	downriver
ecosystem	ecosystem	ecosystem	ecosystem	ecosystem
groundwater	groundwater	groundwater	groundwater	groundwater
headwater	headwater	headwater	headwater	headwater
macroinvertebrate	macroinvertebrate	macroinvertebrate	macroinvertebrate	macroinvertebrate
non-point source pollution	non-point source pollution	non-point source pollution	non-point source pollution	non-point source pollution
pH	pH	pH	pH	pH
point source pollution	point source pollution	point source pollution	point source pollution	point source pollution
pollution	pollution	pollution	pollution	pollution
ridgeline	ridgeline	ridgeline	ridgeline	ridgeline
riparian	riparian	riparian	riparian	riparian
riparian buffer	riparian buffer	riparian buffer	riparian buffer	riparian buffer
runoff	runoff	runoff	runoff	runoff
tributary	tributary	tributary	tributary	tributary
topography	topography	topography	topography	topography
watershed	watershed	watershed	watershed	watershed
wetlands	wetlands	wetlands	wetlands	wetlands

Watersheds Pre-Visit Activity
Leave No Trace Ethics

A park visitor throwing trash on the ground	**A visitor tossing rocks into the vernal pond at Big Meadows**
A hiker feeding potato chips to a squirrel	**Human waste and used toilet paper on top of the ground next to a trail**
Campers cutting down tree branches and bushes to build a campfire	**A hiking group taking a shortcut rather than staying on the designated trail**
A family washing their dirty dishes in a stream	**A group of teenagers making a lot of noise and playing loud music on a nature trail**
Hikers picking wildflowers	**Picnickers throwing leftover food into the woods**
Visitors carving their initials on a tree trunk	**A factory spewing black residue into the water**
A neighbor disposing of his car battery by dumping it in the stream	**Cows standing in the river to drink the water and cool off**
A park visitor throwing plastic in a clean mountain stream	**Children chasing deer in the park for pictures**
Cigarette butts lying on the trail	**An unleashed dog chasing deer**

Shenandoah National Park Education Program

Watersheds Post-Visit Activity
Scenario #1: Homeowner

School_____

Water Fact: People have not always used water wisely. We have over-used it to carry away our waste. We've put hazardous materials in or on the ground where they seep into groundwater. We've often used more water than we need. Yet we can improve our water quality by changing the small ways that people affect water.

Historical Thought: In 1989, the oil tanker *Exxon Valdez* struck a reef and spilled 10.8 million gallons of crude oil into Prince William Sound, Alaska, home to hundreds of thousands of animals, eventually covering 11,000 square miles of ocean.

The challenge for your group: You have just examined the health of a river in the Shenandoah River Watershed. Knowing the various factors and impacts that might influence the water quality, discuss the pros and cons of the following land use along the river.

Why would having a home along the river be of value to you? (give at least 3 reasons)	What are some potential problems with having home sites alongside the river? (name at least 3 negative effects)

Now, determine some ways you, as the owners of the home site, can protect our water.

Decide how you will share your ideas with the other groups (role play, discussion, read a report).

Shenandoah National Park Education Program

Watersheds Post-Visit Activity
Scenario #2: Farmer

School_____

Water Fact: Water makes all life possible. It connects all living things today and through time. In a never-ending cycle, water is used and reused by animals, plants, and people. The water in our environment today is the same water that was available to the dinosaurs.

Historical Thought: The most serious threats to water quality in Virginia today involve non-point sources of pollution. The April 1996 water quality assessment found that 83 percent of water pollution problems in Virginia are due to runoff that carries excess fertilizers, manures, toxic chemicals, pathogens and sediments into rivers and streams.

The challenge for your group: You have just examined the health of a river in the Shenandoah River Watershed. Knowing the various factors and impacts that might influence the water quality, discuss the pros and cons of the following land use along the river.

Why would having farmland along a river be valuable to you, the farmer? (give at least 3 reasons)	What are some potential problems with having farmland bordering the river? (name at least 3 negative effects)

Now, determine some ways you, as the owners of the farmland, could protect our water.

Decide how you will share your ideas with the other groups (role play, discussion, read a report).

Shenandoah National Park Education Program

Watersheds Post-Visit Activity
Scenario #3: Factory Owner

School_____

Water Fact: Only a small percentage of the Earth's water is available for human use for agriculture, industry, recreation, and home. If all of the water used in our country each day were divided by our population, each person would "use" 2,000 gallons each day. It takes 25 gallons of water to grow an ear of corn and more than 100,000 gallons to make a car.

Historical Thought: : In 1969, the Cuyahoga River flowing through Cleveland, Ohio, contained so much noxious sludge from steel mills, paint factories, and sewage plants that the river caught fire and burned.

The challenge for your group: You have just examined the health of a river in the Shenandoah River Watershed. Knowing the various factors and impacts that might influence the water quality, discuss the pros and cons of the following land use along the river.

How is having your factory alongside a river important to you? (give at least 3 reasons)	What are some potential problems when your factory is placed right next to the river? (name at least 3 negative effects)

Now, determine some ways you, as the owners of the factory, can protect our water.

Decide how you will share your ideas with the other groups (role play, discussion, read a report).

Shenandoah National Park Education Program

Post-Visit Activity

Watersheds Portfolio Page

Name _____ **Date** _____

School _____ **Teacher** _____

#1 – 2 Facts And Knowledge:

Identify 2 new facts you learned in this unit of study and tell why you think each is important.

1)
2)

#3 – 4 Behaviors:

List 2 behaviors you learned in this unit that can help protect our national parks and/or preserve the natural resources of our world.

3)

4)

#5 <u>Environmental Writing:</u>
Write a paragraph, creative story, poem, essay, rap, song, etc. about these stewardship behaviors. You might tell how using them will change your life and your future world.
If you have time, create a picture to go along with your writing.

5)

Shenandoah National Park Education Program

Watersheds
Pre-Visit/Post-Visit Assessment

Name _____ **Date** _____

Instructions: Read each question carefully and choose the one best answer. Circle the letter of your choice.

1. A *watershed* is _____.
   a. a stream or lake
   b. a building where water is collected for study
   c. a location where two or more bodies of water are found
   d. the area draining into a river, river system, or other body of water

2. A stream that flows into another stream or body of water is called a _____.
   a. wastewater
   b. runoff
   c. tributary
   d. salt marsh

3. Which of these is NOT an *abiotic* factor influencing the pH of a stream?
   a. Limestone rocks
   b. Acid rain
   c. Plants
   d. Temperature

4. Which of the following indicates a high level of acidity?
   a. pH=3
   b. pH=7
   c. pH=9
   d. both a and b

5. Animals with no backbones and large enough to be observed without the aid of a microscope are called _____.
   a. fish
   b. macroinvertebrates
   c. amphibians
   d. salamanders

6. Factories may dump harmful sewage into a waterway causing _____.
   a. evaporation
   b. condensation
   c. pollution
   d. erosion

7. Which of the following determines the boundary or perimeter of a watershed?
   a. Weather patterns
   b. Roads
   c. Ridgelines
   d. Agricultural land use

8. Which of the following would NOT have a harmful effect on a stream?
   a. Cows standing in the water to cool off
   b. Humans throwing their leftover lunch in the water
   c. Pesticides sprayed on crops along the river bank
   d. Deciduous trees dropping leaves in the Fall

9. Shenandoah National Park provides a clean water source for all these Virginia watersheds *except* _____.
   a. York River
   b. Rappahannock River
   c. Shenandoah River
   d. James River

10. A factor that can affect water quality in Shenandoah National Park is _____.
    a. acid rain
    b. flood
    c. human activity
    d. all of the above

Shenandoah National Park Education Program

Watersheds
Pre-Visit/Post-Visit Assessment

Answer Key

1. A *watershed* is _____.
   d. **the area draining into a river, river system, or other body of water**

2. A stream that flows into another stream or body of water is called a _____.
   c. **tributary**

3. Which of these is NOT an *abiotic* factor influencing the pH of a stream?
   c. **Plants**

4. Which of the following indicates a high level of acidity.
   a. **pH=3**

5. Animals with no backbones and large enough to be observed without the aid of a microscope are called _____.
   b. **macroinvertebrates**

6. Factories may dump harmful sewage into a waterway causing _____.
   c. **pollution**

7. Which of the following determines the boundary or perimeter of a watershed?
   c. **Ridgelines**

8. Which of the following would NOT have a harmful effect on a stream?
   d. **Deciduous trees dropping leaves in the Fall**

9. Shenandoah National Park provides a clean water source for all these Virginia watersheds *except* _____.
   a. **York River**

10. A factor that can affect water quality in Shenandoah National Park is _____.
    d. **all of the above**