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The NASA Sci Files™

# The Case of the Wacky Water Cycle

An Educator Guide with Activities in Mathematics, Science, and Technology

http://scifiles.larc.nasa.gov
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*The Case of the Wacly Water Cycle* educator guide is available in electronic format.

A PDF version of the educator guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site: **http://scifiles.larc.nasa.gov**

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# The NASA SCI Files™ The Case of the Wacky Water Cycle

## A Lesson Guide with Activities in Mathematics, Science, and Technology




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Registered users of the NASA SCI Files™ may request a Society of Women Engineers (SWE) classroom mentor. For more information or to request a mentor, e-mail **kimlien.vu@swe.org**


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# Program Overview

The tree house detectives are eager to earn money to help Kathryn sponsor her soccer team on a white-water rafting trip. They plan to have a car wash to raise money. However, their efforts soon dry up as KSNN™ announces that the water level in the reservoir has dropped drastically and water restrictions are in force. The tree house detectives are disappointed but understand the importance of following the restrictions. They are a little confused, however, because they have been unaware of any drought-like conditions that could have caused the lower water level in the reservoir.

One group of tree house detectives decides to head to NASA Langley Research Center in Hampton, Virginia where they speak with Dr. David Hamilton to learn about the water cycle. Another group of detectives heads to Luray Caverns in Virginia to speak with Dr. D to learn more about water and where it is found on Earth. They are surprised to learn that a lot of the Earth's freshwater is located underground, which leads them to Ms. Hamilton, a hydrologist with the United States Geologic Survey (USGS), who explains facts about groundwater.

As the tree house detectives continue their investigation into the problem, they decide that if a lot of freshwater is underground, they need to learn more about how water gets into the ground. They contact a NASA SCI Files™ Kids' Club that is conducting an experiment on the permeability of soil types with help from their Society of Women Engineers (SWE) mentors. After learning more about groundwater, they find out that the groundwater levels will rise when it rains. They set off to check out the weather forecast and contact Dr. James Hoke of the National Oceanic and Atmospheric Administration (NOAA), who helps them understand how weather forecasts are made. After learning that weather forecasts today are pretty accurate, they become discouraged because there is no rain predicted for the next three days. The car wash is in four days! Not sure whether they are experiencing a drought or if something has happened to change the climate, the detectives contact Corinne, one of the NASA SCI Files™ Kids' Club members, to have her meet Dr. D at the Petrified Forest in Arizona to learn more about climates.

After learning that climates change very slowly over time, the detectives rule out the possibility of a climate change causing the drop in the water level. However, Dr. D mentioned that some climatic events could disrupt the normal climate patterns, so they decide to learn more from Dr. David Adamec at NASA Goddard Space Flight Center in Greenbelt, Maryland. Dr. Adamec explains the phenomenon of the El Niño and La Niña weather patterns and tells how they affect the weather across the United States. Getting more discouraged, the detectives decide that they need to find an alternate source of water. Jacob hopes to find a source of water just under their feet with his divining rod. On the more practical end, Corinne agrees to meet Dr. D again at the Hoover Dam in Henderson, Arizona. Dr. D explains watersheds and the purpose of dams. Realizing that there is no way they can build a dam in the next two days and that they have no expectations the divining rod will work, they decide to find a different alternate source of water.

With a whole ocean of water just a few miles away, the detectives decide to learn more about how to turn saltwater into freshwater. They dial up Mr. Ken Herd in Tampa, Florida at the Tampa Bay Desalination Plant. The tree house detectives now become truly discouraged. Desalination is very expensive, there is no rain in the forecast, the climate has not changed, and they are running out of ideas.

They decide that if the restrictions are going to continue, they had better learn more about water conservation. They are off to enjoy a hot summer day and visit Mr. Brian Nadeau at Busch Garden's Water Country USA in Williamsburg, Virginia. Next stop is the Hampton Roads Water Efficiency Team in Hampton, Virginia, where they learn more about water conservation from Ms. Hillegass. They are also surprised to learn that Ms. Hillegass questions the need for the current water restrictions. After one more trip to Dr. D, they are confident that the water will flow soon.

## National Science Standards (Grades K – 4)

| Standard | Segment 1 | Segment 2 | Segment 3 | Segment 4 |
|---|---|---|---|---|
| **Unifying Concepts and Processes** | | | | |
| Systems, orders, and organization | ✖ | ✖ | ✖ | ✖ |
| Evidence, models, and explanations | ✖ | ✖ | ✖ | ✖ |
| Change, constancy, and measurement | ✖ | ✖ | ✖ | |
| Evolution and equilibrium | ✖ | ✖ | | |
| **Science as Inquiry (A)** | | | | |
| Abilities necessary to do scientific inquiry | ✖ | ✖ | ✖ | ✖ |
| Understandings about scientific inquiry | ✖ | ✖ | ✖ | ✖ |
| **Physical Science (B)** | | | | |
| Properties of objects and materials | ✖ | | | |
| **Life Science (C)** | | | | |
| Organisms and their environments | | | ✖ | ✖ |
| **Earth and Space Science (D)** | | | | |
| Properties of Earth materials | ✖ | ✖ | | |
| Changes in Earth and sky | ✖ | ✖ | ✖ | ✖ |
| **Science in Personal and Social Perspective (F)** | | | | |
| Type of resources | ✖ | ✖ | ✖ | ✖ |
| Changes in environment | ✖ | ✖ | ✖ | ✖ |
| Science and technology in local challenges | | ✖ | ✖ | ✖ |
| **History and Nature of Science (G)** | | | | |
| Science as a human endeavor | ✖ | ✖ | ✖ | ✖ |

## National Science Standards (Grades 5 – 8)

| Standard | Segment 1 | Segment 2 | Segment 3 | Segment 4 |
|---|---|---|---|---|
| **Unifying Concepts and Processes** | | | | |
| Systems, order, and organization | ✖ | ✖ | ✖ | ✖ |
| Evidence, models, and explanations | ✖ | ✖ | ✖ | ✖ |
| Change, constancy, and measurement | ✖ | ✖ | ✖ | |
| Evolution and equilibrium | ✖ | ✖ | | |
| **Science as Inquiry (Content Standard A)** | | | | |
| Abilities necessary to do scientific inquiry | ✖ | ✖ | ✖ | ✖ |
| Understandings about scientific inquiry | ✖ | ✖ | ✖ | ✖ |
| **Physical Science ( B)** | | | | |
| Properties and changes of properties in matter | ✖ | ✖ | ✖ | |
| Transfer of energy | ✖ | ✖ | | |
| **Earth and Space Science (D)** | | | | |
| Structure of the Earth system | ✖ | ✖ | ✖ | ✖ |
| Earth's history | | ✖ | ✖ | ✖ |
| Earth in the solar system | ✖ | ✖ | ✖ | ✖ |
| **Science and Technology (Content Standard E)** | | | | |
| Abilities of technological design | ✖ | ✖ | ✖ | ✖ |
| Understanding science and technology | ✖ | ✖ | ✖ | ✖ |
| **Science in Personal and Social Perspectives (Content Standard F)** | | | | |
| Science and technology in society | ✖ | ✖ | ✖ | ✖ |
| **History and Nature of Science (Content Standard G)** | | | | |
| Science as a human endeavor | ✖ | ✖ | ✖ | ✖ |
| Nature of science | ✖ | ✖ | ✖ | ✖ |
| History of science | | ✖ | | |

## National Mathematics Standards (Grades 3 - 5)

| Standard | Segment 1 | Segment 2 | Segment 3 | Segment 4 |
|---|---|---|---|---|
| **Number and Operations** | | | | |
| Understand numbers, ways of representing numbers, relationships among numbers, and number systems. | ✖ | ✖ | | ✖ |
| Understand meanings of operations and how they relate to one another. | ✖ | ✖ | | ✖ |
| Compute fluently and make reasonable estimates. | ✖ | ✖ | | ✖ |
| **Algebra** | | | | |
| Use mathematical models to represent and understand quantitative relationships. | | | ✖ | |
| **Geometry** | | | | |
| Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships. | ✖ | | | |
| Use visualization, spatial reasoning, and geometric modeling to solve problems. | ✖ | | | |
| **Measurement** | | | | |
| Understand measurable attributes of objects and the units, systems, and processes of measurement. | ✖ | ✖ | ✖ | |
| Apply appropriate techniques, tools, and formulas to determine measurements. | ✖ | ✖ | ✖ | ✖ |
| **Data Analysis and Probability** | | | | |
| Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them. | ✖ | ✖ | ✖ | |
| Select and use appropriate statistical methods to analyze data. | | ✖ | ✖ | |
| Develop and evaluate inferences and predictions that are based on data. | ✖ | ✖ | ✖ | ✖ |
| Understand and apply basic concepts of probability. | ✖ | ✖ | ✖ | |
| **Problem Solving** | | | | |
| Build new mathematical knowledge through problem solving. | ✖ | ✖ | ✖ | ✖ |
| Solve problems that arise in mathematics and in other contexts. | ✖ | ✖ | | |
| Apply and adapt a variety of appropriate strategies to solve problems. | | ✖ | | |
| **Communication** | | | | |
| Organize and consolidate mathematical thinking through communication. | ✖ | ✖ | ✖ | ✖ |
| Communicate mathematical thinking coherently and clearly to peers, teachers, and others. | ✖ | ✖ | ✖ | ✖ |
| **Representation** | | | | |
| Create and use representation to organize, record, and communicate mathematical ideas. | ✖ | ✖ | | |

## International Technology Education Association (ITEA Standards for Technology Literacy, Grades 3 – 5)

| Standard | Segment 1 | Segment 2 | Segment 3 | Segment 4 |
|---|---|---|---|---|
| **Nature of Technology** | | | | |
| Standard 1: Students will develop an understanding of the characteristics and scope of technology. | ✖ | ✖ | ✖ | ✖ |
| Standard 2: Students will develop an understanding of the core concepts of technology. | | | ✖ | ✖ |
| Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study. | | ✖ | ✖ | |
| **Technology and Society** | | | | |
| Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology. | | | ✖ | |
| Standard 5: Students will develop an understanding of the effects of technology on the environment. | ✖ | ✖ | ✖ | ✖ |
| Standard 6: Students will develop an understanding of the role of society in the development and use of technology. | | ✖ | ✖ | |
| Standard 7: Students will develop an understanding of the influence of technology on history. | | ✖ | ✖ | |
| **Design** | | | | |
| Standard 8: Students will develop an understanding of the attributes of design. | ✖ | ✖ | ✖ | ✖ |
| Standard 10: Students will develop an understanding of the role of troubleshooting, research, and development, invention and innovation, and experimentation in problem solving. | ✖ | ✖ | ✖ | ✖ |
| **Abilities for a Technological World** | | | | |
| Standard 11: Students will develop the abilities to apply the design process. | ✖ | ✖ | ✖ | ✖ |
| Standard 12: Students will develop abilities to use and maintain technological products and systems. | ✖ | ✖ | ✖ | ✖ |
| **The Designed World** | | | | |
| Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies. | ✖ | ✖ | ✖ | ✖ |

## National Technology Standards (ISTE National Educational Technology Standards, Grades 3 – 5)

| Standard | Segment 1 | Segment 2 | Segment 3 | Segment 4 |
|---|---|---|---|---|
| **Basic Operations and Concepts** | | | | |
| Use keyboards and other common input and output devices efficiently and effectively. | ✖ | ✖ | ✖ | ✖ |
| Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide. | ✖ | ✖ | ✖ | ✖ |
| **Social, Ethical, and Human Issues** | | | | |
| Discuss common uses of technology in daily life and their advantages. | | ✖ | ✖ | |
| **Technology Productivity Tools** | | | | |
| Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum. | ✖ | ✖ | ✖ | ✖ |
| Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom. | ✖ | ✖ | ✖ | ✖ |
| **Technology Communication Tools** | | | | |
| Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom. | ✖ | ✖ | ✖ | ✖ |
| Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests. | ✖ | ✖ | ✖ | ✖ |
| Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom. | ✖ | ✖ | ✖ | ✖ |
| **Technology Research Tools** | | | | |
| Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom. | ✖ | ✖ | ✖ | ✖ |
| Use technology resources for problem solving, self-directed learning, and extended learning activities. | ✖ | ✖ | ✖ | ✖ |
| Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems. | ✖ | ✖ | ✖ | ✖ |
| **Technology Problem-Solving and Decision-Making Tools** | | | | |
| Use technology resources for problem solving, self-directed learning, and extended learning activities. | ✖ | ✖ | ✖ | ✖ |
| Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems. | ✖ | ✖ | ✖ | ✖ |
| Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources. | ✖ | ✖ | ✖ | ✖ |

## National Geography Standards, Grades 3 - 5

| Standard | Segment 1 | Segment 2 | Segment 3 | Segment 4 |
|---|---|---|---|---|
| **The World in Spatial Terms** | | | | |
| Standard 1: How to use maps and other graphic representations, tools, and technologies to acquire, process, and report information from a spatial perspective. | | | ✖ | |
| **Places and Regions** | | | | |
| Standard 4: The physical and human characteristics of places. | ✖ | ✖ | ✖ | |
| Standard 5: People create regions to interpret Earth's complexity. | | ✖ | | |
| **Physical Systems** | | | | |
| Standard 7: The physical process that shapes the patterns of Earth's surface. | ✖ | ✖ | ✖ | |
| Standard 8: The characteristics and spatial distribution of ecosystems on Earth's surface. | ✖ | ✖ | ✖ | |
| **Environment and Society** | | | | |
| Standard 14: How human actions modify the physical environment. | ✖ | ✖ | ✖ | ✖ |
| Standard 15: How physical systems affect human systems. | | ✖ | | |
| Standard 16: The changes that occur in the meaning, use, distribution, and importance of resources. | ✖ | ✖ | ✖ | |
| **The Uses of Geography** | | | | |
| Standard 17: How to apply geography to interpret the past. | | ✖ | | |

The NASA SCI Files™
The Case of the
Wacky Water Cycle

# Segment 1

Just as the tree house detectives begin planning a car wash to raise money for a white-water rafting trip, they hear a report from KSNN™ suggesting that water restrictions will begin at once! Unsure if the report is accurate and not knowing much about water levels, they decide to do some investigating on their own. As the detectives begin their research, they stop by to see Dr. D, who just happens to be at Luray Caverns conducting research on water in caves. Dr. D amazes them with the idea that the total amount of water on the Earth is the same today as it was millions of years ago. Meanwhile, Catherine and Tony stop by to see Mr. Hamilton, an aerospace technologist at NASA Langley Research Center to learn more about the water cycle. New clues lead them to a hydrologist at the United States Geological Survey (USGS) to gather some important information about aquifers and how they are used.

# Objectives

The student will

- demonstrate how water molecules move through the water cycle.
- identify the processes of evaporation, condensation, and precipitation as part of the water cycle.
- learn how caves are formed.
- understand that water is a limited resource.
- identify where water can be found on the Earth.
- observe how water moves through the ground.
- construct a model of an aquifer.

# Vocabulary

**acid** – a corrosive solution which is able to break down or destroy something by chemical action

**aquifer** – an underground bed of saturated rock that holds large quantities of water

**condensation** – the process by which a gas becomes a liquid

**drought** – an extended period of time with little or no precipitation

**evaporation** – the process by which a liquid becomes a gas

**groundwater** – water found in spaces between soil particles underground

**hydrologist** – scientist who studies water

**meteorologist** – scientist who studies weather and climate patterns

**precipitation** – water falling in a liquid or solid state from the atmosphere to Earth as rain, sleet, snow, or hail

**recharge (of groundwater)** – groundwater supplies are filled again or replenished as water enters the saturation zone by actions such as rain or melting snow

**reservoir** – a large tank or natural or artificial lake used for collecting and storing water for human use

**saturated zone** – the portion below the Earth's surface that is soaked with water

**stalactite** – an icicle-like deposit of calcite hanging from the ceiling of a cave

**stalagmite** – a pillar in a limestone cave that is slowly built upward from the floor as a deposit from groundwater seeping through and dripping from the cave's roof

**surface water** – water above the surface of the land, including lakes, rivers, streams, ponds, floodwater, and runoff

**water cycle** – the paths water takes as a liquid, solid, or gas as it moves throughout Earth's systems; also known as the hydrological cycle

**water restrictions** – limits put on public and private use of water

**water table** – the top of an unconfined aquifer that indicates the level below which soil and rock are saturated with water

**water vapor** – the state of water in which individual molecules are highly energized and move about freely; water as a gas

**well** – a hole that is drilled or dug for the purpose of getting water from the ground

# Video Component

## Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

## Before Viewing

1. Prior to viewing Segment 1 of *The Case of the Wacky Water Cycle*, read the program overview (p. 5) to the students. List and discuss questions and preconceptions that students may have about the water cycle, how much usable water can be found on Earth, or how water in an aquifer is measured.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. The following tools are available in the educator area. To locate them, click on the educator's menu bar on the home page, then click on "Tools" and then "Instructional Tools." You will find them listed under the "Problem-Based Learning" tab.

   **Problem Board**—Printable form to create student or class K-W-L chart

   **Guiding Questions for Problem Solving**—Questions for students to use while conducting research

   **Problem Log and Rubric**—Printable log for students with the stages of the problem-solving process

   **Brainstorming Map**—Graphic representation of key concepts and their relationships

   **The Scientific Method Flowchart**—Chart that describes the scientific method process
3. Focus Questions—Questions at the beginning of each segment that help students focus on a reason for viewing. These questions can be printed ahead of time from the educator's area of the web site in the "Activities/Worksheet" section under "Worksheets" for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to answer the questions. An icon will appear when the answer is near.
4. What's Up? Questions—Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the educator's area of the web site in the "Activities/Worksheet" section under "Worksheets" for the current episode.

## View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

## After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about the water cycle and how it functions as a system on Earth. Have the students conduct research about the water cycle and brainstorm what might be causing the significant decline in the water table. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide students with the information needed.
4. Have the students complete Action Plans, which can be printed from the educator area or the tree house's "Problem Board" area in the "Problem-Solving Tools" section of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the "Research Rack" section of the "Problem Board" area in the tree house. Educators can also search for resources by topic, episode, and media type under the Educator's main menu option Resources.

5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. Have the students work individually, in pairs, or in small groups on the Problem-Based Learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on the tree house and then the "Problem Board." Choose the "2003–2004 Season" and click on The Land of Fill.
   - To begin the PBL activity, read the scenario (Here's the Situation) to the students.
   - Read and discuss the various roles involved in the investigation.
   - Print the criteria for the investigation and distribute.
   - Have students begin their investigation by using the "Research Rack" and the "Problem-Solving Tools" located on the bottom menu bar for the PBL activity. The "Research Rack" is also located in the tree house.
7. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
8. Have students complete a Reflection Journal, which can be found in the Problem-Solving Tools section of the online PBL investigation or in the Instructional Tools section of the Educator's area.
9. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

### Careers

hydrologist
meteorologist
geologist
aerospace technologist

# Resources (additional resources located on web site)

## Books

Hobbs, Will: *Downriver*. Bantam Doubleday, 1996, ISBN: 0440226732.

Hooper, Meredith: *The Drop in My Drink: The Story of Water on Our Planet*. Viking Penguin, 1998, ISBN: 0670876186.

Lesser, Carolyn: *Storm on the Desert*. Harcourt, 1997, ISBN: 0152721983.

Locker, Thomas: *Water Dance*. Voyager Books, Harcourt, Inc., 1997, ISBN: 0152163964.

London, Jonathan: *White Water*. Penguin Putnam, 2001, ISBN: 0670892866.

Petersen, P.J.: *White Water*. Random House Books, 1999, ISBN: 0440415527.

Polacco, Patricia: *Thundercake*. Putnam Publishing, 1990, ISBN: 0399222316.

Pratt-Serafini, Kristen: *Salamander Rain*. Dawn Publications, 2001, ISBN: 1584690186.

Rauzon, Mark J. and Bix, Cynthia: *Water, Water Everywhere*. Sierra Club Books for Children, 1995, ISBN: 0871563835.

Robinson, Sandra: *The Rainstick: A Fable*. Globe Pequot Press, 1994, ISBN: 1560442840.

Taylor, Barbara: *Earth Explained: A Beginner's Guide to Our Planet*. Henry Holt and Company, 1997, ISBN: 0805048731.

Wick, Walter: *A Drop of Water: A Book of Science and Wonder*. Scholastic, Inc., 1997, ISBN: 0590221973.

## Web Sites

**USGS—Water Science for Schools**
*http://wwwga.usgs.gov/edu/wugw.html*
This comprehensive water site sponsored by the USGS includes information about the Earth's water, aquifers, rainfall, and groundwater, as well as the chemical properties of water and common water measurements. Special topics include acid rain, water shortages, and why the ocean is salty. An interactive quiz section allows students to test their knowledge.

**BrainPop**
*http://brainpop.com/science*
Pick an animated movie that explains the water cycle, play a game, or participate in an experiment with Bob, the Rat. The site also contains dozens of additional science and history topics. Users may register to score points and keep track of activities they have done.

**Ozark Cave Formation and Geology**
*http://www.nps.gov/ozar/skindeep.htm*
This online teachers' guide developed by the National Park Service at Ozark National Scenic Riverways includes information on the geology and biology of caves, as well as several hands-on activities to help students understand cave formation.

**The Water Cycle Starring H2O**
*http://www.nwf.org/nationalwildlifeweek/games/waterrcyc_swf.html*
Learn about the parts of the water cycle in this animated story with sound.

**Kids-Only Game Time**
*http://kids.earth.nasa.gov/games*
Students will enjoy playing these interactive games on-line that will help them understand Earth science concepts such as the water cycle, plate tectonics, and the data NASA collects about the Earth. Choose from eight different puzzles, quizzes, or games to test your knowledge.

**Science Court**
*http://www.tomsnyder.com/classroom/scicourt/watercycle.html*
Investigate the water cycle with Judge Stone and the Science Court as you determine whether you can find water in the air. Check your findings.

# Activities and Worksheets



On the Web

**Spelunking**
Explore a cave online and plan a spelunking expedition of your own.

**Tree-mendous**
Calculate the amount of water that becomes part of the water cycle as a tree loses water through transpiration.

**Sing a Song of Water**
Write and perform your own song about the water cycle.

**What Is Water Anyway?**
Investigate the chemical and physical properties of water that make it so unique.

# Around and Around It Goes

## Purpose

To understand how water molecules move through the water cycle

## Materials

Water Cycle Score Card (p. 20)
8 cups
pencil
scenario strips

## Background

Water covers about 75 percent of the Earth and is constantly moving. Energy from the Sun, which allows evaporation, and gravity are the driving forces that power the water cycle. The movement is greatly influenced by the contour of the land and geologic features such as mountains, valleys, and hills. While water does circulate from one state to another in the water cycle, the path it can take is variable.

## Teacher Prep

Make a sign for each station that includes the station name and number. Cut the scenario strips apart and place them in a cup at each station. Before playing the game, discuss cycles with the students. Divide the class into eight groups and send each group to a station to begin. Say the word "CYCLE" when you are ready for students to move to the next station. Repeat until most of the students have cycled through the Cloud station a couple of times.

## Procedure

1. You are a water molecule. To find out about your journey through the water cycle, remove a strip from the cup at your station.
2. Read the strip.
3. Write the information on your Water Cycle Score Card.
4. Put the strip back in the cup.
5. When you hear the word "CYCLE", move to the next station, as directed by the strip. You may not be with the same group any longer.
6. Repeat steps 1–5 until you are told to stop. You may go to the same station more than once; be sure to always follow the directions on the strip you removed from the cup.
7. After you finish playing the game, go back to your seat and look at your Water Cycle Score Card.
8. Make a diagram of the path you took. For example, your journey might have taken you from the Cloud • Mountain • Cloud • Lake • Animal • Lake.

## Conclusion

1. Even though each water molecule took a different path, was anything similar about the journeys you took?
2. Classify each part of your journey as evaporation, condensation, or precipitation.
3. Can you think of other parts of the water cycle that were not included in the game?
4. What makes water move through the water cycle?
5. What would happen if all of Earth's water stayed in the oceans?
6. Why did the tree house detectives need to understand the water cycle to help solve their problem?

## Extension

1. Write a story about the journey you took or illustrate the journey by making a cartoon or comic book.
2. Choose two different locations on a map. Write a story about how you, as a water droplet, got from one place on the map to the other. Be creative.

# Water Cycle Score Card

| Station Stop | What Happens | Destination | Classification |
|---|---|---|---|
| **Example:** *Cloud* | *Falls as rain* | *Mountain* | *Precipitation* |
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

On the back, draw a diagram of your entire journey.

# STATION PAGE

## STATION STOPS

| STATION 1 – CLOUD |
|---|
| You fall as rain onto a mountain. Go to the mountain. |
| You fall as snow onto a mountain. Go to the mountain. |
| You fall as rain onto a stream. Go to the stream. |
| You fall as rain on a farmer's field. Go to the plant. |
| You fall as rain onto a parking lot. Go to the stream. |
| You fall as snow onto a lake. Go to the lake. |

| STATION 2 – MOUNTAIN |
|---|
| You evaporate into the air. Go to the cloud. |
| You soak into the ground and become part of the groundwater. Go to the groundwater. |
| You soak into the ground and are absorbed by a plant's roots. Go to the plant. |
| You roll downhill and become part of a lake. Go to the lake. |
| You become frozen and stay there. Stay at the mountain. |
| You drip off the rocks and join other drops in a small stream. Go to the stream. |

| STATION 3 – LAKE |
|---|
| An animal drinks you. Go to the animal. |
| You flow into a stream. Go to the stream. |
| You remain in the lake. Stay in the lake. |
| You are absorbed by the leaves of a plant. Go to the plant. |
| You evaporate into the air. Go to the cloud. |

| STATION 4 – STREAM |
|---|
| You evaporate into the air. Go to the cloud. |
| You continue rolling across the land and become part of the ocean. Go to the ocean. |
| You are pulled down into the soil on the bank. Go to the groundwater. |
| An animal drinks you. Go to the animal. |
| You flow into a lake. Go to the lake. |
| While flowing down the mountain, you freeze and stay there. Go to the mountain. |

| STATION 5 – GROUNDWATER |
|---|
| You become part of an underground river that flows to the ocean. Go to the ocean. |
| You are absorbed by the roots of a plant. Go to the plant. |
| You are pumped out of a well for a person to drink. Go to the person. |
| You are pumped out of a well for a person to wash dishes. Go to the stream. |
| You are pumped out of a well for a farmer to irrigate his field. Go to the plant. |
| You become part of an underground river that flows to the ocean. Go to the ocean. |
| You stay in the aquifer. Stay at the groundwater. |

## STATION PAGE

| STATION 6 – ANIMAL |
|---|
| You are breathed out of a person's lungs into the air as water vapor. Go to the cloud. |
| A person uses you for brushing his or her teeth. Go to the stream. |
| After using you to process food, the animal urinates, and you end up on the ground. Go to the mountain. |
| You are excreted as sweat and evaporate into the air. Go to the cloud. |
| A person takes a drink of water and spits you out onto the ground. You seep into the soil and become part of the groundwater. Go to the groundwater. |

| STATION 7 – PLANT |
|---|
| The plant transpires you through its leaves. You evaporate into the air. Go to the cloud. |
| The plant stores you in its fruit and you are eaten. Go to the animal. |
| The plant uses you to grow. Stay at the plant. |
| The plant transpires you through its leaves. You evaporate into the air. Go to the cloud. |
| The plant stores you in a root and you are eaten. Go to the animal. |

| STATION 8 – OCEAN |
|---|
| You are one of the many water molecules in the ocean and you stay there. Stay at the ocean. |
| You evaporate into the air. Go to the cloud. |
| A kelp plant takes you in, releases you through its leaf, and transpires you into the air. Go to the cloud. |
| You are swallowed by a fish. Go to the animal. |

# A Cycling We Will Go

## Purpose

- To identify the processes of evaporation, condensation, and precipitation as part of the water cycle
- To measure the volume of liquid added to the water cycle and estimate the amount of liquid that evaporates after a period of time

## Materials

large size plastic, zippered storage bags
bathroom size clear plastic cups (3.5 oz)
masking tape
beaker or graduated cylinder
water
marker
tape

## Procedure

1. Place 60 mL of water in a cup and use a marker to mark the water line.
2. Put the cup in the bottom corner of the bag so the bag is tilted like a diamond. This step is important so the sides will slant down from the top and allow the water drops to slide down and collect in the bottom of the bag. See diagram 1.
3. Tape the cup to the inside of the bag to prevent spilling.
4. Close the bag tightly and carefully tape it in a warm, sunny place.
5. In your science journal, predict what will happen to the water in the cup.
6. Observe the bag several times a day for four days.
7. Record and illustrate your observations.
8. On day 5, open your bag and carefully remove the cup.
9. Estimate how much water is in the cup and in the bag.
10. To measure the amount of water remaining in the cup, carefully pour the water from the cup into the graduated cylinder. Read and record.
11. Add the water that is in the bag to the graduated cylinder by carefully pouring it from one corner of the bag.
12. Read and record the total amount of water from the bag and cup. How much water was in the bag?

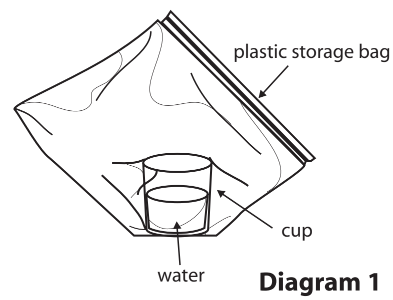



**Diagram 1**

## Conclusion

1. Use this experiment to define the three major processes in the water cycle.
2. What happened to the water that was not in the cup or in the bag?
3. Explain what would happen if you left the water cycle bag in a warm place for a month?

## Extension

1. Perform the same experiment again by using another liquid such as saltwater, soda, or rubbing alcohol. How did your results change?
2. Change other variables of the experiment such as the amount of light, temperature, color of the bag, amount of water, or size of the bag. How did these factors affect your findings?
3. Add a few drops of food coloring to represent contaminants. Observe and record what happens to the contaminants as they become part of the water cycle.
4. Based on the mini-water cycle, design a self-watering plant container.

# Cave-Cicles

## Purpose

To understand how limestone formations are created inside a cave

## Background

When water mixes with carbon dioxide in the air, it forms a weak acid. This carbonic acid eventually ends up in groundwater. One type of rock that is easily dissolved by this acid is limestone. As the water dissolves the limestone, the calcite in the limestone mixes with the water. As this mixture drips and evaporates, it creates calcite crystals in two formations:

- stalactites, which hang tight from the top or ceiling (Think of the "c" for ceiling.)
- stalagmites, which grow from the floor of the cave and might reach the ceiling some day (Think of "g" for ground.)

It may take hundreds and even millions of years for these formations to grow even a few centimeters.

## Materials

2 plastic cups
250 mL Epsom salts
250 mL warm water
60-cm cotton or wool string
2 nails
spoon
cardboard (about 30 cm square)
science journal

## Procedure

1. Stir Epsom salts into the warm water until no more will dissolve.
2. Pour the warm water equally into the two plastic cups.
3. Place the string in one cup to soak for three minutes.
4. Place the cardboard in an area where it will not be disturbed for several days.
5. Remove the string from the cup and tie a nail to each end of the string.
6. Place the two cups at opposite ends of the cardboard.
7. Put one nail into each cup.
8. Adjust the distance of the two cups from each other until the string is slightly taut, leaving a dip in the middle of the string. See diagram 1.
9. Observe and record your observations daily in your science journal.

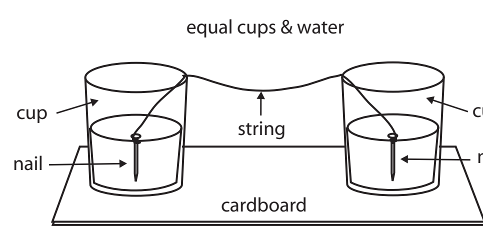



**Diagram 1**

## Conclusion

1. What formed on the string and how?
2. How are these "cave-cicles" like the formations found in a real cave? How are they different?

## Extension

With the help of an adult, find a recipe for rock candy and make it. Observe and illustrate the crystals that formed.

# Caving Caverns

## Materials

modeling clay (do not use Play Doh® or other water soluble clay)
3–6 sugar cubes
toothpick
table knife
clear plastic bowl
500 mL of water

## Purpose

To demonstrate how water forms caves

## Background

The two basic kinds of rocks found in most caves are limestone and sandstone. Limestone is a type of rock that is more easily dissolved by water. Sandstone is less water soluble but porous enough to allow water to pass through it.

## Procedure

1. Flatten the clay into a pancake shape. The clay will be the outer layer of sandstone and shale for your cave.
2. Place the sugar cubes on the clay so that each cube touches at least one other cube and one cube touches the edge of the clay. The sugar cubes will be the limestone in your cave.
3. Wrap the clay around the sugar cubes, forming a ball. See diagram 1.
4. Poke holes in the clay with the toothpick to represent cracks and pores in the rocks. See diagram 2.
5. Put the water into the plastic bowl and set the clay ball into the water.
6. Observe and record your observations in your science journal.
7. Allow the clay to stay in the water for about 30 minutes.
8. Remove the clay ball from the water and set on a paper towel.
9. Carefully cut the clay ball in half.
10. Observe and record.

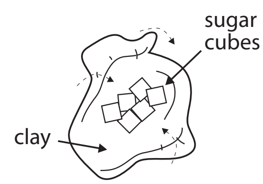



**Diagram 1**

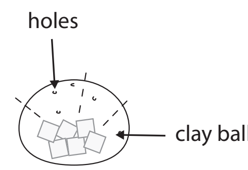



**Diagram 2**

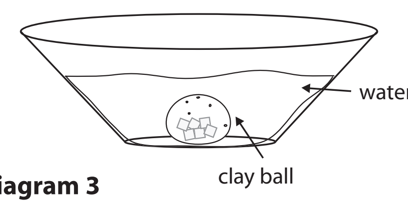



**Diagram 3**

## Conclusion

1. What happened to the sugar cubes inside the clay ball?
2. How are the sugar cubes like the limestone found inside a cave? How are they different?
3. What effect does water have on limestone over many years?

## Extension

1. Conduct research on caves that are open for public tours. Make a travel brochure that would encourage people to visit the cave. Be sure to tell about the features of the cave and where it is found.
2. Make a cave in a clear plastic container, such as a plastic glass. Stack sugar cubes in the bottom of the glass. Place a layer of clay over the top of the sugar cubes, pressing the clay tightly to the sides of the glass to form a cap. Using a toothpick, poke a few holes in the clay. Use a spray bottle or eyedropper to make it rain. Observe and record what happens as the water gets into the cracks and collects at the bottom.

# Water, Water Everywhere

## Purpose

To understand that water is a limited resource and to demonstrate where usable water can be found on the Earth

## Teacher Note:

This activity can be done as a class demonstration or in small groups.

## Background

Although water covers about 75% of the Earth's surface, water is not as abundant as you may think. The amount of freshwater available on Earth for human use is only a small fraction (0.003%) of the total amount of water on the planet.

## Materials

20 L water (5.3 gal)
large container (10-gal aquarium)
medium container (quart size)
3 small containers (pint size)
graduated cylinder
eyedropper
marker

## Procedure

1. Label the large container, "Earth's Water."
2. Label the medium container, "Freshwater," and the small containers, "Unavailable Water" and "Non-Usable Water."
3. Place 20 L of water in the "Earth's Water" container, which represents all the water in the world, including oceans, lakes, rivers, and groundwater.
4. Using a graduated cylinder, measure and pour 500 mL of water from "Earth's Water" into the "Freshwater" container, which represents the total amount of freshwater on the planet.
5. Create a second label, "Ocean Water," and place it over the "Earth's Water" label. The remaining 19.5 L in the large container now represents the water in the oceans, too salty for human beings to use. The oceans make up 97.5% of the total water volume on Earth.
6. Using a graduated cylinder, measure and pour 375 mL of water from the "Freshwater" container into the "Unavailable Water" container, which represents all the freshwater in glaciers, ice caps, the soil, and the atmosphere. This container is also unavailable for human use.
7. Using an eyedropper, remove 5 drops from the remaining "freshwater" container.
8. Pour the remaining water from the "Freshwater" container into the "Non-Usable Water" container, which represents all the water that is not readily available because it is very deep in the ground, in remote places, or polluted.
9. Place the five drops of water back into the "Freshwater" container, which represents the amount of clean water that is available for human use, only 0.003% of the 20 L you had in the beginning!

## Conclusion

1. Where does our drinking water come from?
2. Why can't we use the majority of the water on the planet?
3. Is water a renewable resource?
4. Why is it important to manage water resources?

## Extension

1. Develop a television commercial telling reasons why water is a limited resource.
2. Research a water habitat, such as the oceans, wetlands, or rivers. Find out what kind of animals and plants live there. Make a mural about these habitats.

# Seepy Sandwich

## Purpose

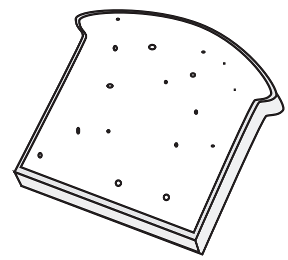
To demonstrate how water moves through the soil

## Materials

food coloring
slice of bread
spray bottle of water
plastic tarps or outside area
science journal

## Background

Groundwater is one of Earth's most valuable natural resources. More water is stored beneath the surface of the Earth than in rivers, streams, and lakes. The water stored in the pores, cracks, and openings of rock material found below the surface and between the particles of soil is groundwater. Scientists use the word aquifer to describe the layer of permeable rock that has connecting pores and transmits water freely (water-bearing rock). Gravity and the weight of the rocks and soil above the water level cause the water to seep downward toward the areas of least resistance.



## Procedure

1. In an open outside area or over a tarp, hold a slice of bread (which represents the soil) vertically.
2. Add a drop of food coloring to the top crust edge of the bread.
3. Spray the water (rain) on the food coloring.
4. Allow drainage to seep through the crust into the bread.
5. Observe and record your observations in your science journal.
6. Illustrate your observations.

## Conclusion

1. How did the water move through the soil (bread)?
2. What can you learn about groundwater from doing this experiment?
3. Why is groundwater an important resource?
4. What human factors might affect Earth's groundwater?

## Extension

Place sand, gravel, and clay in separate clear containers. Look closely at each container with a hand-held magnifying lens. Pour water into each container. Observe the flow of the water through each material. Record your results.

# Edible Aquifers

## Purpose

To learn about the geology of an aquifer and how pumping can cause a decline in the water table

## Materials

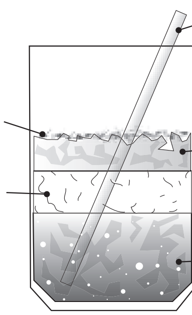
400 mL crushed ice
1 scoop vanilla ice cream
200 mL clear soda
30 mL colored cake decoration sprinkles
drinking straw
clear plastic cup
spoon
napkin
science journal

## Background

Aquifers come in all shapes and sizes. Water quality and water quantity vary from aquifer to aquifer. The age of groundwater within an aquifer also varies. An unconfined surface aquifer might hold water that is only a few days, weeks, or months old. On the other hand, a deep aquifer that is covered by impervious layers may contain water that is hundreds or even thousands of years old. Some aquifers can yield millions of liters of water each day and maintain their level, while others are able to produce only small amounts of water.

## Procedure

1. Fill a clear plastic cup 1/3 full of crushed ice to represent the permeable rock found underground.
2. Add enough soda (which represents water in your aquifer) to just cover the ice.
3. Add a layer of ice cream to serve as the layer over the water-filled aquifer.
4. Add more crushed ice on top of the confining layer.
5. Sprinkle cake decorations over the top to create the porous top layer of soil.
6. Using your straw, drill a well into the center of the aquifer.
7. Slowly begin to pump the well by sucking on the straw. Observe the decline in the water table.
8. Record your observations in your science journal.
9. Now try to recharge your aquifer by making it rain (slowly add more soda).
10. Observe and record your observations.
11. At the direction of your teacher, drain your aquifer dry and enjoy!




## Conclusion

1. What purpose does a confining layer serve in an aquifer?
2. In what ways could an aquifer be recharged?
3. What might happen to an aquifer that was used but not recharged?

## Extension

Poke holes in the ice cream layer and add 2–3 drops of food coloring to the top of the aquifer. Notice what happens as the contaminant seeps through the soil and the top layer. How does it affect the water in the aquifer? What happens to the contamination when water is pumped out through the well? Keep in mind that the same thing happens when contaminants are spilled on the Earth's surface.

# Answer Key

## Around and Around It Goes

1. Answers will vary but might include that they all visited the same places—just in a different order; there were more chances to evaporate than anything else.
2. Situations may not always be obvious. Encourage discussion.
3. Rivers, puddles, saltwater lakes and inland seas, reservoirs, glaciers, soil, and so on.
4. The water cycle is powered by the energy from the Sun that controls temperature and allows evaporation. Gravity is also a driving force in the water cycle. Geologic features, such as mountains, valleys, hills, and the general contour of the land play important roles in the movement of water through the water cycle as well. Finally, the chemical and physical properties of water itself enable the water to move through the hydrological cycle. Cohesion, surface tension, and the ability of water to exist in all three natural states play important roles in this dynamic cycle.
5. If all water remained in the oceans, life on Earth, as we know it, would cease to exist. All living things, both plant and animal, depend on water for survival. If no evaporation occurred, no precipitation would fall. Without rain, the plants would soon die. People would have no fresh drinking water, and the shape of the land would change dramatically without rivers, lakes, and streams.
6. The tree house detectives need to understand where our water comes from, that it is a limited resource, and that water moves in a dynamic cycle as a solid, a liquid, or a gas before they can determine what happened to the aquifer.

## A Cycling We Will Go

1. Evaporation is the process by which liquid water is changed into water vapor, a gas. This process occurs through the application of heat energy during the water cycle. Condensation is the cooling of water vapor, or removal of heat energy, which allows it to become a liquid. (Dew is an example of condensation in the water cycle.) Precipitation occurs when water falls from the atmosphere to the Earth as rain, sleet, snow, or hail.
2. The water evaporated from the plastic bag into the air. The air inside the bag also contains vapor. Some students may have difficulty understanding how water could leave the plastic bag. A simple demonstration can help clarify that plastic is semipermeable. Put a couple of drops of vanilla extract inside a balloon. Blow up the balloon and tie the end. The balloon holds the air, but the smell of the vanilla will escape from the balloon. This process is known as osmosis.
3. Eventually, all the water would evaporate from the bag, leaving nothing behind. Conducting this same activity in a sealed glass jar, however, will allow you to see a long-term water cycle. It is this principle that makes bottle terrariums popular.

## Cave-Cicles

1. The Epsom salts crystals were dissolved in the water, making a solution. As the water was absorbed into the cotton string, it traveled along the string to its lowest point. As the water evaporated into the air, the Epsom salt crystals were left behind.
2. In a cave, the limestone or dolomite is dissolved by groundwater that has mixed with carbon dioxide from the air to form a weak acid. This dissolved mineral drips into the cave. When the carbon dioxide is given off and the water begins to evaporate, the water no longer carries the minerals, and they are deposited in the shape of tiny crystals. These crystals are known as calcite, or cave onyx. Many different types of formations may occur, but the most recognizable are the stalactites, which hang from the ceiling, and stalagmites, which are formed when the supersaturated solution drips from the ceiling onto the floor of the cave before evaporating. This process is very slow, and it may take thousands and even millions of years for these formations to grow a few centimeters.

# Answer Key (continued)

## Caving Caverns

1. The sugar cubes inside the ball of clay dissolved as water made contact with the sugar.
2. Both the sugar and the limestone will dissolve in water. Water forms a solution with the sugar. A solution is a type of mixture in which one substance is evenly mixed with another. When water is added to the sugar, the taste of the water changes and the sugar becomes invisible, but the chemical makeup of each substance remains unchanged. Similarly, when water that has absorbed carbon dioxide passes through limestone (calcium carbonate), it dissolves the limestone. The water then carries away the solution of minerals, redepositing the calcite crystals in a variety of shapes as the water evaporates.
3. The process of forming caves in soluble rock is very slow. As a solution of water and carbon dioxide seeps through the cracks and crevices, it dissolves the soluble rock and forms cavities and channels as it moves downward and laterally. After thousands of years in the solution, underground rooms and chambers can be formed.

## Water, Water, Everywhere

1. Our drinking water comes from the freshwater found on Earth. However, freshwater makes up only 3% of the Earth's water supply. Of that 3%, 77% is found in glacial ice caps, 22% in groundwater, and the remaining 1% in lakes, rivers, and the atmosphere. Surface water (lakes, rivers, reservoirs) and groundwater are the primary sources for drinking water, regardless of where you live.
2. We cannot use most of the water on Earth because 97% of it is salty ocean water. To make freshwater from saltwater, desalinization or distillation must occur, and it is a complicated process. With most of the freshwater on Earth locked into glaciers, ice caps, or as water vapor in the atmosphere, there is very little water that is accessible for human use.
3. No, water is not a renewable resource. However, water is a reusable resource because it can be used over and over, but the amount of water on the Earth is limited.
4. It is important that we protect both the quantity and the quality of our planet's water supply because all living things on Earth depend on it. Overuse and pollution can greatly diminish the available supply of potable, or usable water, and new water sources cannot be created, so we must learn to manage the water we already have on Earth.

## Seepy Sandwich

1. As the water seeped through the bread, it branched out, moving in different directions in a general downward pattern.
2. Water seeps downward into the zone of saturation, an underground area in which every available space is filled with water. The size of the soil particle or grain determines the rate and path the water will take. The larger particle size provides more air space between particles through which water can flow. Watching the water seep through the bread makes it possible to see how the water branches out, seeking the available spaces to fill.
3. Much of our usable water on the planet (approximately 22%) is stored as groundwater. Almost half the people in the United States use groundwater as their primary water source.
4. Answers will vary but might include that overuse and pollution are two major human factors that affect groundwater.

## Edible Aquifers

1. The confining layer in an aquifer is the impermeable layer of rock or clay that holds the water in the space above and below it. When the confining layer is the top layer, it forms a lid on the aquifer. The water inside the aquifer is then pressurized. If it is tapped by a well, it is forced upward and is known as an artesian well.
2. Aquifers are recharged by any water source that seeps into the ground. Precipitation, such as rain and snow, river runoff, irrigation, and discharge from households or industry are all viable recharge sources.
3. Continued and expanded use from an aquifer, especially shallow aquifers, will use up the contained water. If no recharge takes place, the aquifer could dry up or water levels could fall below a point where it is possible to reach them.

# Answer Key (concluded)

## On the Web

### Spelunking

1. Spelunkers are aware of the fragile nature of a cave and that the formations before them took millions of years to appear as they do at that moment. Even the touch of a hand on a growing cave formation can cause permanent damage because the oils from human hands leave a film that prevents the new calcite crystals from adhering to the existing crystals.
2. Answers will vary.

### Tree-mendous Transpiration

1. About 90% of the water that is taken from the soil by plant roots is reintroduced into the water cycle through the process of transpiration. Plants take water out of the soil and, in turn, use the water for growth, photosynthesis, and reproduction. The water is lost through the stomata, or openings on the leaves and evaporates into the air.
2. Water and minerals are drawn up through the roots of the plant, partly by a process called capillary action. Capillary action occurs when water molecules in a thin tube are more attracted to the surface they travel along than to each other or when they are pulled down by gravity. A plant contains tiny capillaries, or vessels, which allow the water to travel through the plant to the leaves. Transpiration "pull" also helps draw water through the vascular system. Transpiration pull is the pulling of water up into the leaf to replace the water that is lost through transpiration or used by photosynthesis.
3. All but a very small amount of the water that is lost through the leaves evaporates into the air. Some of the water that is lost through the leaves may drip onto the ground and be absorbed or used as drinking water by small insects, birds, or animals.

### Sing a Song of Water

1. Answers will vary. Students' songs should explain components of the water cycle.

### What Is Water Anyway?

1. Unlike most other matter, water is less dense in its solid state than in its liquid state, so ice floats instead of sinking. This property permits life to develop in polar and subpolar regions and allows life to continue living below the surface. If ice were denser than water, it would sink, and more ice would form on top of it. As a result, in the many areas where the temperature drops below the freezing point, life would be trapped in the ice.
2. The arrangement of the atoms in some molecules determines whether the molecule is polar or nonpolar. If the molecule has a positive electrical charge on one end and a negative charge on the other end, the molecule is called a polar molecule, meaning that it has electrical poles. The polarity of molecules determines whether or not they will form a solution with other molecules. The rule for determining whether a mixture becomes a solution can be explained this way: polar molecules will mix with each other to form solutions and nonpolar molecules will do the same, but a polar and nonpolar combination will not form a solution. Water is a polar molecule (with a positive and negative end), and oil is a nonpolar molecule. Thus, they will not form a solution.
3. A drop of water is small, but it is made of even smaller parts called molecules. Water molecules have bonds that hold them together. At the surface of the water, the molecules hold on to each other even more tightly because there are no molecules pulling on them from the air above. As the molecules on the surface stick together, they form an invisible "skin" called surface tension.
4. Soap molecules are attracted to both water and oil. One end of the soap molecule sticks to oil; the other end sticks to water. The soap breaks up the surface tension and keeps the oil drops mixed with the water.

The NASA SCI Files™
The Case of the
Wacky Water Cycle

# Segment 2

The tree house detectives continue their search for the cause of the large drop in the local water table. They visit Indian Wells Elementary School in Indian Wells, Arizona to learn more about permeability and to find out how water travels through soil to become groundwater. R.J. decides to visit Dr. Hoke, a meteorologist with the National Oceanic and Atmospheric Administration (NOAA) to discuss how forecasters predict weather and rainfall. Meanwhile, the tree house detectives contact Corinne, a member of the NASA SCI Files™ Kids Club in Arizona, to meet with Dr. D at the Petrified Forest to learn more about climate. Dr. D explains that climate can change over time, and the detectives begin to wonder if an unusual climatic event is happening to cause a drought in their area.

# Objectives

Students will

- calculate the permeability rate of soils.
- make a model of a soil profile.
- understand how thunderstorms affect the water cycle.
- measure the amount of rainfall in an area.
- interpret weather maps.
- investigate folklore and customs related to rain.
- simulate how living things become petrified.
- explain the factors that are related to climate.

# Vocabulary

**climate** – the average weather conditions of a particular place or region over a period of years

**divining rod** – a forked rod believed to reveal the presence of water or minerals by dipping downward when held over a vein

**forecasting** – to calculate or predict weather conditions that are likely to happen in the days ahead by study and examination of data

**permeability** – the rate at which a liquid or gases are able to pass through materials such as soil

**petrify** – the process of turning something organic, or once living, into stone

**soil profile** – a vertical section of soil layers (horizons)

**topsoil** – the rich soil material found on the surface of the Earth

**weather** – the state of the atmosphere in regard to temperature, wind, pressure, precipitation, and humidity at a particular place and time

# Video Component

## Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

## Before Viewing

1. Prior to viewing Segment 2 of *The Case of the Wacky Water Cycle*, discuss the previous segment to review the problem and reaffirm what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site in the educator area under the "Tools" section. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 1 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 1. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Focus Questions—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.
5. What's Up? Questions—Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. The questions can be printed from the web site ahead of time for students to copy into their science journals.

## View Segment 2 on the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

## After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about the water cycle, soil permeability, and how weather affects the water cycle.
4. Organize the information and determine if any of the students' questions from Segment 1 and 2 were answered.
5. Decide what additional information is needed for the tree house detectives to determine what may have caused a significant drop in the water level. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
6. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
7. For related activities from previous programs, go to the NASA SCI Files™ web site **http://scifiles.larc.nasa.gov** and download the Educator Guide for *The Case of the Phenomenal Weather*. Also visit the "Educator Area" of the web site and click on "Activities/Worksheets" in the menu bar at the top. Scroll down to "2001–2002 Season" and click on *The Case of the Phenomenal Weather*.
   a. In the educator guide you will find
      a. Segment 1—*Particular Particles and It's Time To Get Cirrus with Clouds*
      b. Segment 2—*Vaporizing Vapor and Humble Humidity*
      c. Segment 3—*The Probability Factor and Around and Around It Goes*
   b. In the "Activities/ Worksheet" Section you will find
      1. *Storm Tracking Log*
      2. *Weather Status Report – Shuttle Launch*
8. If time did not permit you to begin the web activity at the conclusion of Segment 1, refer to number 6 under "After Viewing" (page 16 ) and begin the Problem-Based Learning activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, Problem-Based Learning activity:
   - **Research Rack**–books, internet sites, and research tools
   - **Problem-Solving Tools**–tools and strategies to help guide the problem-solving process
   - **Dr. D's Lab**–interactive activities and simulations
   - **Media Zone**–interviews with experts from this segment
   - **Expert's Corner**–listing of Ask-An-Expert sites and biographies of experts featured in the broadcast
9. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the *PBL Facilitator Prompting Questions* instructional tool found in the Educator Area of the web site.
10. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. For more assessment ideas and tools, visit the Educator area and click on "Instructional Tools" in the menu bar.

### Careers

climatologist
hydrometeorologist
meteorological technician
watershed manager

# Resources

## Books

Aardema, Verna: *Bringing Rain to the Kapiti Plain*. Penguin USA, 1983, ISBN: 014054612.

Barrett, Judith: *Cloudy with a Chance of Meatballs*. Simon and Schuster, 1982, ISBN: 0689707495.

Bird, E.J.: *The Blizzard of 1896*. Lerner Publishing Group, 1990, ISBN: 0876146515.

Diamond, Lynnell: *Let's Discover Petrified Forest National Park: A Children's Activity Book*. Mountaineers Books, 1991, ISBN: 0898862868.

Fleischman, Sid: *McBroom, the Rainmaker*. Penguin Putnam, 1999, ISBN: 084317496X.

Gibbons, Gail: *Weather Forecasting*. Simon and Schuster, 1993, ISBN: 0689716834.

Ketteman, Helen: *The Christmas Blizzard.* Scholastic, Inc., 1995, ISBN: 0590458787.

Ketteman, Helen: *Heat Wave*. Walker and Company, 2000, ISBN: 0802775772.

Peterson, David A.: *Petrified Forest National Park*. Scholastic Library, 1997, ISBN: 0516261118.

Tomecek, Steve: *Dirt*. National Geographic, 2002, ISBN: 0792282043.

Trueit, Trudi Strain: *Rain, Hail, and Snow.* Scholastic Library, 2002, ISBN: 053111970X.

White, Nancy: *Magic School Kicks up a Storm: A Book About Weather.* Scholastic, Inc., 2000, ISBN: 0439102758.

## Web Sites

### How Much Soil Is There?

Follow this interactive demonstration to learn how much soil can be found on the Earth. You may be surprised!
*http://ltpwww.gsfc.nasa.gov/globe/app_soil/hmsoil.htm*

### What Is the Shape of a Raindrop?

Visit this web site to find out how raindrops are really shaped.
*http://www.ems.psu.edu/~fraser/Bad/BadRain.html*

### Petrified Forest National Park

A wonderful National Park Service site where you can learn about the history and geology of the Petrified Forest in Arizona and much more!
*http://www.petrified.forest.national-park.com/*

### What Is the Petrified Forest National Park?

Find out why the Petrified Forest of Arizona is so unique. Learn about the geologic history and current events at the Park. View cartoon images to learn how wood became petrified.
*http://www.geo.arizona.edu/geos256/azgeology/pwood/parkintro.html*

### Interactive Weather Maps

On this web site, just type in your zip code to learn about the weather in your area. View weather maps in motion from the National Weather Service.
*http://www.weather.com*

### Info Please–Average Rainfall for US Cities

Find the average temperature and precipitation results for cities around the United States.
*http://www.infoplease.com/ipa/A0762183.html*

### State Soils

Learn about your state soil and its soil profile.
*http://soils.usda.gov/gallery/state_soils/*

### All About Snow

Learn about snow facts, snow science, and snow blizzards in this web site sponsored by the Colorado Climate Center and NOAA.
*http://nsidc.org/snow/index.html*

# Activities and Worksheets

In the Guide



On the Web

**A Hole in One**
Calculate the permeability of the soil in your own backyard.

**Gauging Rainfall**
Build your own rain gauge and compare your rainfall measurements to those recorded by the National Weather Service.

**Stately Soils**
Learn about your state soil and compare its soil profile to other states' soils.

# The Ability of Permeability

## Purpose

To investigate how quickly water moves through various materials

## Teacher Prep

For each group, prepare a 2-L bottle by using a marker to draw a cutting line around the middle of the bottle. With a sharp knife or scissors, cut the bottle at the cutting line.

## Teacher Note

If a beaker is not available, use measuring cups or create your own from paper cups

## Materials

prepared 2-L bottle
1050 mL of sand
1050 mL of topsoil
1050 mL of gravel
3 pieces of gauze 5 cm x 5 cm
2 rubber bands
watch or stopwatch
9 coffee filters
beaker
marker
science journal
paper towels

## Procedure

1. Place a piece of gauze over the spout of the bottle. (Cap should be removed.)
2. Use a rubber band to hold the gauze in place.
3. Measure 50 mL of water into a beaker and pour it into the bottom of the 2-L bottle.
4. On the outside of the bottle, use a marker to mark the level of water.
5. Empty the water out of the bottle.
6. Place the top of the bottle into the bottom. See diagram 1.
7. Observe the sand, gravel, and topsoil. Write your observations in your science journal.
8. Predict which material will allow water to pass through the quickest and which one will be the slowest. Record your predictions below.
9. Measure 350 mL of gravel and pour it into the top of the bottle.
10. Place a coffee filter on top of the gravel. See diagram 2.
11. Fill the beaker with 250 mL of water.
12. Set the stopwatch to begin timing when you start pouring the water into the bottle.
13. Quickly pour the water into the bottle, being careful not to splash the water out.
14. When the water level reaches the 50-mL mark, stop the stopwatch and record the time in the Data Chart (p. 39).
15. Empty the bottle of both water and gravel. Use a paper towel to clean the bottle for the next experiment.
16. Conduct two more trials for gravel by repeating steps 9–15.
17. Conduct three trials for sand by repeating steps 1 and 2 and steps 9–15.
18. Conduct three trials for topsoil by repeating steps 1 and 2 and steps 9–15.
19. Find the average time for each material and record.
20. Share your average times for each of the three materials with the class and create a class chart.
21. Find the class average time for each material.

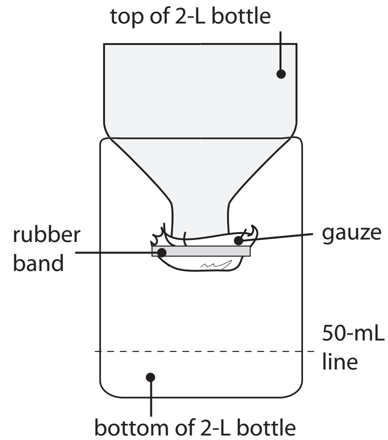



**Diagram 1**

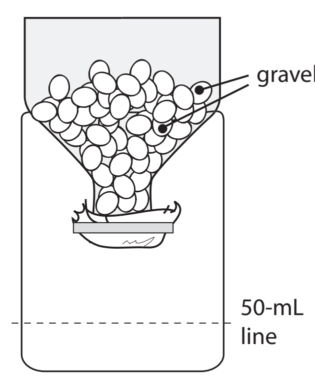



**Diagram 2**

# The Ability of Permeability (concluded)

**Predictions:** **Quickest:** ______________________ **Slowest:** ______________________

**Data Chart**

| Material | Trial 1 | Trial 2 | Trial 3 | Average |
|---|---|---|---|---|
| Gravel | | | | |
| Sand | | | | |
| Topsoil | | | | |

## Conclusion

1. Compare all three of your trials for gravel. Did you have about the same time for each trial? Why or why not? How about the sand? Topsoil?
2. Did other groups have similar times for each trial as your group did? Why or why not?
3. Which material allowed the water to pass through the quickest? Why?
4. Which material allowed the water to pass through the slowest? Why?
5. Did your predictions match your outcomes? Why or why not?
6. Which material is the most permeable?

# A Thunderstorming We Will Go!

## Problem

To simulate a thunderstorm through visual imagery and generate precipitation maps

## Background

Precipitation is monitored through a network of recording stations. A record of rainfall measurements helps watershed managers predict possible water shortages. If there is a chance the water table may be depleted, managers will need to implement water conservation strategies.

## Materials

masking tape
20 sheets of 1-cm square grid paper
scissors
basket or paper bag
meter stick
science journal

## Teacher Prep

1. Use masking tape to create a grid of 1-m squares. The grid should be large enough for each student to have a square.
2. Optional: This activity can be performed with the students standing in the square, but they can also sit in a chair within their square.
3. Have students cut apart the 1-cm square grid paper and place the squares of paper in a paper bag or basket. One sheet of 1-cm square paper for each student should be sufficient. Note: If 1-cm square paper is not available, have students make their own by using a metric ruler and notebook paper.
4. Discuss thunderstorms and create a list of the sights and sounds that are seen and heard during a storm.
5. Choose one student (rainmaker) to hold the bag of paper squares and stand in the center of the grid to disperse the rainfall (small squares of paper) on cue.
6. Explain that when you stand in front of or point to a row of students, they should imitate your motions continuously until told what the next motion is.
7. Start with a row on one end and begin with the first motion listed below.
8. Continue the motion as you stand in front of or point to each row down the line.
9. Return to the first group and start the second motion. This rhythmic motion will create a crescendo as the sounds being produced move from one end to the other.
10. Periodically, cue the rainmaker to make rain.

**Motions**

- Rub your hands together.
- Snap your fingers.
- Clap your hands together in an irregular cadence.
- Slap your hands on your legs.
- Optional: At this time, a student could flick a light switch on and off to simulate lightning while another student beats a drum to symbolize thunder.
- Stomp your feet.
- Slap your hands on your legs and stomp your feet (represents the height of the storm).
- Stomp your feet.
- Slap your hands on your legs.
- Clap your hands together in an irregular cadence.
- Snap your fingers.
- Rub your hands together.
- Open palms (quietly).

# A Thunderstorming We Will Go! (concluded)

## Student Procedure

1. Discuss thunderstorms and brainstorm a list of sights and sounds that are seen and heard during a thunderstorm.
2. Choose a square and stand in the center of it. This square represents one recording station.
3. As the group leader performs a motion in front of your row, copy that motion and continue the motion until given a new one.
4. If you are the rainmaker, you will need to stand in the center of the grid and be responsible for making it rain on cue by throwing a small handful of the squares of paper into the air.
5. When the storm has finished and everyone is quiet, collect all the rain squares inside your square of the grid. (This activity is not a contest to see who can collect the most. Rain will have fallen in different amounts in the different areas.)
6. Calculate the amount of precipitation for your station (square) by counting each piece of paper collected as a mm.
7. In your science journal, record the amount of precipitation in cm for your station. Remember that 10 mm make 1 cm.
8. Create a class chart of all monitoring stations and the amount of "rain" collected at each station.
9. In your science journal or in a class chart, draw a grid of the monitoring stations.
10. Record the precipitation calculated at each station.
11. Locate the station that received the most precipitation and mark it with a large "X".
12. Determine the areas that received about the same amounts of precipitation. For example, find every place that got between 2 and 2.5 cm of rainfall.
13. Draw a line to connect these stations of equal precipitation. They should form circles.
14. These circles are called isohyetal lines, and they indicate that every point along the line received the same amount of precipitation.

## Conclusions

1. What information can a meteorologist gain from looking at a map with isohyetal lines?
2. How might a hydrologist use the data from a weather map?
3. Why is it important to have local weather stations collecting weather data?
4. Why is NASA interested in studying thunderstorms?

## Extension

1. Convert the precipitation amounts on the map to snow depth: 2.5 cm of rain is equal to 25 cm of snow.
2. Create a wild and crazy weather report. For fun, give your report from the perspective of a trout, a tree, a fox, or a bird. What would they say about the storm? What would they tell their wild friends to do?
3. Practice presenting your weather report to an audience or videotape it.

# It's Raining Rainsticks

## Problem

- To learn about weather customs and folklore
- To make a rainstick

## Background

All cultures throughout history have been dependent on rain for an ample food supply. Without a sufficient amount of food, the culture would not survive. Rain was and is an important part of every culture, and droughts were and are serious business. Many cultures developed their own ways to welcome and celebrate the coming of rain, and since the earliest times various cultures have practiced an assortment of rainmaking rituals. The rainstick is one such ritual. Rainsticks were probably made originally from a naturally occurring plant that has internal fibers and mature seeds. When the ends were sealed off, the stick was tipped over so the seeds would bounce around inside, creating a sound like falling rain.

## Materials

one cardboard tube
two plastic cups with the bottoms cut out
a selection of seeds, beads, or other small items (called fill)
glue (wood glue works the best)
tape measure
pencil
masking tape
scissors
nail clippers
compass
toothpicks
paper
markers, paint, feathers, yarn, or other items to decorate your rainstick

## Procedure

1. Use a pencil to mark dots 5 cm apart on all the sides of the cardboard tube.
2. With adult supervision, carefully use the sharp end of a compass to poke holes through the dots on the cardboard tube, being careful not to press too hard and cause the tube to collapse. See diagram 1.
3. Place the toothpicks in the holes so that a small piece of each end of a toothpick is sticking out. To create a variety of sounds, insert the toothpicks into the tube at different lengths. See diagram 2.
4. Place a small amount of glue around the toothpick where it sticks out of the tube.
5. Set aside and let the glue dry completely.
6. Once dried, carefully use fingernail clippers to clip off any toothpicks that stick out from the tube.
7. Tape one of the cup bottoms to one end of the rainstick tube. See diagram 3.
8. Turn the tube upside down and pour in the fill.
9. Tape the other cup bottom to the open end of the tube.
10. Carefully turn your rainstick over and over, listening to the sounds it creates.
11. To decorate the outside of your rainstick, cut paper the same length as your tube and wrap the paper around the tube and glue it in place. Add glue drops and roll in colored sand or add paint, feathers, or other decorations of your choice.
12. Individually or with a partner, use books and/or the Internet to conduct research to learn more about rain customs and rainmaking. Look for scientific projects as well as cultural traditions.
13. Create an oral or written report and present the information to your class.

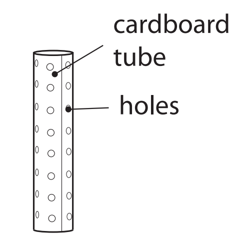



**Diagram 1**

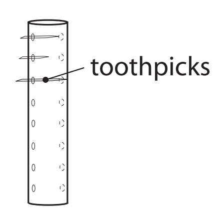



**Diagram 2**

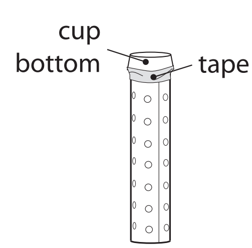



**Diagram 3**

# It's Raining Rainsticks (concluded)

## Conclusion

1. Why are people so concerned about the weather?
2. What are some of the customs related to rain?
3. What are some things scientists today do to try to make it rain?
4. Do you think rainmaking really works? Why or why not?

## Extension

1. Use the resource list or ask your librarian to help you find a weather book. Create an oral or written report on weather instruments, forecasting, weather fronts, violent storms, rain-making, or any other information you find interesting.
2. Use books or the Internet to learn about popular weather sayings, such as, "rain before seven, clear by eleven", or " when dew is on the grass, no rain will come to pass," and discover the origins of the sayings. Survey parents and other adults to learn what weather sayings they have heard. Create a weather "saying" book and illustrate each saying.
3. Once a list of weather sayings has been created, survey students in other classes and/or adults to find out if they know the meaning of each.

# Petrified Sponges

## Problem

To simulate how living things may become petrified

## Background

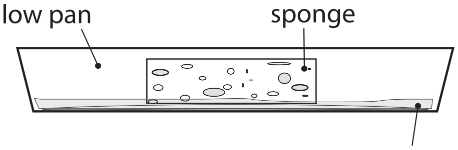
Petrified fossils are made when water saturated with dissolved minerals seeps into the pore spaces found in once-living things. The water dissolves the bone, wood, or other remains and the minerals in the water crystallize, replacing the original material. The English word, petrify, actually means " to convert into rock or stone."

### Materials

two sponges with large, visible holes
a shallow pan
small bowl
200 mL Epsom salts
200 mL warm water
food coloring
magnifying glass (optional)

## Procedure

1. Set one sponge aside as a control to be used for comparison.
2. Put the warm water in the small bowl and slowly stir in Epsom salts until the solution becomes super saturated and no more salts will dissolve.
3. To make the solution easier to see, add a few drops of food coloring.
4. Pour the Epsom salts solution into a shallow pan.
5. Place the other sponge (test sponge) into the pan and watch the water absorb and travel up through the holes in the sponge.




6. Set the pan with the sponge in a warm, dry place where it will not be disturbed for several days.
7. When the sponge is completely dry, feel it and compare it to the control sponge.
8. Carefully observe inside the holes. Use a magnifying glass to observe more closely. Record and illustrate your observations.

## Conclusion

1. Explain what happened to the sponge that was put into the Epsom salts solution?
2. Explain how the sponge is similar to the trees in the Arizona Petrified Forest?

## Extension

1. Use books and other resources to learn more about the Petrified Forest National Park in Arizona.
2. Learn about geologic time and create a geologic time line illustrating the way the Petrified Forest National Park may have looked through each time period, starting with the Triassic Period.
3. The petrified trees of the Petrified Forest National Park were conifers or cone-bearing trees. What kinds of conifers exist today? Make a list of the conifers in your area.
4. Like human beings, trees can become unhealthy and die. Observe nearby trees and note such things as broken branches, holes, unusual leaf color or shape, splits in the wood, or scars. Sketch the tree in your science journal. Develop a hypothesis about what might have happened to each tree. Write a story about the event and share your story with the class.

# Sunny Ray

## Purpose

To explore how the angle of the Sun's rays affects climate

## Background

The amount of energy coming from the Sun is nearly constant. However, because the Earth is shaped like a sphere, the Sun's rays strike the Earth's surface at different angles, creating variances in temperatures on Earth. The equator receives the most direct sunlight because the same number of sunlight rays are concentrated in smaller areas of direct exposure, causing warmer temperatures and climates. Latitudes near the poles always receive the Sun's rays at low angles, thus creating a cold climate. In the middle latitudes, like the United States, the angle of the Sun's rays varies from low in the winter to higher in the summer, causing seasonal temperature changes. Hawaii is the only state in the United States where the Sun's rays are directly overhead.

### Materials

flashlight
construction paper
graph paper
tape
colored pencils
metric ruler (optional)
science journal

## Procedure

1. Roll a piece of construction paper into a tube that is slightly larger than the glass of the flashlight. Use tape to hold the roll in place.
2. Using tape, attach the paper tube to the outer edge of the flashlight glass. See diagram 1.
3. Place a sheet of graph paper, which represents the Earth's surface, on a table or flat surface.
4. Point the flashlight and tube, which represent a ray from the Sun, straight down at a 90˚ angle about 15 cm above the paper. See diagram 2.
5. Draw a line around the outer edge of the lighted area on the paper.
6. Count and record in your science journal the number of lighted squares. Note: If half or more of a square is lighted, count it as one.
7. Repeat step 4, holding the flashlight at a 45˚ angle to the paper. Make sure that the height of the flashlight and tube remains 15 cm above the paper. See diagram 3.
8. Using a different color pencil, repeat steps 5–6.
9. Compare and discuss the results.
10. Write one paragraph explaining why there were more or fewer squares when the light was at a 45˚ angle.

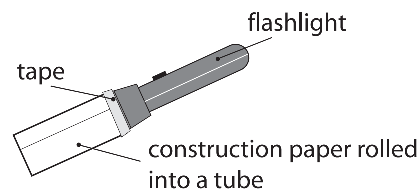



**Diagram 1**

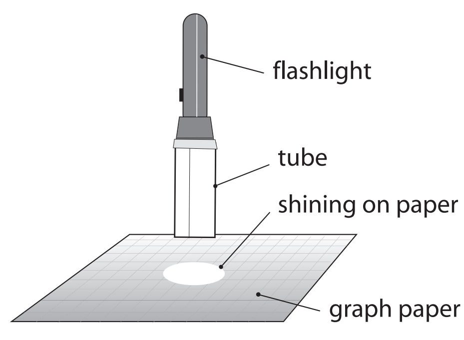



**Diagram 2**

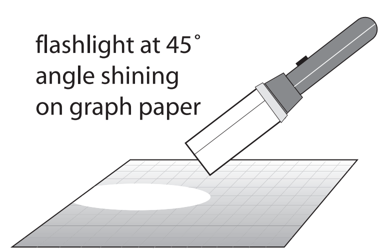



**Diagram 3**

# Sunny Ray (concluded)

## Conclusions

1. At what angle did you get the smallest area of light?
2. If you were able to measure the temperature of the two areas, which one do you think would be hotter?
3. The tree house detectives learned that an area's climate is determined by an area's weather over a long period of time. If the angle of the Sun can affect the temperature of an area on Earth, how can it affect climate?

## Extension

1. Using a globe and the Internet, look up the temperatures of cities around the world on any given day. Compare them to the temperature of your city. Mark the locations of the cities on a world map. What relationship, if any, is there between the temperatures of the cities and their latitudes? What other factors might influence temperature?
2. Read a book about climate or weather. Choose a book on weather or climate from the resource list or ask your librarian for assistance. Give an oral or written report about what you learned.

# Just an Ocean Away

## Problem

To explore how large bodies of water affect climate

## Background

Large bodies of water, such as oceans or very large lakes, such as the Great Lakes have a great affect on climate. Oceans warm and cool slowly; therefore, ocean temperatures in a region usually do not vary much throughout the year. Land, on the other hand, heats and cools quickly, and temperatures can vary greatly even between day and night.

### Materials

2 small, same size containers
sand or soil
water
lamp (heat lamp works best)
stopwatch or clock
2 metric rulers
2 thermometers
tape

## Procedure

1. Fill one container with room temperature water (about 20˚ C) until the water is 3 cm from the top rim.
2. Fill the other container with sand or soil 3 cm from the top rim.
3. Tape a ruler to the outside of each container.
4. Insert a thermometer in each container so that the bulb is 1 cm below the surface of the water and sand.
5. To keep the thermometers secure, tape each one to the ruler on its corresponding can. See diagram 1.
6. Read and record the temperature of both the water and the sand.
7. Place a heat lamp 30 cm from the containers so that the light from the lamp will shine directly on them. See diagram 2.
8. Turn the lamp on.
9. After 1 minute, read and record the temperature in each container.
10. Repeat step 9 at 3- and 5-minute intervals.
11. After the last reading, turn off the lamp.
12. Wait 4 minutes.
13. Read and record the temperatures of the sand and water.
14. Create a line graph to show your results.

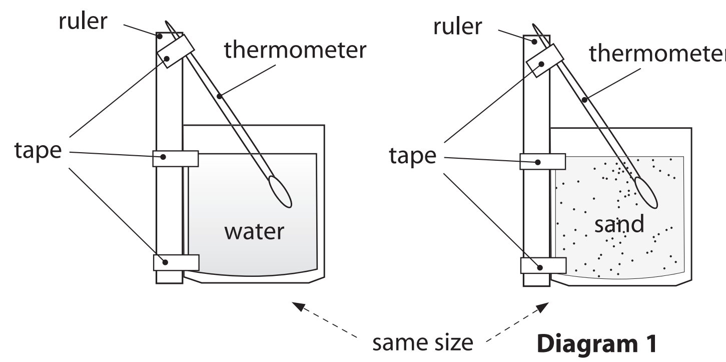



**Diagram 1**

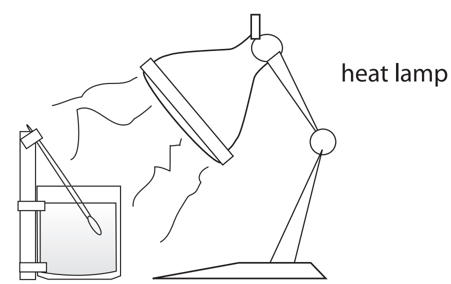



**Diagram 2**

# Just an Ocean Away (concluded)

| Substance | Starting Temp. | Lamp On 1 minute | Lamp On 3 minutes | Lamp On 5 minutes | Lamp Off Wait 4 minutes |
|---|---|---|---|---|---|
| *Sand* | | | | | |
| *Water* | | | | | |

*Draw graph below*

## Conclusion

1. When the light was turned on, which substance, sand or water, had the quickest change in temperature?
2. When the light was turned off, which substance had the slowest change in temperature?
3. After completing this experiment, what generalizations can you make about how land and water heat and cool?
4. How would the ability of water and land to heat and cool affect the temperature of nearby land areas?
5. The tree house detectives live in Virginia. What land or water features might affect the temperature in their area?
6. Are there any land or water features that might affect the temperature where you live? Explain why or why not?

## Extension

1. Climate is influenced by three main factors: latitude, land or water mass, and surface differences, such as mountains or valleys. Using clay or papier mâché, make a 3-D topographical map of your area. Examples of topographic maps may be found at *http://mcmcweb.er.usgs.gov/topomaps/* On your map, be sure to include any large bodies of water and determine the latitude of your city. In your science journal, discuss how these factors affect the climate in your area.
2. Find at least three other cities in the world that have similar latitudes as your city. Using the Internet or a newspaper, record, for one month, the daily temperatures of your city and each of the cities you chose. To record your findings in your science journal, create a chart. Graph your data. To compare each city's temperature, graph and analyze the data. In your group or class, discuss your findings and offer any explanation for what you found.

# Answer Key

### The Ability of Permeability

1. Answers will vary, but similar times should have been received for each gravel trial. The gravel in each trial is basically the same consistency and the time it took water to pass through it should not vary too much. Same for the sand and topsoil.
2. Other groups should have had similar times because they too were using the same gravel, sand, and topsoil mixture.
3. In most instances, the gravel allows the water to pass through the quickest because it has larger pore spaces between pieces of gravel.
4. This answer will vary, depending on the type of soil and topsoil used for your area.
5. Answers will vary.
6. The gravel is the most permeable.

### The Incredible Edible Soil Profile

1. The parent material determines the texture of a soil. As the soil breaks down, the amount of weathering also plays a role, but the type of rock from which the material is weathered determines whether it will be clay, sand, silt, or loam.
2. As the subsoil is exposed to weather, such as freeze-thaw cycles, rain, and wind, the pieces are broken down even further into smaller and finer particles. It is at this stage that horizons, or visible layers form. Topsoil, the uppermost layer, is formed as the soil continues to break down.
3. Besides being indicators of a healthy soil, earthworms and other organisms are important decomposers. They break up the dead plant material that is left in the soil, forming dark, rich topsoil. Some organisms take nitrogen from the air and make it available to plants for growth.
4. Because soil holds and absorbs water, provides nutrients for plants which use and store water, and helps regulate surface temperature, it plays an important role in the water cycle.

### A Thunderstorming We Will Go!

1. Isohyetal lines indicate patterns of precipitation that fall in nearly the same amounts over different areas.
2. A hydrologist will use this information to help determine water use regulations, predict crop success, and investigate groundwater recharge.
3. It is important to have local weather stations record rainfall and temperature because these weather phenomena can change very quickly in nearby geographic areas. People have reported seeing it rain in the front yard but not in the back yard. The more weather information you collect, the more precise the weather data you record, the more accurate is the forecast.
4. Although thunderstorms play a critical role in the water cycle, they can also cause problems for aircraft. NASA is studying thunderstorms to help make air travel safer.

### It's Raining Rainsticks

1. Weather affects both work and recreation in our lives every day. It influences what we eat, how we dress, what types of transportation we use, how we will work or play that day, and even the type of home in which we live. Predicting weather can make our lives more comfortable and safer.
2. Answers will vary.
3. Answers will vary, but students should have discovered information on cloud seeding.
4. Answers will vary.

### Petrified Sponges

1. The sponge in the Epsom salts solution hardened like stone.
2. The sponge absorbed the mineral saturated solution. As the water in the solution began to evaporate, the salts that were left behind began to crystallize. They hardened and the sponge, like the wood, became petrified, or turned to stone. In the petrified wood, however, the mineral crystals replace the original material as it rots away.

### Sunny Ray

1. The smallest area of light is recorded when the flashlight is held directly over the paper at a 90˚ angle.
2. Because the energy from the Sun remains constant, the temperature in the larger area would be lower than that in the smaller area because the Sun's rays must be distributed over a larger area.
3. The lower the angle of the Sun's rays, the more area is exposed to those rays. The temperature would therefore be cooler. Consider how the evening temperatures cool off when the Sun's rays are no longer directly overhead. The temperature of an area is affected by the Sun's angle and the temperature of an area is one factor that determines an area's climate. So the climate of a region is dependent on the angle of the Sun.

# Answer Key (concluded)

**Just an Ocean Away**

1. The container of sand had the fastest change in temperature.
2. The container of water had the slowest change in temperature.
3. Answers will vary but should include that land areas cool and heat more quickly than water areas.
4. Large bodies of water such as oceans help to create a more consistent temperature on nearby land. During the day in the summer, the water helps to make the land temperature cooler, while at night it helps to make it warmer. The differences in the temperatures between land and water also create land and sea breezes.
5. The Virginia shoreline is approximately 5,000 miles long and includes the four tidal rivers of Virginia (the Potomac, the Rappahannock, the York, and the James), the Chesapeake Bay, into which they drain, and the Atlantic Ocean.
6. Answers will vary.

## On the Web

**A Hole in One**

1. Once water has filled the air spaces between the soil particles the first time, the saturated soil allows water to flow through the soil more quickly. One of the physical properties of water is its ability to adhere to other materials. As water moves down through the soil, it adheres to soil particles and fills the spaces between the materials. Some of the water is trapped, so new water has fewer spaces to fill, allowing it to flow downward at a faster rate.
2. Perc tests determine how water will flow from household or industrial waste or where drainage/sewer systems should be placed.
3. The tree house detectives needed to understand how fast water moves through the soil so they could determine how groundwater supplies are recharged.

**Gauging Rainfall**

1. The amount of rainfall is one of the climate predictors for an area. Meteorologists use this information to help them determine what kinds of weather to expect in the future, to find weather patterns, and to make predictions about the effect of such weather on human populations.
2. The rainfall for a specific time period (e.g., monthly) is recorded for several years. The amounts are then averaged (the totals added and divided by the number of rainfalls) to find the average precipitation for that particular time period. Data may be collected for 20–30 years to determine weather averages.

**Stately Soils**

1. Answers will vary, but appropriate responses should be found on the web site.
2. Answers will vary.

The NASA SCI Files™
The Case of the
Wacky Water Cycle

# Segment 3

As Jacob continues searching for water with his divining rods, the tree house detectives seek assistance from Dr. Adamec at NASA's Goddard Space Flight Center. Dr. Adamac helps the detectives better understand weather and climate and introduces them to the concept of El Niño. Meanwhile, the detectives once more contact Corrine, a member of the NASA SCI Files™ Kids' Club, to meet with Dr. D at Hoover Dam in Arizona to learn more about alternative sources of water. Dr. D suggests that the tree house detectives contact Mr. Ken Herd at the new desalination plant in Tampa Bay, Florida. After some creative brainstorming, the detectives wade even deeper into their wacky water problem.

# Objectives

The students will

- demonstrate the movement of ocean currents.
- build a reservoir and water distribution system.
- identify the watershed that serves a local community.
- explain the process of desalination.
- build a solar water still.
- demonstrate the concept of parts per million.

# Vocabulary

**desalination** – the process of removing salts from saltwater to make freshwater

**El Niño** – the most powerful weather phenomenon on the Earth that alters the climate across more than half the planet; this recurring set of climate conditions is linked to unusually warm water in the central Pacific Ocean

**La Niña** – a recurring set of climate conditions linked with unusually cold water in the central Pacific Ocean

**osmosis** – the passage of material, such as a solvent, through a membrane, such as a plant or animal cell, that will not allow all kinds of molecules to pass

**NOAA** – National Oceanic and Atmospheric Administration; a federal agency that monitors weather in the United States

**reverse osmosis** – the mechanical process in which solutions are forced through semipermeable membranes under high pressure

**satellite** – a heavenly body orbiting another larger one; any object put into orbit around Earth or any other planet to relay signals or transmit scientific data

**semipermeable** – a membrane or tissue that allows some types of particles to pass through, but not others

**upwelling** – the rising to the surface of deeper, cooler layers of ocean water that are often rich in nourishing substances

**watershed** - the land area that drains into a particular lake, river, or ocean

# Video Component

## Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

## Before Viewing

1. Prior to viewing Segment 3 of *The Case of the Wacky Water Cycle*, discuss the previous segments to review the problem and assess what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 2. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Focus Questions — Print the questions from the Educator's Area of the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program so they will be able to answer the questions. An icon will appear when the answer is near.
5. What's Up? Questions — Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the Educator's Area of the web site ahead of time for students to copy into their science journals.

## View Segment 3 of the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

## After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about the water cycle, climate, and alternative sources of water. Organize the information, place it on the Problem Board, and determine if any of the students' questions from Segment 2 were answered.
4. Decide what additional information is needed for the tree house detectives to determine what may have caused a significant drop in the water level. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
6. For related activities from previous programs, download the Educator Guide for *The Case of the Phenomenal Weather*. Visit the home page and click on the fence post that says "Guides." Click on "2001–2002 Season". Scroll down and click on either the full guide or a segment of the guide for *The Case of the Phenomenal Weather*. In the guide you will find the following:

   a. **Segment 3** – 3-2-1 Blast Off!

   b. **Segment 4** – NASA Needs Help
7. If you did not have time to begin the web activity at the conclusion of Segments 1 or 2, refer to number 6 under "After Viewing" on page (16) and begin the Problem-Based Learning (PBL) activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, PBL activity:

   **Research Rack** — books, internet sites, and research tools

   **Problem-Solving Tools** — tools and strategies to help guide the problem-solving process

   **Dr. D's Lab** — interactive activities and simulations

   **Media Zone** — interviews with experts from this program

   **Expert's Corner** — listing of "Ask-An-Expert" sites and biographies of experts featured in the broadcast
8. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the PBL Facilitator Prompting Questions instructional tool found in the educator's area of the web site.
9. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. Visit the Research Rack in the tree house, the online PBL investigation main menu section, "Problem-Solving Tools," and the "Tools" section of the educator's area for more assessment ideas and tools.

### Careers

engineer
marine biologist
marine geologist
oceanographer
water treatment plant operator

# Resources

## Books

Arnold, Caroline: *El Niño*. Clarion Books, 1998, ISBN: 0395776023

Breen, Mark: *Kid's Book of Weather Forecasting*. Williamson Publishing, 2000, ISBN: 1885593392.

Locker, Thomas: *Where the River Begins*. Penguin Putnam, 1993, ISBN: 0140545956.

Niesen, Thomas M.: *Marine Biology Coloring Book.* Harperinformation, 2000, ISBN: 006273718X.

Rose, Sally: *El Niño and La Niña*. Simon & Schuster, 1999, ISBN: 0689820151.

Sayre, April Pulley: *El Niño and La Niña: Weather in the Headlines*. Millbrook Press, 2000, ISBN: 0761314059.

Seibert, Patricia: *Discovering El Niño: How Fable and Fact Together Help Explain the Weather.* Millbrook Press, 1999, ISBN: 0761312730.

Singer, Marilyn: *On the Same Day in March*. Harper Collins, 2000, ISBN: 0-06443528-8.

Trueit, Trudi Strain: *The Water Cycle*. Scholastic Library, 2002, ISBN: 0531119726.

Williams, Jack: *The Weather Book*. Random House, 1997, ISBN: 0679776656.

## Web Sites

**EPA—Surf Your Watershed**
Use this site to locate and learn about the watershed where you live. The site includes links to real time stream flow maps, fact sheets, and watershed quizzes.
*http://www.epa.gov/surf2*

**Dateline: El Niño**
Dateline: El Niño is an interdisciplinary weather lesson where students can take on the role of a reporter who must find out why the weather has been so strange in their area. Students visit other sites for graphics and real time data regarding this weather phenomenon.
*http://weathereye.kgan.com/expert/nino/index.html*

**NOVA—Water Temperature Graphics**
Watch the water temperature change week to week in this graphic from Nova.
*http://www.pbs.org/wgbh/nova/elnino/anatomy/warmwater.html*

**Visit to an Ocean Planet**
This web site includes extensive educational activities, in PDF format, provided by various educational organizations and educators as part of the Visit to an Ocean Planet CD-ROM. The free CD may be ordered from NASA.
*http://topex-www.jpl.nasa.gov/education/activities.html*

**NOAA—Climate Division Drought Graphics**
Use this web site to generate graphs to show temperature, precipitation, or drought indices for any region in the United States.
*http://lwf.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmgrg3.html*

**World Climates**
Look at different climates of the world. Use the Koeppen Classification System to determine how climates are defined. Maps included.
*http://www.blueplanetbiomes.org/climate.htm*

**Brookfield Zoo's Biome Game**
Play this exciting game, In Search of the Ways of Knowing Trail, to learn more about the biomes of Africa.
*http://www.brookfieldzoo.org/pagegen/wok/ways_index.html*

**NASA—Water Witching from Space**
Learn about NASA's Aqua satellite, which will provide crucial information about the water in the ground and the weather on the horizon.
*http://science.nasa.gov/headlines/y2001/ast23may_1.htm*

**NASA—Global Hydrology and Climate Center**
Check out lightning observations from space, learn about climate changes, or learn the effects of big cities on climate in this NASA sponsored web site.
*http://wwwghcc.msfc.nasa.gov/ghcc_home.html*

# Activities and Worksheets

# Going Up, Going Down

## Purpose

To demonstrate the movement of warm and cool ocean currents

## Materials

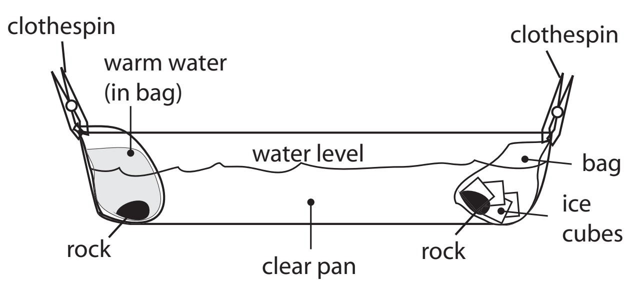
clear glass casserole dish
tap water
hot water
2 small waterproof zipper bags
2 clip clothespins or small clamps
2 different colors of food coloring
small rock
4–6 ice cubes
science journal

## Background

Thermohaline circulation is the name for currents that occur when colder, saltier water sinks and displaces water that is warmer and less dense. In a cycle known as the global conveyor belt, warm water from the equator flows toward the poles and begins to cool. In a few regions, such as the North Atlantic, cold, salty water can sink to the ocean floor. The water then travels in the deep ocean back towards the equator and begins to rise to replace the water that is being pushed away from the equator by normally strong winds. The cool water that rises to the surface is known as upwelling. This entire process, which may take a thousand years to complete, helps regulate the climate as heat is transported from the equator to the polar regions of the Earth. During a period of El Niño, these winds along the equator are weaker than usual and may actually blow in the opposite direction. Warm water begins to pile up along the nearby coasts. Where the ocean is warm, more clouds form and more rain falls. Weather patterns around the world are then affected by this change in ocean temperature. NASA collects satellite data to measure the sea surface and temperature and uses the data to make maps of the ocean. From these maps, scientists can monitor the speed and direction of ocean currents.

## Procedure

1. Fill the glass pan with tap water. Let the pan rest for a few minutes to let the water settle.
2. Place a rock in each of the plastic bags.
3. With adult supervision, fill the bag with hot water from the faucet and seal the bag.
4. Put the bag in one end of the glass pan and use the clothespin to clip the bag in place.
5. Fill the other bag with ice cubes and seal.
6. Put the ice bag in the pan opposite the warm water bag and use the other clothespin to clip the bag to the pan.
7. Carefully add four drops of food coloring to the water next to the ice cubes.
8. Now add four drops of a different food coloring to the water next to the bag of hot water.
9. Observe the food coloring for several minutes.
10. Record your observations and illustrate them in your science journal.
11. Gently blow across the top of the water surface.
12. Observe what happens and record your observations.
13. Blow across the top of the water from the other side.
14. Observe and record.



# Going Up, Going Down (concluded)

## Conclusion

1. Explain what happened to the water near the colder end of the pan?
2. Explain what happened to the water near the warmer end of the pan?
3. When you began to blow across the water, adding "wind power" to the water currents, how did they change?
4. What factors might change the flow of ocean currents?
5. How do changes in the ocean currents affect the Earth?

## Extension

1. Locate maps of ocean currents. On a blank world map, use red- and blue-colored pencils to mark the warm and cool currents. Include arrows to show direction. Notice the difference in current flow between the northern and southern hemisphere. Why do you think this difference occurs? To demonstrate this phenomenon, go to the NASA SCI Files™ web site. From the home page, click on the tree house and then on "Dr. D's Lab." In the lab, click on the 2001–2002 season. Click on *The Case of the Phenomenal Weather* and you will find the experiment, "Round and Round We Go". This experiment will help you learn more about the Coriolis effect.
2. Examine satellite image maps of ocean temperatures and make your own edible ocean map by using colored gelatin and lemon sherbet. For directions, visit http://spaceplace.nasa.gov/topex_make2.htm
3. Measure the temperature at the surface and bottom of the warm end of the pan as you repeat steps 2-14. Record the temperature as you make changes. Explain what is happening.

# Where the Water Sheds

## Problem

To become familiar with watersheds and to identify the watershed that serves the local community

### Materials

state road map
colored markers
Internet (optional)

## Background

Each small stream can have thousands of liters of water flow through it each day, and each stream is only one part of a river system. Just as a tree is a system of stems, twigs, branches, and a trunk, a river system also has many parts. Water runs off the ground into small streams. As the small streams merge, they form a larger body of water called a river. A watershed is the land area from which surface water runoff drains into a stream, lake, reservoir, or other body of water. Watersheds are also called drainage basins. Areas of higher elevation separate watersheds from each other. The Environmental Protection Agency (EPA) and the United States Geological Survey (USGS) monitor the water quality in the watersheds.

## Teacher Note

To create a set of reusable maps, laminate the maps and use washable markers. If a sufficient number of computers are not available for students to conduct the optional Internet search, then prior to conducting this activity (for 1–2 weeks) print off the data charts needed, make copies, and have students graph the data.

## Procedure

1. Locate your city or town on the road map.
2. Put a box around the name of the town.
3. Find the river on the map closest to your city.
4. Use a colored marker and trace the flow of the river from its origin. If your map is not large enough to include the river's origin, use the closest state boundary.
5. Use a different color marker to highlight any small creeks or streams that feed into the river along the way.
6. Color any lakes by using a third color.
7. By looking at the map, can you tell which way the water flows?
8. With a fourth colored marker, broadly circle the area around your markings but do not cross any other streams.
9. The area inside the circle is the watershed for your local area.
10. Optional: On the Internet, open the Environmental Protection Agency (EPA) web site, Surf Your Watershed. *http://www.epa.gov/surf2*
11. Click on "Locate Your Watershed."
12. Click on "Search by Map."
13. Find your state and click on the appropriate picture.
14. On the state map, click on your specific area.
15. Find the link for "Stream Flow" and click on it.
16. In your science journal, create a chart and record the date and time, stream stage in feet (ft), and the stream flow in feet per second (ft/sec).
17. Check and record the data for several days.
18. After one week, create a graph depicting your data.
19. Graph your findings at the end of two weeks and compare graphs.

# Where the Water Sheds (concluded)

## Conclusion

1. Why is it important to protect the water in an entire watershed?
2. How can understanding watersheds help geologists predict where water will flow?
3. What effects do people and animals have on a watershed?
4. How could a watershed change over time?
5. Based on the data you collected about stream stage and flow, what information can you learn about your watershed?

## Extensions

1. On a United States map, determine where the water from your watershed eventually ends up. Follow the path of the water downstream until you reach a gulf or ocean. Discuss how decisions made for a watershed in one area affect other parts of the country.
2. Compare the branching of your watershed to other branching networks, such as the human nervous system or the roots of a tree. How are these the same? Different?
3. Visit some of the other links on the Surf Your Watershed web site. Take the Watershed Quiz to test your knowledge about watersheds. Participate in the Watershed Patch Project *http://www.epa.gov/adopt/patch/certificates* and learn about things you can do to protect your watershed. Do a stream site survey or test a local stream for water quality.
4. Use the reference list to choose a story about a river. After you have read the story, write your own story about a river near where you live. How has the river changed over time?

# A "Reservoiring" We Will Go

## Purpose

- To illustrate how a reservoir works
- To build a model of a water delivery system

## Materials

clear plastic box
pebbles
soil
sand
leaves
spray bottle with water
large piece of paper
2 paper towel tubes
2 toilet tissue tubes
straws
toothpicks
wooden skewers
small milk carton
scissors
glue
metric ruler
markers
tape
Optional: toy houses (game pieces)

## Procedure

1. Line the bottom of the clear plastic box with small pebbles. Slope the pebbles so that they are higher on the sides (4–5 cm) and lower in the middle (1–2 cm). This middle area will become the reservoir.
2. Add a layer of sand, following the same sloping created in step 1.
3. Repeat step 2 with soil.
4. On top of the soil, place leaves around the outer edges. See diagram 1.
5. Using a spray bottle, carefully spray water on the four corners of the model until the soil mixture is saturated and the water has seeped through to the reservoir.
6. In your group, discuss how a reservoir is formed and write a brief paragraph describing the process.
7. On a flat surface, place the reservoir at one end of the large piece of paper or cardboard.
8. To create a water treatment plant, stand a small toilet tissue tube on end so as to trace its circumference on one side of the milk carton.
9. Use scissors to cut out the circle.
10. Repeat steps 8 and 9 on the opposite side of the milk carton. See diagram 2.
11. Connect the water treatment plant to the reservoir by using a small toilet tissue tube in each of the cutout holes. See diagram 3.
12. Brainstorm ideas on how a pipe system works to get water from the reservoir to the water treatment system and finally to the homes and businesses in a community. Remember that you have four different sizes of pipes to use in your pipe system.

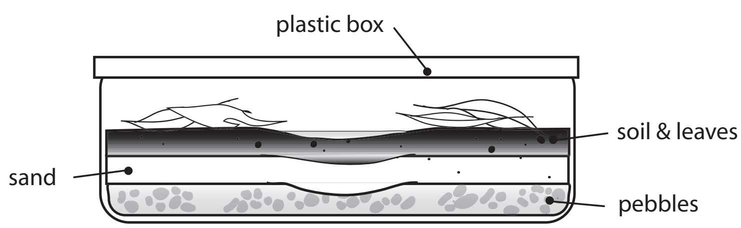



**Diagram 1**

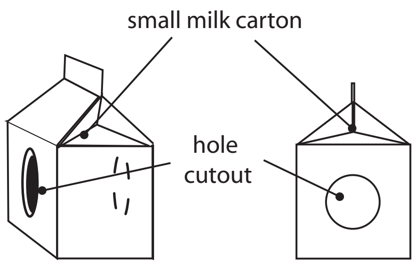



**Diagram 2**

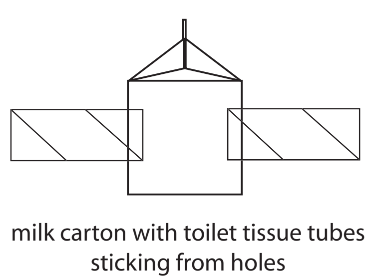



**Diagram 3**

# A "Reservoiring" We Will Go (concluded)

13. After reaching a consensus, draw a design for your pipe system in your science journal. Be sure to consider which size "pipe" should be used for each level of the pipe system and explain why.
14. Following your design, use cardboard tubes, straws, wooden skewers, and toothpicks to create your pipe system for a community of homes. If necessary, use scissors to cut pipes to length.
15. Use glue to secure the system together and in place.
16. Connect your system to the reservoir.
17. If using game pieces for houses, place them at the end of the pipe system for each branch or draw houses and businesses on the cardboard.
18. Discuss how water gets into the reservoir and then to your house. Trace its path and record in your science journal. Illustrate the path.

## Conclusion

1. What are sources of water for a reservoir?
2. How does water get into a reservoir?
3. In a real reservoir, what holds the water in?
4. In your pipe system, how did the size of the pipe get larger or smaller as it left the water treatment plant? Explain why.

## Extension

Conduct research on water towers and give a report on their importance to a water system. Add a water tower to your system.

# To Still Water

## Purpose

To understand how salt can be removed from saltwater

## Materials

clean, wide mouthed glass gallon jar with lid
small paper cup
35 mg salt
965 mL warm water
bowl
spoon

## Background

Ocean water can and is being desalinated. However, turning ocean water into freshwater can be expensive, up to ten times more than the cost of obtaining water the normal ways. The most expensive process used to convert saltwater into freshwater is distillation. During distillation, the saltwater is boiled, and as the water turns into steam and evaporates, it leaves the salt behind. As the steam is cooled, it condenses into relatively pure water. Saltwater can also be frozen. After it is frozen, the salt is separated from the water and the ice melts back into freshwater. Another method is to electronically separate the salt into positive and negative ions, which are then filtered out of the water as the ions pass through microscopic holes in special plastic sheets. Algae and some kinds of bacteria are also used to biologically absorb the salt, and a final way is reverse osmosis, a mechanical process that forces saltwater through semipermeable membranes under high pressure. In this process, the freshwater is squeezed out and the salts are left behind.

## Procedure

1. In a bowl, use a spoon to mix 35 mg of salt into the warm water. This mixture represents the ocean's saltwater.
2. Pour the solution into the paper cup. Do not over fill.
3. Place the jar lid upside down in full sunlight.
4. Set the cup of saltwater in the center of the large lid.
5. Place the jar carefully on the lid so the cup fits inside the jar. The jar should be level but does not need to be screwed onto the lid. See diagram 1.
6. Wait at least one hour.
7. Observe and record in your science journal what you see on the inside of the jar.
8. Carefully pick up the jar so as not to spill the saltwater.
9. Taste one of the water droplets that has fallen into the lid.

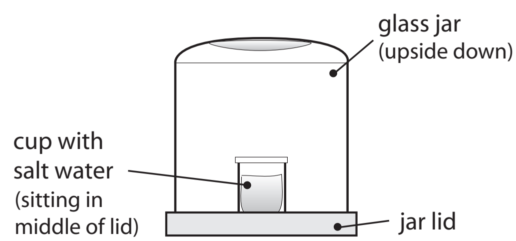



**Diagram 1**

## Conclusion

1. What causes the water droplets to form?
2. Is the water on the inside surface of the jar fresh or salty?
3. What causes this change to happen?
4. Why can't the tree house detectives make a solar still to solve their water problem?

## Extension

1. Conduct research and find other ways of removing salt from saltwater.
2. Pour saltwater through a series of coffee filters. **NOTE: DO NOT use a drip coffeemaker in this experiment, as it will ruin it**. Collect the water and filter it again. Is the water less salty than it was in the beginning? Set out the filters to dry. Examine them carefully after they have dried completely. What do you see?

# One in a Million

## Purpose

To understand the concept of parts per million

## Background

Water often contains various substances besides the water itself. Certain minerals, such as iron, chloride, and sodium may be in tap water in different concentrations. Some substances that are found in the water may be hazardous to human or animal life. Scientists conduct tests to look closely at the substances contained in water and determine whether the concentrations of these substances are at safe levels. The amount of a substance in water is often expressed in parts per million or p/m.

### Materials

7 small paper cups
metric measuring cup
metric measuring spoon
240 mL of mouthwash (choose one that is strongly colored and flavored)
1 liter (L) of tap water
cup for rinse water
marker
science journal

## Procedure

1. Use a marker to label each cup 1 through 7.
2. Place 150 mL of mouthwash in cup 1.
3. Remove 15 mL of mouthwash from cup 1 and put it in cup 2.
4. Rinse the measuring spoon with tap water.
5. Now add 135 mL of tap water to cup 2.
6. Stir thoroughly.
7. Repeat steps 3–6, taking from cup 2 and putting into cup 3.
8. Observe what happens to the solution's color as the mouthwash is diluted.
9. Make a hypothesis for when (which cup) you think the solution will be a clear color and record in your science journal.
10. Repeat steps 3–6, taking from cup 3 and putting into cup 4.
11. Repeat the dilution process until you have used all 7 cups.
12. Observe and record your observations, describing the color of each solution.
13. Observe and record your observations, describing the odor of each solution.
14. To make a chart showing the concentrations of the various cups in parts per million.
    a. Use cup 1 as 100% (mouthwash), or one million parts per million.
    b. Cup 2 is a 1 to 10 or 1/10 concentration, which means there are 100,000 parts per million.
    c. Cup 3 is one-tenth (1/10) the concentration of cup 2. It is 1/100 or 10,000 parts per million.
    d. Calculate the concentration of each of the other cups.
    e. Compare these concentrations to maximum allowable levels of some common minerals in drinking water:

| | |
|---|---|
| chloride | 250 p/m |
| sodium | 250 p/m |
| iron | 0.30 p/m |
| fluoride | 4.00 p/m |

## Conclusion

1. In which cups were you able to detect any color? Odor?
2. What is the concentration of mouthwash in the last cup?
3. Why is it important for scientists to measure the amount of a substance that is in our water?
4. Why is it important to learn about dilution and parts per million as they relate to the water cycle?
5. Is dilution an effective way to clean up pollution or to reduce harmful materials found in water? Why or why not?

# One in a Million (concluded)

## Extension

1. Use a pH kit to determine the pH of water samples from various sources and compare. Water that has a high percentage of dissolved mineral salts is called hard water. Hard water has a pH greater than 7. Hard water may appear perfectly clear, but the dissolved salts make it difficult to get soapsuds. The water may then leave behind a hard, crusty build-up when the water evaporates. Add dish or laundry soap to each sample. Shake well and observe how the sudsy action relates to the pH level. Record your observations.

## Challenge

You have a 1-liter (L) bottle with a small amount of contaminating chemical. You want to rinse out the bottle and you only have 1 L of clean water. Should you pour in all the water at once and dump it out? Should you pour in a small portion of the water and dump it out, repeating the process several times? Choose one and explain your choice.

# Answer Key

**Going Up, Going Down**

1. The water at the cold end of the pan sinks to the bottom and begins moving across the pan towards the warmer end.
2. The water at the warmer end of the pan immediately rises to the top and begins traveling across the top of the water toward the cooler end.
3. By blowing on the water, you caused the warm water to cool faster. It began to sink below the surface. The wind you created also helped push the water along.
4. Temperature and winds are important factors for ocean currents.
5. Ocean temperatures affect the temperature of nearby landmasses and the amounts of rainfall that can be expected over the land.

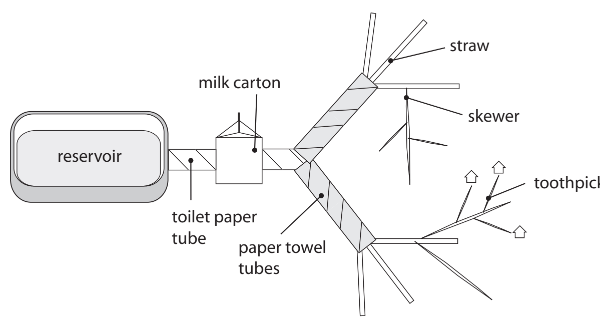
**Which Watershed Are You In?**

**Note:** *Students should be able to determine the direction of flow of the river in their watershed by knowing that smaller streams flow into larger streams.*

1. Answers will vary but should include that although areas of higher elevation may separate watersheds, all watersheds eventually drain into waterways that connect and drain into the oceans of the world. Pollutants in any of these waterways are then carried with the water to the ocean.
2. There are many benefits to understanding the flow of water in a watershed. For example, scientists can learn about water flow by studying the shape of the landscape and the stream flow amounts where the watershed drains. They can use this information to help control floodwaters and store water in reservoirs.
3. The effects are many, but answers should include that people and animals may change the face of the land, causing water flow to change. They may also introduce pollutants that can travel through a watershed.
4. Answers may vary but should include that mountains and hills may erode over time, changing the path along which the water flows.
5. Information will vary.

**A "Reservoiring" We Will Go**

1. The sources of water for a reservoir are any forms of precipitation such as rain, snow, sleet, hail, and so on.
2. Water gets into a reservoir by precipitation and by seeping over and through the soil above a reservoir.
3. In a real reservoir, a dam holds the water in.
4. The circumference of the pipes decreases as the distribution system expands into the community. As water travels through the pipe system, it is continuously diverted down different pathways leading to individual homes and businesses. The circumference of the pipe determines the amount of water that can be contained in the pipe at any one time and also determines the rate at which the water will travel through the pipes. The amount of water needed by an individual home or business is much smaller than the amount that left the treatment plant. Therefore, smaller pipes are needed the farther away you go from the treatment plant.




**To Still Saltwater**

1. Water inside the jar heats and begins to evaporate. As the water vapor rises, it is trapped against the jar and begins to cool, condensing into water droplets. The droplets run down the sides of the jar, collecting in the lid at the bottom.
2. The water is fresh.
3. When the water evaporates, the salt is left behind.
4. The solar still is an inefficient way to distill water. The still would have to be very large to create enough water to wash even one car.

# Answer Key (concluded)

**One in a Million**

1. Depending on the original color of the mouthwash, the color should disappear by the third or fourth dilution. Odor will remain longer.
2. The dilution is one part to a million.
3. Some substances can be harmful to living things. Scientists can monitor these harmful substances to determine what concentrations are safe for human and animal use.
4. As hydrologists monitor water flow, they may also check for substances that are dissolved in the water. These substances may be natural or man-made and may be introduced into the water cycle as ground pollutants or acid rain.
5. Answers will vary.

## On the Web

**To Orbit or Not To Orbit, That Is the Question**

1. The marble rolled around the inside of the cone. Its path began to curve downward as the speed of the marble became faster until the marble finally reached the bottom of the cone and stopped.
2. The conical shape of the poster board forced the marble into a circular path and gravity pulled the marble downward. As friction decreased the forward speed of the marble, the unchanging pull of gravity forced it to move down the cone toward the bottom.
3. The speed of the marble did not affect its "path." The marble eventually fell to the bottom of the cone because gravity won out as the speed of the marble decreased. However, the speed of the marble did affect the initial start point (higher) and the amount of time that it took for the marble to fall. The greater the speed, the more momentum the marble had, and the longer it took to overcome gravity. However, if the marble had gone too fast, it would have flown out.

**Stationary Stations**

1. The person on the outside had to move faster than the person on the inside so that both people would stay in line with each other.
2. The distance around the outside path (circle) around the tree is larger than the path (circle) near the tree. A person must walk at a faster speed to travel around the larger circle at the same time that the person travels around the smaller circle. Geostationary satellites travel at very fast speeds to give them orbital periods of 24 hours to match the rotation of specific positions on Earth; thus, the satellites appear to remain stationary.
3. Answers will vary but might include that geostationary satellites make it possible for weather satellites to constantly monitor the weather of a region. They also enable television satellite dishes to receive a constant signal so that programming is uninterrupted.
4. Due to a limited amount of "space" directly above the equator, it is possible to have too many satellites. If it gets too crowded, the various satellite signals might begin to interfere with each other.

**Move Over. You're in My Way**

1. Light waves travel in a straight line. When the light hit the mirror, it bounced off in a straight line, but at an angle. The mirror had to be adjusted away from the can so that the angle of the light's reflection could shine on the flap of paper. As the mirror moved, the angle of reflection stayed the same, but the beam's position shifted towards the other side of the can.
2. If the satellite is placed too close to Earth, its signal will not travel very far due to the curve of the Earth's surface. The movement of the light from one side of the can to the other is similar to the transmission of radio waves around the Earth via satellites. A communication satellite in orbit above the Earth's equator transmits radio signals from one place on the Earth to a receiver on the opposite side. If the satellite were not placed correctly, the reflection would not be in a position high enough to send the radio waves to the receiver.

# Segment 4

As the tree house detectives try to find the answers to their questions about water use, they visit Busch Gardens, Williamsburg, Virginia to learn more about water conservation. Mr. Brian Nadeau of Water Country, USA explains the importance of water recycling but can't give them a solution for their car wash problem. Finally, the detectives turn to Ms. Hillegass of the Hampton Roads Water Efficiency Team (HRWET). They learn some surprising things about using water wisely and return to the tree house just in time to hear a KSNN™ update that will make their day and wash their blues away!

# Objectives

The students will

- simulate the steps in the water treatment process.
- describe land use activities within a watershed by analyzing water quality.
- learn what happens to groundwater when more and more water is used.
- construct and calibrate a shower timer that can help conserve water.
- practice using metric measurements.
- identify plant and animal adaptations.
- estimate the water content of certain foods.

# Vocabulary

**adaptations** – physical traits that allow a plant or animal to change to fit its surroundings

**conservation** – protecting resources from being lost or used up

**drought tolerant** – adaptations that allow a plant to go for long periods of time without water

**purify** – to make clean; to remove dirt or other materials

**recycle** – to use again in a new way

**tributaries** – small streams that flow into larger bodies of water

# Video Component

## Implementation Stratey

The NASA SCI Files™ is designed to enhance and enrich the existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

## Before Viewing

1. Prior to viewing Segment 4 of *The Case of the Wacky Water Cycle*, discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site in the tree house section and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 3 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 3. Use tools located on the Web, as was previously mentioned in Segment 3.
4. Focus Questions—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to answer the questions. An icon will appear when the answer is near.

## View Segment 4 of the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

## After Viewing

1. At the end of Segment 4, lead students in a discussion of the focus questions for Segment 4.
2. Have students discuss and reflect upon the process that the tree house detectives used to learn about the water cycle and solve the water table problem. The following instructional tools located in the educator's area of the web site may aid in the discussion: Experimental Inquiry Process Flowchart and/or Scientific Method Flowchart.

3. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
4. Wrap up the featured online Problem-Based Learning (PBL) investigation. Evaluate the students' or teams' final product, generated to represent the online PBL investigation. Sample evaluation tools can be found in the educator's area of the web site under the main menu topic "Tools" by clicking on the "Instructional Tools."
5. Have students write in their journals what they have learned about the water cycle, water uses, water conservation, and/or the problem-solving process and share their information with a partner or the class.

### Careers

resource conservationist
water park manager

# Resources

## Books

Blobaum, Cindy: *Geology Rocks*. Williamson Publishing, 1999, ISBN: 1885593295.

Berger, Melvin: *Oil Spill!* HarperCollins Children's Books, 1994, ISBN: 0064451216.

Cherry, Lynne: *A River Ran Wild*. Harcourt, 2002, ISBN: 0152163727.

Duvall, Jill D.: *Who Keeps the Water Clean? Ms. Schindler!* Scholastic Library, 1997, ISBN: 0516261525.

Kensler, Chris: *Secret Treasures and Magical Measures: Adventures in Measurement*. Kaplan, 2003, ISBN: 0743235258.

Maass, Robert: *Garbage*. Henry Holt & Company, 2000, ISBN: 0805059512.

Pallota, Jerry: *Hershey's Milk Chocolate Weights and Measures*. Scholastic, Inc., 2003, ISBN: 0439388775.

Pringle, Laurence: *Oil Spills, Volume 1*. Morrow, William, and Co., 1993, ISBN: 0688098614.

Rand, Gloria: *Prince William*. Henry Holt & Co., 1994, ISBN: 080503384X.

Ross, Michael Elsohn: *RE-Cycle*s. Millbrook Press, 2002, ISBN: 0761318186.

Schwartz, David M.: *Millions to Measure.* HarperCollins Publishers, 2003, ISBN: 0688129161.

Wilcox, Charlotte: *Trash!* Lerner Publishing, 1988, ISBN: 0876143117.

# Resources (concluded)

## Web Sites

**Virtual Field Trips: Salt Marshes**
Students will be introduced to the coastal environment through participation in a field study of the beach, dunes, estuary, and salt marsh habitats. This informative virtual field trip contains beautiful pictures and interesting information.
*http://www.tramline.com/sci/salt*

**A Wetlands Food Web Story**
Read an interactive story about a wetlands marsh and learn about the plants and animals that live there.
*http://www.natureillinois.org/natwrks.htm*

**Water Recycling Center**
Learn about alternative wastewater treatments, the importance of natural wetlands, and the benefits of water recycling on the site sponsored by the Triangle School Wastewater Treatment Facility in North Carolina.
*http://www.waterrecycling.com/overview.htm*

**The Edwards Aquifer and San Antonio Water System**
Learn about aquifers and how water tables are measured.
*http://www.saws.org/our_water/*

**America's Wetlands**
Investigate the wonders of wetlands as you look at the unique plants and animals that live there as well as the benefits of wetlands to our world.
*http://www.epa.gov/OWOW/wetlands/vital/toc.html*

**Busch Gardens Teachers' Guides**
Check out these online resources for more activities and information about the animals that live in Sea World.
*http://www.seaworld.org/just-for-teachers/guides/index.htm*

**Science for Ohio: The Water Cycle**
Make a water cycle spinner game or check out resources related to the water cycle on this site for teachers and students.
*http://casnov1.cas.muohio.edu/scienceforohio/Water1/index.html*

# Activities and Worksheets



On the Web

**Adaptations**
Do some research to find out what kinds of adaptations plants and animals have that help them survive in different climates and habitats.

**Water Bodies**
Learn about the water content of the foods you eat by doing this online investigation and then dehydrating some of your favorite fruits and vegetables.

# Giving Water the Treatment

## Materials

200 mL tap water
foam cup
3 clear plastic cups
small, clean bowl
paper towel
5 mL powdered alum (available from drugstore)
160 mL clean sand
80 mL clean gravel
2 drops of yellow food coloring to simulate chlorine
10 mL dirt (2 tsp)

## Problem

To simulate the steps in the water treatment process

## Background

A water company goes through several steps to ensure safe and pure drinking water for the community. The water that has been processed typically goes through the following steps:

**aeration** – water is sprayed into the air to release trapped gases and to absorb additional oxygen.

**coagulation** – powdered alum is dissolved in the water, forming sticky particles called floc, which attach to suspended dirt particles in the water.

**sedimentation** – the heavy particles of floc settle to the bottom of the tank, and the clear water above is skimmed from the top and sent on to the next step.

**filtration** – as the clear water passes through layers of sand, gravel, and charcoal, small particles are removed.

**chlorination** – a small amount of chlorine gas is added to kill any bacteria or microorganisms that may be in the water.

## Procedure

1. In a plastic cup, mix 5 mL dirt and then 200 mL of tap water. Stir well. Label cup 1.
2. Repeat step 1 with a second plastic cup. Label this cup "control" and set it aside.
3. Observe the mixtures and record your observations in your science journal.
4. Using an empty cup, aerate the water in cup 1 by pouring it back and forth into the empty cup several times to release trapped gases. See diagram 1.
5. Observe and record.
6. Add 2.5 mL alum to the water.
7. Let the mixture stand for 10–15 minutes. Observe and record.
8. To create a "filter," use a sharp pencil to poke ten small holes in the bottom of the foam cup.
9. Put a layer of gravel in the bottom of the foam cup.
10. Add a layer of sand on top of the gravel.
11. Hold the filter cup above a clean bowl.
12. Carefully pour the water from cup 1 into the filter cup, leaving behind the sediment at the bottom.
13. Observe what happens to the floc particles as they pass through the sand and gravel. Record your observations.
14. A small amount of disinfectant is added at this final stage to kill remaining bacteria and other microorganisms. Add 2 drops of food coloring to the water to represent this step.

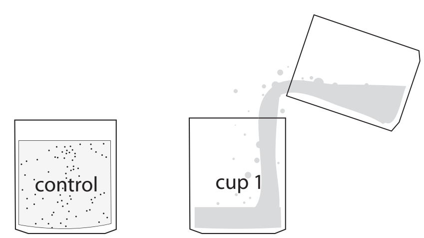


**Diagram 1**

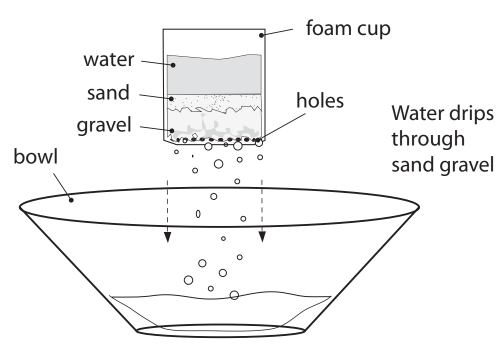


**Diagram 2**

# Giving Water the Treatment (concluded)

15. DO NOT drink or taste the water.
16. Compare your finished product with the control cup.
17. Record your observations in your science journal.
18. Discuss your findings with your group or class and create a list of other kinds of filters that might help purify water.

## Conclusion

1. Why do we need water treatment plants?
2. What is the purpose of adding the alum to the water?
3. Why should chlorine be added to the water at the end of the process?
4. What can you learn about the water cycle from this activity?

## Extensions

1. Make arrangements to visit the water treatment facility in your area and find out what type of water treatment process is used.
2. Make a booklet illustrating the steps to the water treatment process.
3. Read about an oil spill such as the one from the Exxon Valdez. How did workers help clean up the oil spill? What kinds of materials were used to help clean the water? How did the oil spill affect the environment? Share your findings with the class.

# Pollution Perils

## Problem

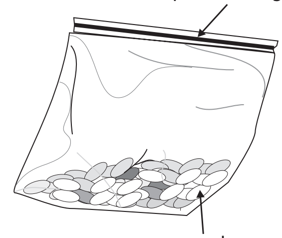
To describe and identify land use activities within a watershed by analyzing water quality

## Materials

3–6 different colored candies
small, plastic bags
graph paper
colored pencils
copies of Land Use Table

## Background

A watershed (drainage basin) is an area of land where all the water drains to the same location. Watersheds may be large, such as the Mississippi River drainage basin, or small, such as the 40 acres that drain into a farm pond. Nonpoint source pollution has many different sources, usually associated with rainfall and snowmelt runoff moving over and through the ground, carrying natural and human-made pollutants into lakes, rivers, streams, wetlands, and groundwater. Pollutants accumulate in watersheds as a result of various practices and natural events. If we can determine the type of pollutant, then we cannot only classify the source of the pollutant, but also take preventive measures to stop any further contamination.




## Teacher Preparation

Students may complete this activity, individually or in a small group. Divide the candy so that each student/group has about 30 pieces of 3–6 different colored candy and place them in a small, plastic bag. Copy and cut apart enough pollutant strips for each bag. Place one strip inside each bag.

## Procedure

1. Each bag of candy represents a watershed. Open your bag of candy and separate the candies by color.
2. The candies represent different kinds of pollutants associated with various land uses that may be found in a watershed.
3. Using the list of pollutants in the bag, assign a pollutant to each color of candy. If you have more colors than pollutants, make the extra colors "harmless" bacteria.
4. In your science journal, create a key indicating what each color represents.
5. Use graph paper to create a bar graph of the pollutants found in your watershed.
6. Be sure to label the x-axis with the names of the pollutants and the y-axis with numbers.
7. Title your graph and add the pollutant color key from step 5.
8. Ask for the "Land Use Table," and, based on the pollutants that were found there, determine what activities are occurring in the watershed.
9. Classify the watershed as agriculture, construction or forestry, urban, mining, or wastewater.

## Conclusion

1. How are watersheds different from one another?
2. What can a scientist learn from studying the kinds of pollutants found in a watershed?
3. How might these pollutants change an ecosystem?

## Extensions

1. Contact your state geological survey office or local zoning office to obtain a land use map for your area. Determine how the land in your area is used. What kinds of pollutants might be a problem?
2. Visit the United States Geological Survey's (USGS) web site at *http://www.usgs.gov/* to learn about water use, land use, and much more about your state. Just click on "USGS Information by State" in the bottom right "Popular Topics" box.
3. Read a story about life in pioneer times. Draw a picture of the land as it might have looked 100 years ago. Write a story about how the land was used at that time. Tell the story of the changes in the land through the years until you reach the present day.

# Pollution Perils

## Pollutant Strips

| | | |
|---|---|---|
| sediments, nitrates, ammonia, phosphate, pesticides, bacteria | sediment, pesticides, ash | bacteria, nitrates, phosphates, chlorine, organic waste |
| sediment, heavy metals, acid, nutrients | oil, gas, antifreeze, nutrients, pesticides, paint | |

## Land Use Table

| Land Use | Activities | Pollution Problems |
|---|---|---|
| Agriculture | cultivation, pest control, fertilization, animal waste management, weed control | sediments, nitrates, ammonia, phosphate, pesticides, bacteria |
| Construction and Forestry | land clearing, grading, timber harvesting, road construction, fire control, weed control | sediment, pesticides, ash |
| Wastewater Disposal | septic systems, laundry, personal hygiene, dishwashing, restaurant waste | bacteria, nitrates, phosphates, chlorine, organic waste |
| Mining and Industry | dirt, gravel, mineral excavation, chemical cooling, waste products, manufacturing | sediment, heavy metals, acid, nutrients |
| Urban storm runoff | automobile maintenance, lawn and garden care, painting, rain runoff from blacktop | oil, gas, antifreeze, nutrients, pesticides, paint |

# Pump Away

## Purpose

To see what happens to groundwater reserves when more and more water is pumped out

## Materials

gravel
rectangular, clear plastic container
soil
watering can
tap water
4 spray pumps
stopwatch or clock with a second hand
metric ruler

## Procedure

1. With a partner, place a 7.5-cm layer of gravel in the bottom of the clear container.
2. Cover with a loose layer of soil.
3. Create an aquifer by using a watering can to "rain" on the container until it holds at least 5 cm of groundwater. See diagram 1.
4. With an erasable marker, mark the level of water in the aquifer (container).
5. With a rubber band, attach a small piece of a paper coffee filter to the open end of each spray pump. See diagram 2.
6. Pretend a family builds a house on one part of your land.
7. Place the tube part of the spray pump into the groundwater in the gravel. Start pumping. See diagram 3.
8. Notice what happens to the level of groundwater. Measure and mark the level of water in the aquifer.
9. Record your findings in your science journal.
10. Use the watering can to make it "rain" for 15 seconds, thus recharging the aquifer.
11. Wait 2 minutes and measure the level of water in the aquifer. Record your findings.
12. Pretend a housing development goes in. Now you will need to add three more pumps.
13. Have your partner help you spray all four pumps at once.
14. Observe what happens to the groundwater now. Measure the new level of water in the aquifer.
15. Record your observations in your science journal.
16. Once again allow it to "rain" on your aquifer for another 15 seconds.
17. Measure the level of water in the aquifer.

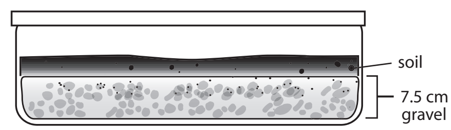



**Diagram 1**

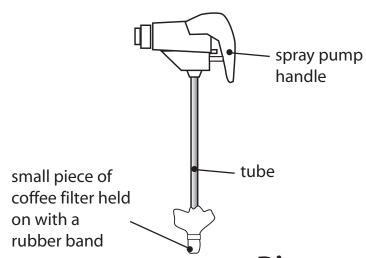



**Diagram 2**

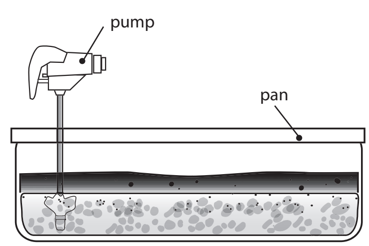



**Diagram 3**

## Conclusion

1. How much water is used from the aquifer when only one pump is used?
2. How much water is used from the aquifer when four pumps are used?
3. Compare the amount of water that is recharged to the aquifer after each rain. Is the aquifer fully recharged the last time?
4. What can we learn about groundwater use from this experiment?
5. How does this experiment relate to the information Jacob shared about the Albuquerque Aquifer?

## Extension

Contact your local water department. Arrange for a guest speaker to come to your classroom. Find out where your water comes from. Does your city depend on groundwater, a reservoir, or individual wells? Ask about the kinds of tests that are done on the water to ensure water purity.

# Shower Saver

## Problem

To construct and calibrate a shower timer that can help save water.

## Background

Over 50% of all residential water usage occurs inside the home. Approximately 30% of that water usage comes under the category of "personal hygiene," which includes baths, showers, and toothbrushing. The average shower uses 19 L (liters) of water for each minute the water is running. Most people take a 4- to 8-minute shower. To conserve water, a 4- to 5-minute shower is recommended.
**NOTE:** *To save time in this experiment, only 200 mL of water is used in each trial.*

### Materials

4 large, same-sized plastic cups
1 pushpin
4 small paper clips
4 30-cm pieces of string
1 large bowl or bucket
permanent marker
stopwatch
metric measuring cup
water
science journal

## Procedure

1. Fill one of the cups with water but do not let it overflow.
2. Pour the water into a metric measuring cup and read the amount. Record below and in your science journal the total amount of water the cup can hold (its volume).
3. Using a pushpin, poke a hole in the bottom of a plastic cup.
4. Hold the cup over the bucket and pour in 200 mL of water. See diagram 1.
5. Using a stopwatch, time how long it takes for the cup to drain. Note: There will always be a small amount of water left in the cup.
6. Record the time (in seconds) in the Flowchart below.
7. With a new cup, poke 2 holes in the bottom by using a pushpin.
8. Repeat steps 2–4.
9. Repeat steps 2–4 for cups with three and four holes.
10. To find the flow rate for each cup (in mL per second (mL/sec), divide the volume (200 mL) by the number of seconds it took for the cup to drain.
11. Divide the total volume of the cup by 200 mL and record the number of 200 mL amounts per cup below. For example, in a cup that has a total volume of 600 mL, there are three 200-mL amounts: (600 divided by 200 = 3).
12. Multiply the answer by each of the flow rates and record in the Flowchart.
13. Look at your data and find the cup that is closest to taking 4 minutes to drain. This cup is your shower timer.
14. In your shower timer cup, poke four equally spaced holes just under the top rim of the cup.
15. Insert a paper clip in each hole.
16. Tie a string to each of the paper clips.
17. To hang the cup in the shower, tie the strings together at the top. See diagram 2.
18. The next time you are ready for a shower, use your shower cup to help you conserve water. When the cup is almost empty or drips very slowly, your shower is over.
**Optional:** *The following can be used to show proportions and to help students extrapolate information.*
19. Plot the data from the 1-hole cup on the graph below.
20. Use a straight edge to draw a line from "0" to the plotted point and beyond.
21. On the y-axis, locate the total volume of the cup.
22. Use your finger or a straight edge and follow across the graph until the line you drew in step 20 meets the line you are tracing for total volume. Plot a point.

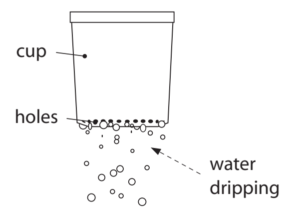


**Diagram 1**

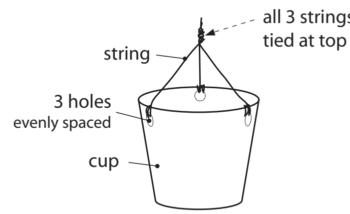


**Diagram 2**

# Shower Saver (concluded)

23. Follow the point you plotted down to the x-axis (Time) and determine how many minutes it would take for the cup to empty. Record in your science journal.
24. Create graphs for each of the other cups with different numbers of holes and repeat.

**Flowchart**

| Cup | Flow Time in Seconds | Flow Rate (FR) 200 mL/ Seconds = mL/sec | Flow Time (FT) #mL x FR = FT |
|---|---|---|---|
| 1 hole and 200 mL water | | mL/ sec | |
| 2 holes and 200 mL water | | mL/ sec | |
| 3 holes and 200 mL water | | mL/ sec | |
| 4 holes and 200 mL water | | mL/ sec | |

Total Volume of Cup: ________ divided by 200 mL = _____ number of 200 mL per cup

**Optional Graph:**

## Conclusion

1. Why is it important to limit the amount of water used for showering?
2. If your average shower uses 19 L of water for each minute the water is running, how much water is used while your shower clock drains?
3. How could you expand the use of a water clock to help save water in other places around your house?

## Extensions

1. Using the Internet, list ways that you can conserve water in your home. Trace your hand onto sheets of construction paper and cut along the outline. Write one way to conserve water on each paper hand. Share your conservation ideas with the class and post the hands on a bulletin board around a picture of our Earth. For conservation ideas, visit the "Research Rack" in the tree house on the NASA SCI Files™ web site *http://scifiles.larc.nasa.gov*
2. Keep a water use record. Every time you use water for any purpose, write it down. Figure out how much water you use in a day or week. Use that number to calculate the amount of water you use in a year. Locate charts online and tell the average amount of water that everyday activities use: For example,
   **a.** flushing toilet – 19 L
   **b.** brushing teeth (water running) – 7 L
   **c.** dishwasher – 75 L
   **d.** dish washing by hand (in sink with stopper) – 37 L
   **e.** load of laundry – 152 L
   **f.** shower/bath – 19 L/minute while the water is running

# Metric Olympics

## Problem

To practice using metric measurements

## Teacher Prep

Set up an Olympic station for each event: javelin throw, discus throw, saturated sponge, and paper towel run. For the javelin and discus throws, you will need an open area with a "start" line marked on the floor for each. For the paper towel run, cut paper towels lengthwise into 3-cm strips and use a permanent marker to mark 2.5 cm from the bottom of the glass. For better organization, number each station and have the students number off 1–4. Students will begin by going to the station that corresponds to their number, and rotate to the next higher number when finished. For example, number 4 will go to number 1. Multiple setups for each station will also help the competition go faster. For a better understanding of each event and to help students with estimating, demonstrate each event.

### Materials

sponge
2 large bowls
metric measuring cups
straws
paper plates
meter sticks
paper towels
pencil
tape
food coloring
tall clear glass
permanent marker
stopwatch or clock with a second hand
pen
metric ruler

## Procedure

1. Discuss each event and predict the distance or amount you will throw or measure.
2. In the Olympic Chart, use a marker or pen to record your estimation for each event. You may not change your estimation unless you have your teacher or adult initial your change.
3. Javelin Throw
   **a.** Stand with toes touching the start line and throw a straw (javelin) as far as you can.
   **b.** Measure the distance the straw traveled.
   **c.** Record the distance under the "Actual" column in the Olympic Chart.
4. Discus Throw
   **a.** Stand with toes touching the start line and throw a paper plate (discus) like a Frisbee® as far as you can.
   **b.** Measure the distance from the line to where the discus landed.
   **c.** Record the distance.
5. Saturated Sponge
   **a.** Place the sponge in the bowl of water and let it soak until it is saturated.
   **b.** In your right hand, hold the wet sponge over the dry bowl and squeeze it as hard as you can, using only your right hand.
   **c.** Pour the squeezed water into a metric measuring cup and record the volume of water.
   **d.** Repeat with the left hand.

# Metric Olympics (concluded)

6. Paper Towel Run
   **a.** Tape one end of a paper towel strip to the middle section of a pencil.
   **b.** Fill the glass to the marked line with water.
   **c.** Add 2–3 drops of food coloring to the glass.
   **d.** Lay the pencil on top of the glass so that the bottom of the paper towel is immersed in the water.
   **e.** After 10 seconds, remove the paper towel strips.
   **f.** Measure the distance the water traveled up the paper towel strip and record.
7. Calculate the difference between your predictions and the actual distance. Record on chart.
8. Add the prediction, actual, and difference columns. Post your totals on a class chart.
9. Determine a winner of the Olympic games by finding the person who has the lowest "Difference" score.

## Conclusion

1. Did using the metric system make it more or less difficult for you to predict results? Explain.
2. Why would scientists prefer the metric system of measurement?
3. What are some common household products that come in metric units?
4. How did units of measurement influence the water problem investigated by the tree house detectives?

## Extensions

1. Using metric units of measurement, practice measuring everyday items around your home or school.
2. Create chart and post daily temperatures in both Fahrenheit and Celsius. If your thermometer does not have both scales, use an online metric conversion tool.
3. Read a story about using metric measures. You may look for one in the resource list or check with your local librarian.
4. Calculate your percentage of error.

**Olympic Chart**

| Event | Prediction | Actual | Difference |
|---|---|---|---|
| **Javelin Throw** | cm | cm | cm |
| **Discus Throw** | cm | cm | cm |
| **Saturated Sponge** | mL | mL | mL |
| **Paper Towel Run** | cm | cm | cm |
| **Totals** | | | |

# Answer Key

## Giving Water the Treatment

1. We must recycle water that has been used or exposed to natural pollutants because water is a limited resource on Earth. Recycling also helps make water safe to drink.
2. Alum dissolves in the water, forming sticky particles that attach to suspended dirt particles floating in the water. These particles become heavier than the water and sink to the bottom.
3. Chlorine is added to kill bacteria and other harmful microorganisms.
4. Most water that reenters the water cycle at some point, as either surface water or groundwater, can be reused when it is treated.

## Pollution Perils

1. Answers will vary, but might include that some watersheds are very large, while others are very small. Some watersheds include brackish water or saltwater; others are freshwater only.
2. Scientists can determine what kinds of activities or land uses were probably causing the pollution. When a they find a contamination source, scientists can develop methods to prevent future pollution.
3. Pollutants may change the ecosystem by killing plants or animals, causing animals to move away from the area, or by chemically breaking down the soil and rock in an area.

## Pump Away

1. Answers will vary. Students should measure the depth of the water table.
2. Answers will vary, but results should indicate that a more significant amount of water was used than with a single pump.
3. The aquifer should be fully recharged (or nearly so) after its use by only one pump, ; however, the same amount of “rainfall” will not recharge the aquifer to its original volume after several pumps have used the water.
4. Although groundwater can be recharged, it may not always be recharged at the rate of use. It is important for geologists to understand how much water is available in the groundwater table and how quickly the aquifer can be recharged.
5. In Albuquerque, geologists incorrectly surveyed the aquifer, and the water use that was approved for the area quickly depleted the too small aquifer. Because aquifers are underground and not easily measured, scientists have to use what they know about rocks and soils in an area to estimate the size an aquifer should be.

## Shower Saver

1. Showering and other personal hygiene tasks account for about 30% of water used inside the home. Water conservation in the home can reduce overuse significantly.
2. Answers will vary, depending on the time required for the shower clock to drain. If the shower clock runs out at 4 minutes, you will have used approximately 76 L of water for your shower. (Number of minutes x 19 L).
3. You could make a shower clock for things like brushing your teeth, hand washing, and so on.

## Metric Olympics

1. Answers will vary depending on familiarity with the metric system.
2. Metric measurements are easy to use because they are based on units of ten. They are also more accurate than standard units of measure because the units are divided into smaller sections than standard units, allowing scientists to be more precise.
3. All packaged foods have the metric measurement listed on the packaging. However, soda, bottled water, and juices are commonly referred to by their metric measurement. For example people often say, “a 2-liter bottle of soda.” Some states also sell gasoline by the liter.
4. When IM Lissning read the measuring tape, she accidentally read the standard unit side (feet) instead of the metric side (meters). She thought the water table had dropped considerably because the number was much larger than she expected.

# Answer Key (concluded)

## On the Web

### Adaptations

1. Adaptations are the physical traits that help a living organism survive in its natural habitat.
2. Climate and habitat conditions are sometimes harsh. The plants and animals may be exposed to conditions such as extreme heat or cold, drought or flood, winds, and heavy snowfall. The living things that make their homes in these conditions are suited to the conditions because of physical adaptations.
3. People have the ability to solve problems and adapt, when necessary, to environmental changes. Human beings can solve problems as an adaptation to their environment. We can learn to create conditions that help us survive.

### Water Bodies

1. Answers will vary.
2. Most of the water is stored inside the cells of the organism.
3. The plant absorbs the water through its roots or leaves and stores it in the cells of the fruit or stem. When animals, or human beings, eat plants, they take in stored water. Some desert animals never actually drink water other than that stored in succulent desert plants.