Clean Watersheds! Clean Water!

In an area known as "God's Country", Potter County, in northern Pennsylvania, there lies a one square mile area of unique importance. It is a watershed divide, embracing the headwaters for streams that flow either south to the Gulf of Mexico or north to Canada. This area represents the diverse landscape and ecology found within Pennsylvania's six major watersheds.

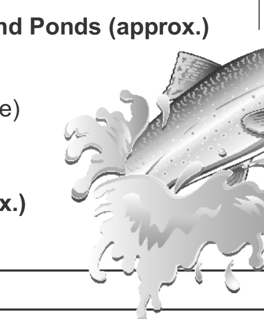
Consider a journey across a state … you could encounter watershed features as diverse as tidal marshes, 1,000-foot deep canyons, 3,200-foot mountains, boreal bogs, arid shale barrens and glacial deposits. The yellow lines on the poster represent watershed divides. Where does the water in your watershed go? The Mississippi River? The Delaware River? Lake Erie? or The Chesapeake Bay?

The questions below direct students to use the images on the poster and information on the charts below to assist in understanding the status of water resources and water quality in Pennsylvania. Students will also see illustrated some of the problems and solutions associated with watersheds.

1. A watershed is defined as the land area from which surface runoff drains into a stream channel, lake, reservoir or other body of water; also called a drainage basin. Can you locate all six of Pennsylvania's major watersheds on the poster?
2. Watersheds are named after the body of water that flows from them. By studying the poster, are you able to name all six watersheds? Check the chart below for assistance.
3. A riparian forest is one that is located along a stream or river. These streamside forests protect water quality. Can you explain why this might be so?
4. Purple Loosestrife is an invasive plant that chokes out native plants and threatens the quality of aquatic life in wetlands. Can you find a purple loosestrife plant on the poster?
5. Nonpoint source pollution is pollution which cannot be traced to a specific (pipe) source. Can you find examples of potential nonpoint pollution sources on the poster?
6. The State's Growing Greener Grants Program invested millions of dollars for open spaces, playgrounds, parks, trails, land reclamation and watershed restoration. Can you find a Growing Greener project on the poster?
7. Point source pollution can be traced to a specific (pipe) source. Can you find a possible point pollution source on the poster?
8. Drainage from abandoned mines increases acidity in streams and rivers, impairing aquatic life. Highly effected streams may appear orange. Can you find this condition on the poster?
9. Streams and rivers in Pennsylvania are assessed for impairment based on designated fish and aquatic life use. The chart below, from DEP's 305b water quality report, details major sources of of stream and river impairment. The major sources of impairment are from abandoned mine drainage, agriculture and urban runoff/storm sewers. Can you find an example of where each cause might be occurring on the front of the poster?
10. The Marcellus Shale is estimated to be North America's largest natural gas reservoir. While the development of natural gas is promising as a cleaner-burning energy source, there are also environmental challenges with its development. To drill for natural gas, it takes a lot of water (4-5 million gallons per horizontal well), combined with sand and a small amount of additives. To help protect the state's streams, rivers, lakes and other water resources, DEP's regulations have led to drilling companies reusing or recycling water (90% or more). Can you find the natural gas drilling site?

Pennsylvania Water Resources

Major Watersheds:	
1. Lake Erie Watershed	511 square miles within Pennsylvania
2. Ohio River Watershed	15,614 square miles within Pennsylvania
3. Genesee River Watershed	94 square miles within Pennsylvania
4. Susquehanna River/Chesapeake Bay Watershed	27,510 square miles within Pennsylvania
5. Potomac River Watershed	1,584 square miles within Pennsylvania
6. Delaware River Watershed	6,422 square miles within Pennsylvania
Miles of Rivers and Streams (approx.)	86,000 miles
Number of Lakes, Reservoirs and Ponds (approx.)	4,000
Estuaries, Harbors and Bays (Delaware and Presque Isle in Erie)	23 square miles
Freshwater Wetlands (approx.)	404,000 acres
Amount of Groundwater (approx.)	80 trillion gallons



Major Sources of Impairment of Streams and Rivers in Pennsylvania

Source of Impairment	Miles
Abandoned Mine Drainage	9,134
Agriculture	6,577
Source Unknown	5,024
Urban Runoff/Storm Sewers	4,582
Other Sources	
Road Runoff	
Small Residential Runoff	
Habitat Modification	
Municipal Point (pipe) Source	
Industrial Point (pipe) Source	
Other – Including: Construction, Onsite Wastewater, Atmospheric Deposition, Land Development Subsurface Mining, etc.	

For more information on water quality in Pennsylvania, access the Pa. Department of Environmental Protection's website at www.dep.state.pa.us, keyword: water quality. You may also learn more about water quality by visiting the Pa. Fish and Boat Commission's website at www.fish.state.pa.us (enter "Water Pollution in Pennsylvania" in the search box).

The activity below has been reprinted with permission from Project WET, a national curriculum endorsed by the Pennsylvania Department of Education (PDE). Project WET deals with water as a cultural, social and consumptive resource that is essential to human life.

The Project WET activity "Branching Out" helps students investigate how water flows through and connects watersheds. Students learn environmental science, earth science and geography while completing this activity.

Project WET
Water Education for Teachers

Branching Out!

- **Grade Level:** Middle School
- **Subject Areas:** Earth Science, Geography
- **Duration:** Preparation time: 50 minutes. Activity time: two 50-minute periods
- **Setting:** Classroom
- **Skills:** Organizing (mapping); Analyzing (contrasting and comparing); Applying (predicting); Evaluating (testing, critiquing)
- **Charting the Course** Prior to or in conjunction with this activity, students can investigate the role their schoolyard plays in a watershed in "Rainy-Day Hike." The concept of watersheds is explored further in "Just Passing Through" and "Color Me a Watershed." Students can investigate how drainage patterns influence human settlements and ecosystems in "Water Crossings."
- **Vocabulary** drainage basin, watershed, divide, tributary, runoff

Is it possible to cross the Mississippi River in one step?

Summary
Students build a model landscape to investigate how water flows through and connects watersheds.

Objectives
Students will:
- predict where water will flow in watersheds.
- describe drainage patterns in watersheds.

Materials
- *Overhead transparency or copies of **Branching Patterns***
- *Blue-colored water*
- *Spray bottles or sprinkling cans*
- *Drawing paper and pencil*
- *Blue pencils*
- *Tracing paper or blank transparency sheets*
- *Copies of a local map showing rivers*

NOTE: In this activity students build a model of a watershed. This is presented as a class activity, but smaller groups of students can construct their own models. Students can build a temporary, simple model or a more durable version that can be used in subsequent activities. The materials for both are listed below.

Temporary model*
- *White scrap paper, newsprint, or butcher paper*

Permanent model
- *Papier-mâché materials* (strips of newspaper dipped in a thick mixture of flour and water)
- *Water-resistant sealer and white paint* (or white waterproof paint)

Both models will require:
- *5 to 10 rocks, ranging from 2 to 6 inches (5 to 15 cm) in height* (If groups of students are making their own models, each group will need its own rocks.)
- *Square or rectangular aluminum tray, large enough to hold rocks*
- *Plastic wrap* (Thick plastic wrap from a grocery or butcher shop works well.)

Making Connections
Children have watched water flowing down a street during a heavy rainstorm and may have asked: Where does all the water go? Viewing turbulent waters in a stream, students may have wondered: Where does all the water come from?

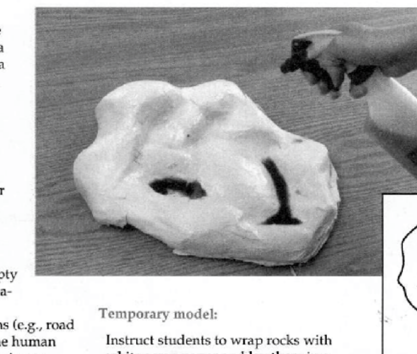
The pattern water makes as it flows through a watershed is familiar to students who have drawn pictures of trees or studied the nervous system. By investigating drainage patterns, students consider how watersheds distinguish different land areas.

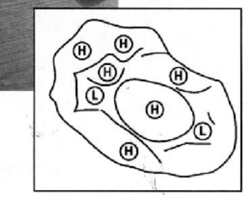
Background
When the ground is saturated or impermeable to water during heavy rains or snowmelt, excess water flows over the surface of land as runoff. Eventually, this water collects in channels such as streams. The land area that drains water into the channels is called the watershed or drainage basin.

Watersheds are separated from each other by areas of higher elevation called ridge lines or divides. Near the divide of a watershed, water channels are narrow and can contain fast-moving water. At lower elevations, the slope of the land decreases, causing water to flow more slowly. As smaller streams merge together, the width of the channel

*TEMPORARY MODEL ADAPTED WITH PERMISSION FROM "FLOWING TO THE RESERVOIR: WHAT IS A WATERSHED?" *WATER WISDOM*. BOSTON, MASS.: MASSACHUSETTS WATER RESOURCES AUTHORITY.

increases. Eventually, water collects in a wide river that empties into a body of water, such as a lake or ocean.





From an aerial view, drainage patterns in watersheds resemble a network similar to the branching pattern of a tree. Tributaries, similar to twigs and small branches, flow into streams, the main branches of the tree. Streams eventually empty into a large river, comparable to the trunk. Like other branching patterns (e.g., road maps, veins in a leaf, the human nervous system), the drainage pattern consists of smaller channels merging into larger ones.

Watersheds are either closed or open systems. In closed systems, such as Crater Lake in southwest Oregon or the Great Salt Lake in Utah, water collects at a low point that lacks an outlet. The only way water naturally leaves the system is through evaporating or seeping into the ground. Most watersheds are open: water that collects in smaller drainage basins overflows into outlet rivers and eventually empties into the sea.

Procedure
Warm Up
Show students copies or an overhead of *Branching Patterns* (the outlines of a watershed's drainage pattern, a tree in winter, the human nervous system, and a road map). Ask them what all the pictures have in common.

The Activity
1. **Depending on whether a temporary or more permanent model is being built, have students do the following:**

Temporary model:

Instruct students to wrap rocks with white scrap paper and lay them in a square or rectangular aluminum tray. Place larger rocks near one end of the tray. Cover the rocks snugly with plastic wrap.

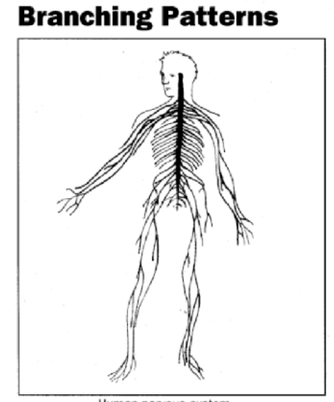
Permanent model:

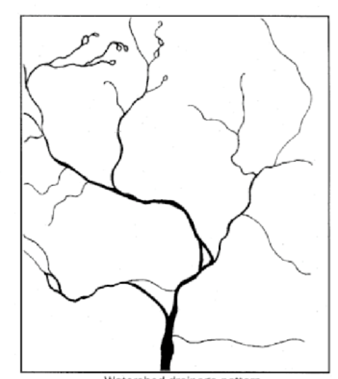
Have students lay rocks in a square or rectangular aluminum tray, with larger rocks near one end. Snugly cover the rocks and exposed areas of the tray with plastic wrap. Apply strips of papier-mâché to cover the rocks. For a sturdier model, apply several layers of papier-mâché. When the mâché has dried, coat the model with waterproof sealant and white paint or waterproof white paint.

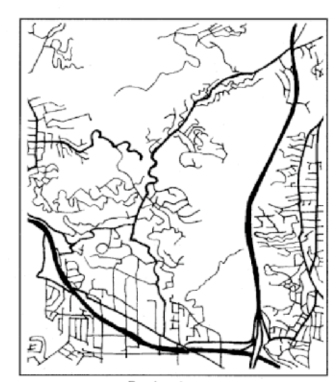
2. **Have students sketch a bird's-eye view of the model.** (See model sketch.) They should mark points of higher elevation with "H"s and low spots with "L"s. To identify possible ridgelines, connect the "H"s.
3. **Tell students that the model will soon experience a rainstorm. Where do they think water will flow and collect in the model? Have them sketch predictions on their drawings.** Show them crevices in the model and possible locations of watersheds.
4. **Spray blue-colored water over the model and note where it flows.** (See photo.) Water may need to be sprayed for several minutes to cause a continual flow. Assist students in identifying branching patterns as water from smaller channels merges into larger streams.
5. **Have students use blue pencil to mark on their drawings the actual branching patterns of water.** Some imagination and logic may be required. Ask them to confirm the locations of watersheds by noting where water has collected in the model.
6. **Have students determine if smaller watersheds overflow into larger ones.** Does all the water in the model eventually drain into one collection site (open watershed system)? Does the model contain several closed watershed systems (collection sites that lack an outlet)?

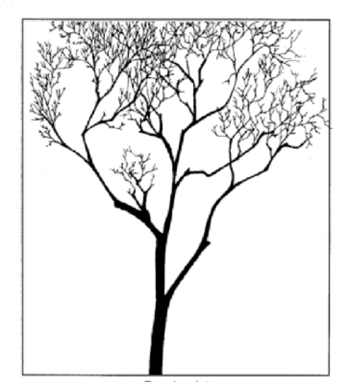
Project WET
Water Education for Teachers

Branching Patterns


Human nervous system


Watershed drainage pattern


Road system


Tree in winter

Wrap Up
Have students place tracing paper or an overhead transparency over their drawings and draw the drainage pattern. Compare the traced lines to the branching patterns presented during the ***Warm Up*** and contrast with drawings of other students. Discuss how all the networks involve smaller channels merging together and becoming larger.

Provide each student with a copy of a local map. Have students locate streams and rivers and note where smaller rivers flow together or merge into larger ones. Ask them to encircle land areas they think drain into the rivers.

Have them pick one river on the map and follow its path in two directions. If all of the river is pictured, one direction should lead to the headwaters or source (where the line tapers off). In the opposite direction, the river will merge with another river or empty into a body of water.

Have students write a story or draw a picture about a local river. Have them describe how water moves to the river from surrounding land areas or tributaries and then flows to a larger body of water.

Assessment
Have students:
- predict where water will flow and collect in their watershed model (step 3).
- test their predictions and use the results to confirm or modify their projected drainage patterns (steps 4 and 5).
- compare the drainage pattern of watersheds to other branching networks, such as a road map, tree, or the human nervous system (***Warm Up*** and ***Wrap Up***).
- write a story about or draw a map of drainage patterns in their watershed (***Wrap Up***).

Extensions
Have children compare their drawings or stories to *Where the River Begins*, a story by Thomas Locker. In the book, two boys and their grandfather follow a river to its source.

If the model were a real land area, do students think the drainage patterns would be the same thousands of years from now? Have students consider the effects of natural and human-introduced elements (e.g., landslides, floods, erosion, evaporation, water consumption by plants and animals, runoff from agricultural fields or residential areas, dams).

Students may want to finish their models by painting landscapes and constructing scale models of trees, wetlands, and riparian areas. They may introduce human influences such as towns and roads. Natural and human-made environmental problems, such as landslides and erosion, could be incorporated into the design.

As in the game "Pin the Tail on the Donkey," blindfold students and have them randomly touch a point on a map of the North American continent, the U.S., or their state. Have students explain likely routes water would flow to that area.

Advanced students may want to make a topographic map of their model. Totally waterproof the model. Submerge it, 1/2 inch (1-2 cm) at a time, in water. At each increment, while viewing from above, trace the water level onto a sheet of glass or plastic covering the model.

K-2 Option
Have children focus on how smaller streams merge into larger ones. Gather pruned branches and let students investigate how the main branches "branch out" into smaller ones. If branches are not available, students can make a branching system out of pipe cleaners.

Help students imagine a drop of water flowing down the twig to the larger branches and finally to the main branch. Students can paint or decorate the branch and name the rivers. Into what body of water might the large river (the main branch) flow?

Relate the branch to a river flowing near or through the community. What smaller channels might feed into this river? Where do students think the water in the river goes? Help them to imagine the water flowing into a larger river and finally to a lake or to the sea.

Lead them in the following hand motions to represent small rivers flowing into larger rivers. A simple song about rivers can accompany the motions.

A babbling brook (hold arm in front of body and wiggle fingers) flows into a small river (place both arms together and wave them in a serpentine motion). The water from smaller rivers goes into a large river (have students merge together in a column) and travels to the sea or lake (students move to a place in the room designated as the sea or a lake and dance in the area like waves splashing about).

Resources
Coble, Charles, et al. 1988. *Prentice Hall Earth Science*. Englewood Cliffs, N.J.: Prentice Hall, Inc.

Holling, Clancy. 1941. *Paddle to the Sea*. Boston, Mass.: Houghton Mifflin Company.

Locker, Thomas. 1984. *Where the River Begins*. New York, N.Y.: Dial Books.

Tresselt, Alvin. 1990. *Rain Drop Splash*. New York, N.,Y.: Morrow.