State of New Jersey

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Department of Environmental Protection

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Dear Educator,

On behalf of the New Jersey Department of Environmental Protection (DEP), we would like to thank you for your interest in celebrating ***National Earth Science Week (October 11 - 17)*** in your instructional setting. Enclosed is one Earth Science lesson plan and New Jersey-specific content information for use in ***grades 6 - 12***. This lesson can provide support for the following ***New Jersey Core Curriculum Content Standards and Cumulative Progress Indicators***:

* ***Science 5.12.5*** (If the extension is performed.)
* ***Science 5.10.14*** (If extension is performed.)
* ***Science 5.5.11***
* ***Science 5.5.9***
* ***Social Studies 6.9.5***
* ***Mathematics 4.9.19***
* ***Mathematics 4.9.12***
* ***CCWR 4.2 and 3.2***
* ***Mathematics 4.9.18***
* ***Mathematics 4.9.14***
* ***Mathematics 4.9.13***
* ***Mathematics 4.9.12***
* ***Mathematics 4.7.16***
* ***Mathematics 4.1.15***
* ***Mathematics 4.1.10***

As you may already know, geology is very important in making wise land use and management decisions. For example, the groundwater recharge areas of the state's major aquifers are currently being identified by the New Jersey Geological Survey. In order to sustain ground water supplies, these areas should not be paved over without providing mitigation, and pollution should be prevented or minimized.

Within DEP, geologists and earth scientists are active in mitigating ground water pollution, developing new ground water supplies, restoring the state's beaches, and defining natural hazards such as radon, landslide prone areas and sinkholes. Elsewhere, geologists are active in the mineral and petroleum industries, which employs about 50% of the country's geoscientists. Earth scientists are extremely involved in developing the earth's natural resources and in safeguarding the environment. We hope that student participation in this lesson serves to introduce them to these exciting and valuable fields of science.

The lesson is entitled "***Where Does Water Run Off After School?***" on pages 82 - 85 in ***Aquatic Project WILD***. Aquatic WILD is a national environmental education curriculum supplement co-sponsored by the Western Regional Environmental Education Council, Inc., and the Western Association of Fish and Wildlife Agencies. Coordinated in New Jersey by DEP, the Aquatic WILD activity guide is obtainable by attending a full-day in-service or enrichment program. Contact DEP Aquatic WILD Coordinator Larry Sarner at 609-748-2031 for additional information about this resource.

We also encourage you to periodically visit the New Jersey Geological Survey's Home Page on the Internet (www.state.nj.us/dep/njgs/). The site focuses on New Jersey-specific earth science information, as well as links to the American Geological Institute (AGI). The Institute features additional classroom materials and a video on earth science careers.

Finally, fee free to contact DEP employee Tanya Oznowich at 609-984-9802 to learn about other environmental education resources and enrichment opportunities provided by the department.

Sincerely,

Haig Kasabach
New Jersey State Geologist

Tanya Oznowich
Environmental Education Specialist

Enclosures

WHERE DOES WATER RUN OFF AFTER SCHOOL?

OBJECTIVE

Students will describe relationships between precipitation, runoff and aquatic habitats.

METHOD

Students measure and calculate the area of the schoolground; calculate the volume and weight of water falling on the schoolground; determine specific and annual rainfall and runoff; and trace the course of that water to aquatic habitats.

BACKGROUND

Rainfall is obvious—but runoff from rainfall is a relatively abstract concept. Although we may notice and in fact get drenched in a rainstorm, we don't typically stop to wonder **how much** rain is falling. The volume and mass of the water in a rainstorm is astounding to those who calculate the values. NOTE: See "Puddle Wonders" for an interesting related activity.

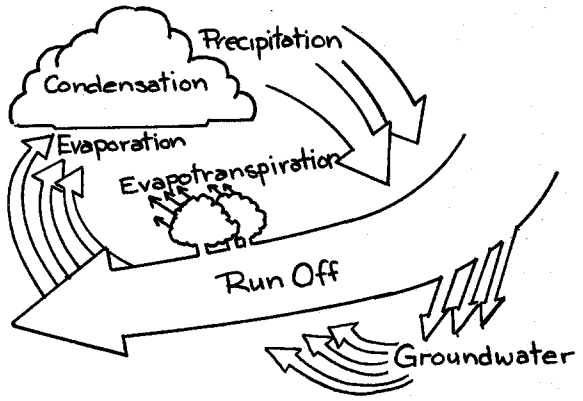
Developing an understanding of precipitation and runoff is an important part of understanding the water cycle. Rainfall is one form of precipitation. Rainfall is one way water re-enters aquatic habitats. Once rain falls upon a surface, water begins to move both laterally outward and vertically downward. Lateral movement is runoff and finds its way into streams, rivers and lakes. Vertical movement seeps into the soil and porous rock and re-charges groundwater supplies.

Age: Grades 6-12
Subjects: Math, Science
Skills: analysis, computation, description, discussion, estimating, inference, measuring
Duration: two 45 to 60-minute class periods; one period, if dimensions of the school grounds are provided
Group Size: any
Setting: outdoors and indoors
Conceptual Framework Reference: III.A.1., III.B., III.B.1., III.B.3., III.C., III.C.1., I.A.1., I.A.2., I.A.3., I.B., I.C., I.C.2., I.C.3., I.C.4., I.D.
Key Vocabulary: runoff, precipitation, volume, area, weight
Appendices: Outdoors, Metric Conversion Chart

Paving and soil compaction can reduce an area's water absorbing ability and therefore increase runoff. Reduced absorption rates can negatively impact vegetation and groundwater recharge.

Runoff is the dominant way that water flows from one location to another. It is in runoff that many pollutants find their way into moving waters. These are kinds of pollutants called "nonpoint source." What this means is that widespread sources of pollution such as garden insecticides, automobile emissions caked on parking lots, lead from paints and exhaust, etc., are washed by runoff into streams, rivers, lakes and oceans. Eventually the water becomes part of an aquatic habitat and the toxins begin their damage.

Runoff is also responsible for erosion, transportation and deposition of sediments scoured from the land's surface. Substandard agricultural and other land practices often prepare fields and their topsoil to be washed away.



On the positive side, the contamination levels in much of runoff are negligible. Runoff waters are necessary to renew many aquatic habitats that are dependent upon inflow for continuity. The inflow prevents lakes from shrinking due to evaporation and it prevents streams from going below minimum flow levels. Inflow thus helps support aquatic life. Without some runoff, aquatic habitats would suffer. In this activity,

the students calculate both the volume and the weight of rainfall. They consider relationships between rainfall and runoff, including effects on wildlife and the environment.

The major purpose of this activity is for students to increase their awareness and appreciation of some things they may take for granted—rainfall, runoff and the connections between surface waters and aquatic habitat.

MATERIALS

writing materials; meter or yardsticks; long piece of twine with marks every yard or meter; rain gauge; local rainfall data
OPTIONAL: calculator; trundle wheel.

PROCEDURE

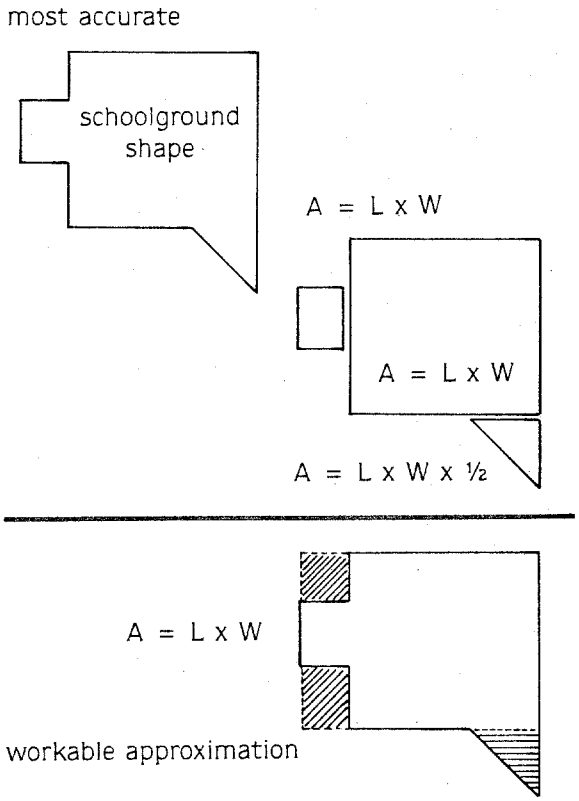
1. In this activity, students will find out how much rain falls on their schoolground—and how much it weighs! First, the students must determine the total area of the schoolground. For the purposes of this activity, the outer dimensions of the property will satisfy. There is no need to subtract the area of the buildings since it is assumed that rain falls upon them as well.

The formula for calculating area is:
Area = Length x Width (or A = LW)

NOTE: See the extensions to this activity for metric approximations.

The length and width of the schoolground must be measured. The students can use a length of twine (approximately 100 feet in length). Mark the twine every three feet. The marking can be done with an ink marker, short pieces of string tied every yard, or a knot each three feet. If a trundle wheel is available, it is convenient to use for measuring.
NOTE: A trundle wheel is a device that makes the measurement of linear distance simple. It is a wheel that operates a counter or clicks as it is rolled over the surface attached to a handle. Each revolution of the wheel represents one yard or meter. Check to see if the school has one. City road crews often have them and may loan one to you for a few days.

The main difficulty with calculating the area in this activity comes from irregularly-shaped schoolgrounds. Try not to get bogged down in detailed exactness. A healthy approximation will do. Here are a few examples:



2. Once the area of the schoolgrounds has been established, the next step is to determine the amount of rain that falls in the area. Three options are possible:

- Calculate the annual rainfall on the schoolgrounds using information from resource agencies, e.g., weather bureau, soil conservation service, local TV weatherpersons, local newspapers.
- Using a rain gauge, measure the amount of rain over a period of time.
- Calculate the amount of rain that falls in a given storm.

When the students have decided on a way to measure the amount of rain that falls on their schoolground during a specified period of time, ask them to calculate the amount. This provides the students with a value for the depth of rainfall on the surface of the land.

3. With the depth of rainfall determined, and the area of the schoolground measured, the next step is to calculate the volume of rainfall. For example, suppose the area of the schoolground is 50,000 square feet and the annual rainfall is six inches or .5 feet. Then the volume of rain would be:

50,000 square feet x .5 ft of rain =
25,000 cubic feet of rain

The volume of rain is 25,000 cubic feet of rain.

4. Knowing the volume, the students can now calculate the weight of the rain. Water weighs 62.5 pounds per cubic foot, thus the weight of six inches of rain (25,000 cubic feet) is:

25,000 x 62.5 = 1,562,500 pounds or 781.25 tons of rain.

5. All of the measurements and calculations done in this activity are intended to impress upon students that there are remarkable volumes and weights of water moving through the water cycle. Even short periods of rainfall produce amazing amounts of water. All the water that the students measure eventually finds its way to a wildlife habitat. A major issue of concern is how humans affect the quality and quantity of water that eventually reaches aquatic habitats. Consider and discuss the following questions:

- Where does the water from rainfall go when it leaves the school site?
- How much water is absorbed by the different surfaces on the school site?
- With what kinds of potential pollutants does the water come in contact?
- Where is the location of the nearest wildlife habitat that receives the school's runoff?
- How do people use the water between the time it leaves the school and arrives in the wildlife habitat?
- What are some of the positive and negative effects that the water may have on the environment at various points on its journey?

EXTENSIONS

1. Obtain a map of the school and check it against the accuracy of the one you made. Make a copy of the school district map, or use your own map, and plot runoff routes on it. Check periodically during rainstorms to identify the drainage patterns. Try to find a way to estimate how much water is draining in specific places.

NOTE: Most school districts have maps in the administrative department concerned with buildings and grounds.

2. If you did not already, place a rain gauge on the schoolground and measure actual amounts of rain. Repeat your calculations.
3. Do this activity in metric:
   - 100 feet = 30.48 meters
   - 3 feet = 1 yard = .9114 meter
   - Square feet x .0929 = square meters
   - Inches x 2.54 = centimeters
   - Feet x .3048 = meters
   - Pounds x .4536 = kilograms
4. A serious modern concern is the contamination of groundwater. How might water in the groundwater table or aquifer become contaminated with chemicals potentially harmful to human health? To the health of other animals, including wildlife? Identify as many sources of contamination to groundwater and runoff in your area as possible. What can, or is, being done to reduce or eliminate these sources and their effects?

EVALUATION

1. Describe at least two relationships between aquatic habitats, precipitation, runoff and surface water.
2. Name two human activities that have affected the quality of runoff.
3. Name two human activities that have affected the quantity of runoff.
4. Name two ways that runoff can affect humans.
5. Name and describe two ways that runoff can affect aquatic wildlife.
6. Write an advertising campaign slogan to convey the importance of runoff to wildlife. Include the need for clean water without toxins.
7. Write a short list of steps to take for wildlife to protect the quality of runoff water.