Follow the Drop

Activity Overview
Students observe and collect information about water runoff on their school property.

Objective
Students will:

- Practice observation and investigative skills
- Survey and collect information about their school site
- Calculate the volume of rain water falling and forming runoff on their school grounds
- Use critical thinking skills to develop ideas for storm water management on their school ground

Subjects Covered
Science and Math

Grades
4 through 12

Activity Time
2 hours: 1 hour on the school ground, 1 hour in the classroom

Season
Any, preferably spring or fall

Materials
Clipboards, pencils (or colored pencils), "Follow the Drop" handout, map of schoolyard showing property lines and building locations (and/or graph paper), average annual rainfall data obtained from the weather bureau, local newspapers or TV weather newscaster, etc.

State Standards
Math: A.4.1, A.4.2, A.4.4, A.8.1, A.8.3, A.12.1, B.8.5, C.4.4, C.12.1, D.4.2, D.12.2; Science: F.8.9, F.4.4, F.12.7, F.12.8

Background

Water moving over the landscape after a rain event in a large city, a medium-sized subdivision or single school yard will flow basically the same. Only the scales are different. A larger volume of water moves across the landscape in a large city compared to a small school yard. Nevertheless, in either case, water may flow in a sheet-like way, collect in channels, drain into pipes, accumulate in puddles, or soak into the ground during a rain storm. Rain water will eventually drain to a river, to a lake, or to groundwater. To have clean water in a life sustaining, healthy watershed, each site—whether large or small—requires thoughtful storm water management planning. One of the best ways to ensure clean water is to control runoff near its source where precipitation first comes in contact with the land. Keeping water out of storm sewer systems lessens erosion and sediment carried into lakes and rivers, reduces pollutants carried by moving water, and decreases chances of flooding. See Background Section of Earth Partnership for Schools' *Storm Water Curriculum and Teaching Guide* for more information.

The purpose of this activity is to promote students' understanding of the patterns of water movement on their school ground and the larger watershed. It will provide a firsthand experience that will hopefully lead them to think critically about issues related to storm water and to develop water-friendly ideas about storm water management. The information they collect can be used to determine ways to reduce runoff leaving the school and to improve water quality in the watershed.

Pre-activity Preparations:

- Make a copy of an existing school map showing the location of buildings, drives, and property lines. Locate north, and indicate a scale on the map.
- If desired, divide the map into sections. Assign a section to each student team. The team will locate and record all features described below that are inside their section. Each section can be reassembled to form a composite map.
- Another option is to give each team a complete map and assign the team only one feature to locate such as downspouts on school buildings.
- Obtain the average rainfall data from the weather bureau, local newspapers, etc. This data is used for calculating runoff on school grounds.

Activity Description

This activity involves three steps. First, you will survey the school ground, identify how water moves over the land, and mark this information on a map. Second, you will measure designated areas, and calculate the amount of runoff produced from those areas. Third, you will begin to identify locations for infiltrating water on the schoolgrounds. These three steps are described below in more detail.

Step 1: Identify Water Patterns.

Form teams and go outside to identify the patterns of water movement. Locate the following features on your maps.

- Locate high and low points.
- Locate impervious (hard) surfaces such as parking lots and sidewalks, where water runs off. Next, locate pervious (porous) surfaces such as planted beds or grassy areas where water may soak in or infiltrate into the ground.
- Identify patterns in water movement such as where water might flow sheet-like, in gullies, or channels. Draw arrows to show direction of water movement.
- Locate storm drains on school property.
- Locate points where water enters the school ground from hillsides, streets, or other locations.
- Identify spots where water exits the school ground such as through ditches or off school parking lots.
- Locate places where water puddles. Areas that puddle may have different plants than the surrounding area. The soil is often wet or it may become hard and cracked when dry.
- Identify where water spills from one surface onto another such as where water is moving from a hard, impervious surface like a sidewalk to a pervious, vegetated area or vice versa.
- Locate downspouts on the school buildings or identify where water falls off roofs.

Step 2: Measure Areas and Calculate Surface Runoff.

Select an area and measure its size—then calculate the amount of runoff it generates. Possible areas include the school roof, a parking lot, a sports field or play area. You may also consider measuring pervious areas compared to impervious areas. If your base map is drawn to scale, these measurements may be made in the classroom using rulers or a grid system. Use measuring tapes or paces to make on-the-ground measurements.

Calculations:

1. Calculate the area of your selected site (roof, parking lot, play area, etc.) by multiplying length by width to obtain a square foot measurement.
Example:

Calculate Area	30 ft.	X	50 ft.	= 1,500 sq. ft.

2. Multiply the area by the average annual rainfall to determine the volume of rainfall falling on your site. In this example, the average annual rainfall data is 30 inches per year.
a) First, convert average annual rainfall data from inches to feet.
Example:

Convert annual rainfall from inches to feet	30 in.	÷	12 in.	= 2.5 feet

b) Next, multiply average annual rainfall data by area to get the volume of rainfall falling on your site.
Example:

Determine volume of rainfall	2.5 ft.	X	1,500 sq. ft.	= 3750 cu. ft.

3. Calculate how much of the rain becomes surface runoff . The amount of surface runoff depends upon the surface type. The harder the surface—the more runoff generated. See the following scenarios:

If rain is falling on hard surfaces such as a parking lot, all or 100% becomes runoff.
Example:

Calculate surface runoff from a parking lot	3750 cu. ft.	X	1	= 3750 cu. ft.

If rain is falling on a lawn, approximately 60% becomes runoff. Runoff from lawns can be a variable, depending upon soil type, condition of the lawn, and topography.
Example:

Calculate surface runoff from a lawn	3750 cu. ft.	X	.60	= 2250 cu. ft.

If water runs into a rain garden, which collects and infiltrates rain water, none or 0% becomes runoff.
Example:

Calculate surface runoff from a rain garden	3750 cu. ft.	X	.00	= 0 cu. ft.

Step 3: Discuss Observations, Results, and Possibilities.

As a class, share your findings based on observations and data generated. Discuss the big picture of water movement by identifying characteristics observed, possible problem areas, etc. Talk about ways the school can reduce runoff on school grounds. Identify likely areas to create rain gardens to collect and infiltrate water.

Extensions

- Go outside when it is raining, and observe storm water runoff in action. (See Rainy-Day Hike activity in *Project Wet: Curriculum and Activity Guide*. Bozeman, MT: The Watercourse and Council for Environmental Education. Pages 186 – 190.)
- Pour a bucket of water or balls on the ground to get a sense of how water moves. Make predictions before pouring the contents of the bucket.
- Identify the watershed(s) the school is located in, and then map what route the school's runoff will take to the nearest body of water.
- Calculate, using the activity formulas, the amount of water falling on the school grounds after a single rain event. Use a rain gauge to obtain rainfall quantity.

- Observe what the rain water runoff is picking up along its route – sediment, trash, oil, gas, etc.
- Determine the number of showers that can be taken with the rainwater runoff. A five-minute shower uses 25 gallons of water, and one cubic foot of runoff produces 7.2827 gallons of water.

Example:

Convert cubic feet to gallons	3750 cu. ft.	X	7.2827 gallons	= 27410.125 gallons
Calculate possible number of showers	27410.125 gallons	÷	25 gallons	= 1093 showers

Additional Resources

- Higgins, S., Kesselheim, A., Robinson, G. (1995). *Project wet: Curriculum and activity guide*. Bozeman, MT: The Watercourse and Council for Environmental Education.
- Leopold, Luna B. (1974). *Water: A primer*. San Francisco, CA: W.H. Freeman & Co.
- Nadeau, Isaac. (2003). *The water cycle: Water in plants and animals*. New York: Rosen Publishing Group, Inc.
- Nadeau, Isaac. (2003). *The water cycle: Water in the atmosphere*. New York: Rosen Publishing Group, Inc.
- .....Where does water runoff after school? *Project WILD*. Bethesda, MD: Western Regional Environmental Education Council.

Assessments

- Describe the topography of your schoolyard and how it affects the flow of water during a heavy rainfall.
- Tell a story about a rain drop falling on the school ground. Describe its journey as it moves on the school property. (See "Odyssey" in Aldo Leopold's *Sand County Almanac and Sketches Here and There.* Oxford University Press.)
- List positive water-friendly landscape features and things that could change on the school ground to provide for a healthy watershed.
- Give an oral report on your findings along with follow-up suggestions for increasing infiltration and reducing surface runoff.

Follow the Drop Calculation Sheet

Calculate area				
Site	**Width**	**X**	**Length**	**Area**
Parking lot/roof	feet	X	feet	square feet
Lawn	feet	X	feet	square feet
Rain garden	feet	X	feet	square feet
Other	feet	X	feet	square feet
Other	feet	X	feet	square feet
Convert annual rainfall from inches to feet				
	Annual rainfall			Annual rainfall in feet
	inches	÷	12 inches	feet
Determine amount of rainfall				
Site	**Annual rainfall (feet)**		**Area**	**Total rainfall**
Parking lot/roof	feet	X	square feet	cubic feet
Lawn	feet	X	square feet	cubic feet
Rain garden	feet	X	square feet	cubic feet
Other	feet	X	square feet	cubic feet
Other	feet	X	square feet	cubic feet
Calculate surface runoff				
Site	**Total rainfall**		**% runoff calculator**	**Surface runoff**
Parking lot/roof	cubic feet	X	1	cubic feet
Lawn	cubic feet	X	.60	cubic feet
Rain garden	cubic feet	X	0	cubic feet
Other	cubic feet	X	1 - 0	cubic feet
Other	cubic feet	X	1 - 0	cubic feet
Total surface runoff	**Add all surface runoffs from above.**			**cubic feet**

Bonus:

_____Cubic Feet X 7.2827 Gallons = _____ Gallons

_____ Gallons ÷ 25 Gallons = _____ Showers