

# When Rain Hits the Land

## Experimenting with Runoff



### Overview

In this activity students will do an experiment to determine how land surfaces affect the flow of rain water as it flows through the watershed. They then apply their knowledge to their own schoolyard.

### Central Question

How do different land surfaces affect the flow of rain water?

### Estimated Time

3 - 3.5 hours

### Objectives

Students will be able to:

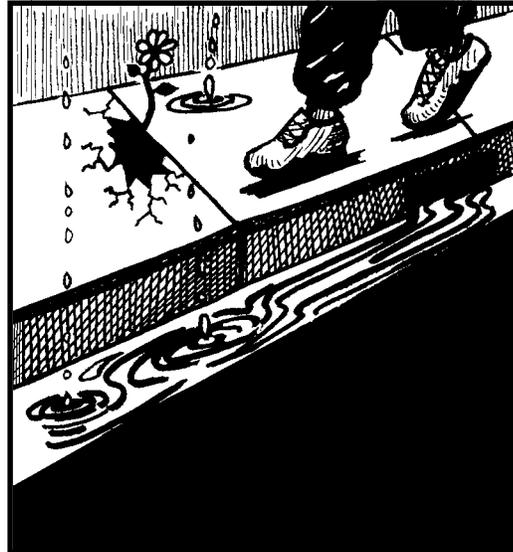
- *build* a model to demonstrate the difference between runoff and groundwater
- *create* graphs to express the result of their experiment
- *identify* which land surfaces cause runoff and which cause water to soak into the ground
- *apply* what they demonstrate in the classroom to the schoolyard environment
- *map* land surfaces around the schoolyard

### Materials

For each group of 4-5

#### Part I:

- Cardboard milk or orange juice carton with back panel cut out
- Plastic cup with small holes in the bottom
- 3 cups of dirt
- 3 cups of sod
- 3 cups of gravel
- 3 cups of sand
- 3" x 6" strip of rooted grass or sod
- 3 handfuls of straw
- Small plastic tub for catching runoff water
- 1 large bucket (or sink) for disposing of wastewater
- 250 ml. or larger beaker or measuring cup
- Pitcher or empty jug for pouring
- Stop watch
- Ruler
- Protractor



Tara Reinertson

- Containers of fresh water (or sink)
- Clean up rags

#### Part II:

- Metal can (or other cylinder) with two open ends
- Beaker or measuring cup
- Pitcher or empty jug for pouring water
- Stop watch

#### Part III:

- Sheet of large paper or posterboard
- Markers, pens, colored pencils
- Other art supplies, as needed

### Vocabulary

*erosion, experimental control, groundwater, impervious, percolation, pollutant, run-off*

### California Science Content Standards

#### Grade 6

**Standard Set 2.a:** water running downhill is the dominant process in shaping the landscape, including California's landscape.

#### Grade 7

**Standard Set 7.a:** select and use appropriate tools and technology (including calculators,

**Additional Resource:** Runoff in the Bay <http://www.savesfbay.org/campaigns/fillpollution/prunoff.cfm>

computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

**Standard Set 7.c:** communicate the logical connection among hypothesis, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

**Standard Set 7.d:** construct scale models, maps and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates and cell structure).

## Grade 8

**Standard Set 9.a:** plan and conduct a scientific investigation to test a hypothesis.

**Standard Set 9.c:** distinguish between variable and controlled parameters in a test.

**Standard Set 9.e:** construct appropriate graphs from data and develop quantitative statements about the relationships between variables.

**Standard Set 9.g:** distinguish between linear and non-linear relationships on a graph of data.

## Background

When rain hits the land, it either flows over the surface or it is absorbed. Whether rain becomes groundwater or runoff depends on the type of land it encounters. Rainwater runs off impervious surfaces such as concrete, asphalt, rooftops, and even packed soil, because it cannot soak in. As runoff glides over these smooth hard surfaces, it encounter no resistance and picks up speed. Depending on the slope of the land, the volume and power of this runoff can erode land and pick up pollutants such as oil and fertilizers. In contrast, water falling on loose soil and vegetated areas is able to seep into the ground to become groundwater. In this case, water is absorbed and slowed, minimizing erosion, filtering out pollutants, and preventing flooding. The faster the runoff and the greater its volume, the more pollutants it can carry to the Bay, and the more flooding and erosion can occur. The type of land surface and the slope of the land determine the volume and the rate of runoff.

## Teacher Procedure

### Part I:

1. Collecting materials: This experiment requires a fairly large quantity of materials. Most of these are inexpensive and may be collected at home. You may wish to distribute a list of materials to students a week in advance and instruct them to gather their own materials. It is probably easiest

if you purchase the gravel and sod.

2. Review the concept of experimental controls with your students. Explain that for the purposes of this experiment, the only thing that should change from trial to trial is the type of material being tested. Note: Students should be especially careful to hold the milk carton at the same angle for each trial. Having a student hold the milk carton so that one end leans against a stand and the other end leans against the runoff container (see illustration) will help keep the angle consistent.
3. Question 5 asks students to predict their results, and step 7 asks for a write-up of the experimental procedure. Consider assigning these steps as homework or class work before the day of the actual experiment, depending on the amount of time you have.
4. Divide the class into groups of 4-5 students. If your students are less experienced with lab procedures, you may wish to show them a demonstration of the activity. Allow plenty of time for students to conduct the experiment and clean up. If your class periods are short, plan to conduct this activity over 2-3 days.
5. Step 14 instructs students to graph the results of their experiment. If graphing is not something with which they are familiar, you may want to determine the axis and the type of graph students use. This is a good opportunity to involve the math teacher.

### Part II:

1. This part of the activity provides a very simple way to solidify concepts illustrated by the experiment in Part I by trying them out in the real world. You will need to take your students outside to explore their schoolyard.
2. Allow a specified amount of time for groups to conduct a "percolation" test on each of the land surfaces they have chosen. This involves pouring a specified amount of water onto various surfaces and recording the amount of time it takes for all of the water to soak into the ground each time.
3. Students can add the results of their percolation tests to the schoolyard maps that they will make in Part III.

### Part III:

1. In this part, students will map land use around the school. They might like to share their maps with another class or display them on a bulletin board so that others can see what they have learned.

# When Rain Hits the Land

## Experimenting with Runoff

Student



Pages

### Part I

#### INTRODUCTION

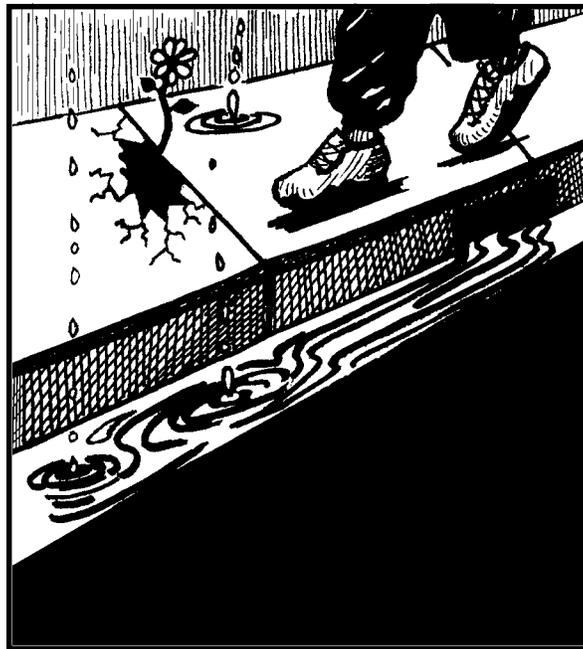
Think about what happens when rain hits the land. What happens to the water as it falls to the ground? Imagine a rainstorm in a wooded area. Grass, leaves, soil, and vegetation act like a sponge, soaking the water into the floor of the forest. Now imagine the same rainstorm on a road, or in a parking lot. These surfaces are solid, and water has nowhere to go. As it flows along, it gains speed and is able to pick up and carry nutrients or chemicals that might be on the land. Soil not protected by vegetation is easily eroded or washed away by fast moving water. In this activity you will work in small groups to test materials that represent various land surfaces and record your observations.

#### MATERIALS

*Your group will need:*

##### Part I:

- Cardboard milk or orange juice carton with back panel cut out
- Plastic cup with small holes in the bottom
- 3 cups of dirt
- 3 cups of gravel
- 3 cups of sand
- 3" x 6" strip of rooted grass or sod
- 3 handfuls of straw
- Small plastic tub for catching runoff water
- 1 large bucket (or sink) for disposing of wastewater
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- Stop watch
- Ruler
- Protractor
- Containers of fresh water (or sink)
- Clean up rags



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## PROCEDURE

### Part I:

In this part, you will conduct an experiment to find out how different land surfaces affect the rate and amount of water that will run off when it hits that surface.

1. Read the introduction to this activity. Explain how a stream might be affected by a rainstorm in a paved area. How is this different from what you expect would happen in a forest?

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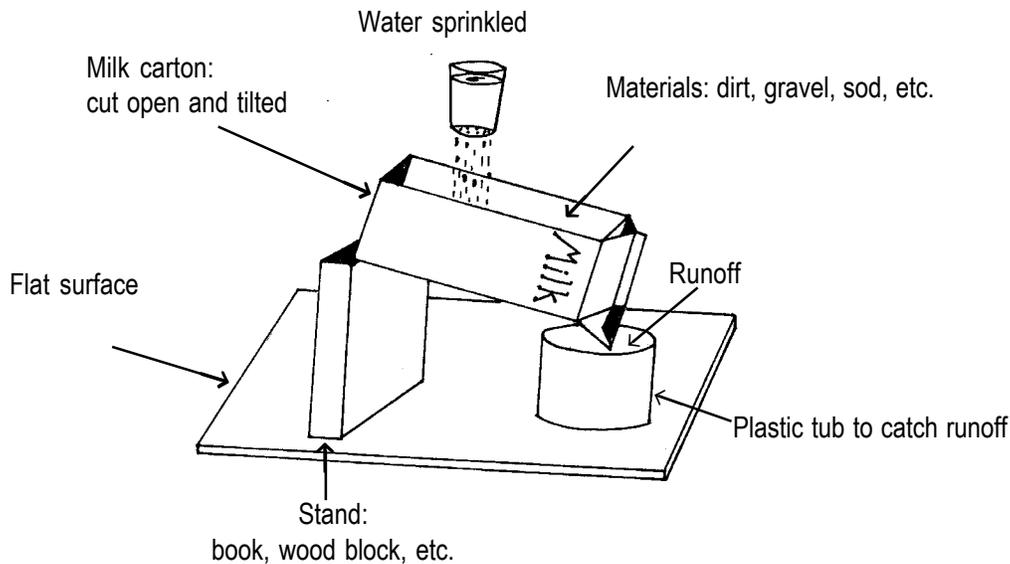
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2. Your group is going to set up an experiment testing what happens when rain hits different land surfaces. Take a look at the diagram of the experiment below. You will be filling the milk carton with a material, creating a rainstorm using your plastic cup, and timing and measuring the resulting runoff. Make a list of all the things that must be done exactly the same way during each trial in order to get good results. These represent the experimental controls. Share your list with another group.



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3. All groups will run their first trial using only the plain surface of the milk carton. What land surface do you think the bare carton represents?

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4. Choose three materials from the following list that you and your group members would like to test. List the materials that you choose in the Runoff Data Table.

- dirt
- sod
- straw
- gravel
- sand

5. Before running your experiment, predict which of your testing materials will produce the fastest and the most runoff, including your 3 choices and the bare carton. Rank the materials from 1 (fastest/most runoff) to 4 (slowest/least runoff), and give a brief explanation for your answer.

Bare Carton:

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#1

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#2

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#3

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6. Each person in your group will be responsible for a certain job in the experiment. Use the descriptions below to decide who will be in charge of each job.

<u>Title</u>	<u>Duties</u>
Water Manager	Measures water quantities Sprinkles water for each trial Disposes of wastewater as instructed
Timekeeper/Recorder	Times each trial Records all data in the chart Keeps group on time
Materials Manager	Organizes all materials Places materials in milk carton each time Cleans the carton after each trial Returns all materials after use
Quality Control	Makes sure the procedures are followed correctly Makes sure everyone has a chance to speak Makes sure everyone understands
Cleanup Crew	Washes materials, desktops, and floor area.

7. Use information from the previous steps and questions to write a plan for conducting your experiment. Write your plan on a separate piece of paper and check it with your teacher when you are finished.
8. Conduct your experiment following your group's plan. Record all data in the table on the following page.

## Runoff Data Table

Material	Predictions		Amount of Water Added	Amount of Runoff Collected	Time for Runoff to slow to one drop every 3 Seconds	Observations
	Time for runoff to slow to one drop every 3 seconds	Amount of Runoff				
Plain carton						
Final combination						

9. Once you have finished running your experiment, use the results from each trial to mix materials in an attempt to make the slowest and least possible runoff. You must follow one new rule:
- You may only fill your carton a total of 3 cm full with materials. List the materials you use in the Runoff Data Table under “Final Combination.” Record your results.

10. When your group has finished, compare your results with those of another group. Which combination produced the best results for slowing and reducing runoff?

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11. Now look back at the predictions that you made for each material. How correct were your predictions? In what way did your predictions differ from actual results?

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**12.** How would you explain these differences?

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**13.** Below, give examples of land surfaces in your schoolyard that correspond to materials you tested.

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**14.** Individually, use graph paper to create a graph that shows how different materials affect the speed and amount of runoff. Be sure to label all parts of your graph.

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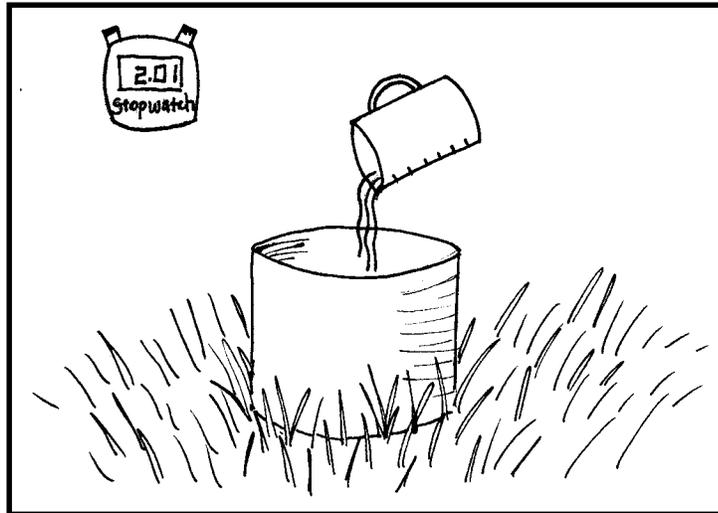
## Experimenting with Runoff

### Part II

#### INTRODUCTION

When rain hits the land, water either soaks into the ground to become groundwater, or runs off the land to become runoff.

In this activity, your group will do a percolation test on various land surfaces around your school. A percolation test measures how long it takes for water to soak into the ground. This test will help you determine whether water that falls on your schoolyard becomes groundwater, runoff, or both.



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#### MATERIALS

- Metal can (or other cylinder) with two open ends
- Pitcher or empty jug for pouring water
- Beaker or measuring cup
- Stop watch
- Data chart (included)

#### PROCEDURE

1. Read through this procedure and answer questions 1, 2 and 3 before beginning your experiment.
2. Find various land surfaces around your schoolyard: grass, gravel, packed dirt, loose dirt, pavement etc. Record these in your data chart .
3. Place the cylinder on a land surface. If possible, twist the percolation cylinder into the ground slightly so that water will not flow out the edges.
4. Measure an amount of water and pour it into the cylinder. Record amount of water in your data chart.
5. With a stopwatch, time how long it takes for all the water to soak into the ground. Record this in your data chart.
6. Repeat steps 3-5 for each land surface.

1. In this experiment you will be pouring water into a can that is placed on a land surface and recording the amount of time that it takes for the water to soak into the ground. List the things that you think should be kept constant in this experiment.

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2. Before you go outside, decide who will be responsible for each task. You will need a timer, a recorder, someone to twist the percolation can into the ground, someone to pour the water, and at least one person to observe the water as it seeps into the ground or runs along the surface. After the first test, switch jobs so everyone gets a chance to do everything.

**Timer:** \_\_\_\_\_

**Recorder:** \_\_\_\_\_

**Can twister:** \_\_\_\_\_

**Water pourer:** \_\_\_\_\_

**Observer:** \_\_\_\_\_

3. Decide the following things before you go outside:

How much water will you pour at each location? \_\_\_\_\_

At what point will you begin timing? \_\_\_\_\_

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4. Summarize and explain the results of your “perc” test. Which surfaces soaked up water quickly? Which did not absorb water? Based on what you learned about land surfaces during this activity, describe the runoff that you think would occur around your school after a big rainstorm.

# Percolation Data Chart

Land Surface/ Location	Amount of Water Poured	Time for water to soak in	Observations

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### Part III:

#### INTRODUCTION

In this section, you will illustrate the land uses around you by making a map that shows where different types of land surfaces are located around your school.

#### MATERIALS

- Sheet of large paper or posterboard
- Markers, pens, colored pencils
- Other art supplies, as needed

#### PROCEDURE

1. Decide within your group how you will show different land surfaces on your map. In the space below, draw a key for your map that indicates the different land surfaces that you will be marking. The key will make your map easy to understand!

2. Use a large sheet of paper to draw your schoolyard.

3. Add your key to the schoolyard map when you are finished.

4. List the different land surfaces that you found in your schoolyard in the table below. Beside each one, decide whether water would more likely “run off” or “soak in” when it hits the surface.

Land Use	Runoff or Soak In?

5. In general, how do you think your schoolyard rates as far as land uses? For example are there more parking lots than fields? What things might you change to reduce runoff? Write these on the back of this piece of paper.