2-1 Schoolyard Follow the Drop

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

Objectives
Students will:

- Practice observation and investigative skills
- Survey and collect information about their school site
- Learn about the nature of water in the landscape
- 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 yard

Subjects Covered
Science, Math

Grades
4 through 12

Activity Time
2 hours: 1 hour on the school grounds, 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.

Background

The purpose of this activity is to give students the tools they need to practice watershed citizenship by developing water friendly stormwater management plans for their schoolyard.

Everyone is a citizen of a watershed. Everyone has a watershed address. And everyone can practice good water citizenship at home, in the neighborhood, and in the schoolyard.

A watershed is the land area surrounding and draining into a specific body of water (stream, river, pond, lake). Water must flow downhill; bodies of water always lie in a low place in the land.

Before development, rain soaked into the land where it fell, because soil is permeable (absorbent). With development, more and more land was covered by structures and surfaces designed to shed water, not absorb it. These impermeable surfaces (such as roofs, sidewalks, driveways, roads and parking lots) create substantial areas that can shed substantial amounts of water. This water is called runoff or stormwater. In urban areas today, stormwater is considered the equivalent of trash: something to get rid of as fast as possible, instead of the precious resource it really is.

Water moving over the landscape in a large city, a medium-sized subdivision or single school yard after a rain 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 schoolyard. 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, a lake or to groundwater. To have clean water in a life sustaining, healthy watershed, each site – whether large or small — requires thoughtful stormwater management. 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 Earth Partnership for Schools' Storm Water 101 for more information.

Pre-activity Preparations

- Make a copy of an existing school map showing the location of buildings, driveways, 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 grounds, 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 school grounds. 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.

-Locate porous (pervious/absorbent) surfaces such as garden beds or grassy areas where water may soak in or infiltrate 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 places where water puddles. Hint: 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.

-Locate downspouts on the school building or where water falls off roofs.

-Locate storm drains on school property.

-Locate where water enters the school grounds from hillsides, streets or other locations.

-Identify spots where water exits the school ground such as through ditches or off school parking lots.

-Identify where water spills from one surface to another such as where water is moving from a hard, impervious surface like a sidewalk to a pervious, vegetated area or vice versa.

Step 2: Measure Areas for Rain and Runoff Calculations

Select an area and measure its size -- then calculate the amount of runoff it generates. Possible areas to measure include the school roof, parking lots, and playing fields or play areas. 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 outdoors.

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 feet x 50 feet = 1,500 square feet area

2. Multiple the area by the average annual rainfall to determine the volume of rainfall falling on your site. In this example, the average annual rainfall 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.

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 examples:

If rain is falling on hard surfaces such as a parking lot, 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, 0% becomes runoff.
Example: Calculate surface runoff from a rain garden 3750 cu. ft. x .00 = 0 cu

4. To help students understand these large volume numbers, have them convert cubic feet to gallons. 1 cubic foot of runoff produces 7.2827 gallons of water.

Example: Convert cubic feet to gallons
3750 cu. ft. x 7.2827 gallons = 27,410.125 gallons

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.)
- Observe what the rain water runoff is picking up along its route – sediment, trash, oil, gas, etc.
- 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.
- Calculate 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 = 27,410.125 gallons
- Calculate possible number of showers 27410.125 gallons ÷ 25 gallons = 1093 showers

Additional Resources

- Cochrane, Jennifer. (1987). *Water ecology.* New York: The Bookwright Press.
- Higgins, S., Kesselheim, A., Robinson, G. (1995). *Project wet: Curriculum and activity guide*. Bozeman, MT: The Watercourse and Council for E
nvironmental Education.
- Hooper, Meredith. (1998). *The drop in my drink*. New York: Penguin Putnam Inc.

- Leopold, Aldo. (1966). *A sand county almanac*. UK: Oxford University Press.
- 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.
- Project Wild. (1999). *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 *A Sand County Almanac)*
- List positive water-friendly landscape features and things that could change on the school ground to prevent runoff from leaving the schoolyard.
- Give an oral report on your findings along with follow-up suggestions for increasing infiltration and reducing surface runoff.

Follow the Drop Calculation Sheet

How much of the rain that falls on our property stays on the property? How much *infiltrates* into the ground? How much exits the site as *run-off*? As part of this investigation you will determine the answers to these questions. Fill in the tables below in order.

Define Key Concepts:

- Infiltration
- Runoff
- Permeable
- Impermeable
- Liter
- Gallon
- Cubic Meters

1. *Calculate areas: Use the grid to determine the area covered in each of these types of cover.*

Cover type	**Number of square (est.)**	**X**	**Area per square (*square meters*)**	**Total Area *square meters***
Roof (downspouts)		X	100	=
Parking lot		X	100	=
Lawn		X	100	=
Native planting		X	100	=
Rain garden		X	100	=
Edible garden		X	100	=

2. *Convert millimeters of rain per year to meters.*

Rainfall in millimeters_____876mm____ ÷ 1000mm/1 meter = _______.0876_____meters

3. *Determine the amount of rain that falls on each cover type every year.*

Cover type	Area from #1 *square meters*	X	Annual rainfall (#2) *meters*	Total Rainfall per area *meters*
Roof (downspouts)		X	.0876	=
Parking lot		X	.0876	=
Lawn		X	.0876	=
Native planting		X	.0876	=
Rain garden		X	.0876	=
Edible garden		X	.0876	=

4. *How much of the rain runs off? Use the runoff calculator for each cover type.*

Cover type	Total rainfall (#3) *cubic meters*	X	% runoff calculator	= Surface runoff *cubic meters*
Roof (downspouts)		X	1	=
Parking lot		X	1	=
Lawn		X	.6	=
Native planting		X	.4	=
Rain garden		X	0	=
Edible garden		X	.4	=
Total runoff	------------	----	------------	

Information:

1. 3.78 liters = 1 gallon.
2. One cubic meter = 1,000 liters
3. On average, Americans use 2,500 cubic meters of water per year.
4. An average American uses 94.5 liters of water per shower (25 gallons/shower).

Curriculum Connections

Purpose Statement (3-5): We can analyze stormwater runoff in our schoolyard by describing and graphing surface impermeability and calculating water volume. We can use this information to help us make responsible decisions as watershed citizens, emphasizing that water is a precious resource and only a tiny fraction is available in our ecosystem.

Purpose Statement (MS): We can study surface permeability and storm water runoff in our schoolyard, understanding how human developments such as lawns and pavement can cause erosion, pollution, and flooding. We can use this data as we begin to design a system for catching and filtering rainwater.

Purpose Statement (HS): We can investigate the mechanical properties of water by studying its ability to erode land surfaces and transport materials across our schoolyard, considering how we can apply our understanding of water's functionality to our design of a water catchment system.

Disciplinary Component Ideas:
ESS2.C: The Roles of Water in Earth's Surface Processes. How do the properties and movements of water shape Earth's surface and affect its systems?

ESS3.C: Human Impacts on Earth Systems. How do humans change the planet?

Unit builds toward students meeting performance expectations:

5-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

For more curriculum connections for this activity, please see Appendix A.

For strategies for English Language Learners for this activity, please see Appendix B.