Section Preview of the Teacher's Edition for

EDC Earth Science

Chapter 2 (through Activity 2)

Suggested student responses and answer keys have been blocked out so that web-savvy students do not find this page and have access to answers.

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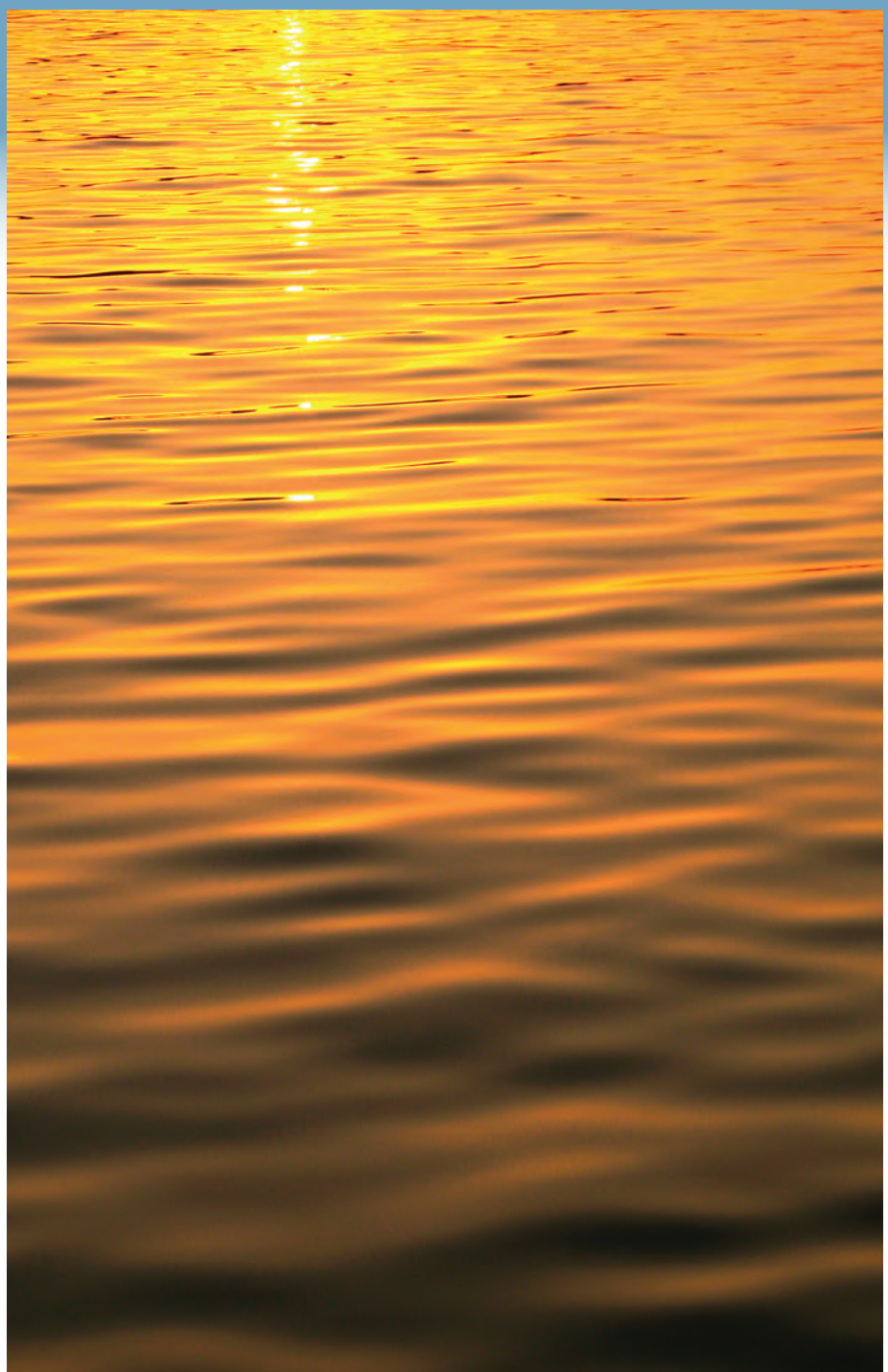
UNIT 1

Hydrosphere: Water in Earth's Systems



CHAPTER TWO

Life's Blood: Seeking Water from Earth

Overview

In this first chapter of Unit 1, students explore a precious resource—freshwater. In stark contrast to Mars, water seems to be everywhere on Earth. It flows in rivers and streams, fills the ocean basins, and rains down from the atmosphere. The idea that in the future wars could be fought over water seems ridiculous in this context. However, the reality is that people are already suffering from severe water shortages around the globe. As such, students are challenged in this chapter to answer some very personal and local questions—where does their water come from? Could their water supply be threatened?

To obtain the knowledge necessary to answer these questions, students revisit the science of water, analyzing how water cycles through the hydrosphere into freshwater reservoirs that people can use. They model how water collects in the two primary sources of drinking water: surface water and groundwater. To gain perspective on their local situation, students research water supply case studies from different physical settings around the world, learning about the various ways communities obtain their water and the challenges they face. Ultimately, students design and implement a strategy for researching their own water supply. They determine where their water comes from and identify potential threats to the supply.

Goals for Student Understanding

This table shows alignment of *Framework for K–12 Science Education* (the *Framework*) content, practices of science and engineering, and crosscutting concepts with chapter learning objectives. This is not intended to be used as a checklist, but it shows how students' learning experiences in *EDC Earth Science* map to the *Framework* goals.

Learning Objective	Framework Content, Practices, and Crosscutting Concepts	Where Taught
Water, due to its abundance and unique qualities, is central to Earth's dynamics and to human survival.	ESS2.C.1, ESS2.C.2 Asking questions and defining problems Analyzing and interpreting data Using mathematics and computational thinking Patterns, scale, proportion, and quantity	*What's the Story?* "Water Running Dry" *Task 1*—"How Much Water Do You Use?" *Task 2*—"Thinking Beyond the Bathwater: Your Water Footprint" *Reading*—"The Unique Qualities of Water" *Final Reading*—"The Most Precious Resource"
There are many potential pathways a molecule of water can take through the hydrosphere and into and out of freshwater reservoirs that humans can use.	ESS2.C.1, ESS3.A.1 Asking questions and defining problems Systems and system models	*Activity 1*—"Reservoir Roulette: A Journey Through the Water Cycle"
Communities most often obtain their water from surface-water supplies such as rivers, or lakes, or from groundwater aquifers.	ESS3.A.1 Developing and using models Constructing explanations Cause and effect Systems and system models	*Activity 2*—"Where's the Drinking Water?" Part A: "Modeling a Watershed" Part B: "Groundwater Model" *Activity 3*—"Water Supply Case Studies" *Final Reading*—"The Most Precious Resource"
The amount of surface and groundwater available in a given area is a function of climate (the amount of rainfall and evaporation rates), the size of the watershed, and the rate at which freshwater resources are used by people.	ESS2.C.1 Developing and using models Constructing explanations Systems and system models Stability and change	*Activity 2*—"Where's the Drinking Water?" Part A: "Modeling a Watershed" Part B: "Groundwater Model" *Activity 3*—"Water Supply Case Studies"
A variety of technologies help communities obtain and store valuable freshwater, such as groundwater pumping wells, dams used to create artificial reservoirs along rivers, and desalination plants.	ESS3.A.2 Asking questions Planning and carrying out investigations Constructing explanations Systems and system models	*Activity 2*—"Where's the Drinking Water?" Part A: "Modeling a Watershed" Part B: "Groundwater Model" *Activity 3*—"Water Supply Case Studies"
There are a number of ways that water supplies can be threatened: as a result of drought, population growth, and failure to protect water supplies from contamination	ESS3.A.1, ESS3.B.3 Analyzing and interpreting data Engaging in argument from evidence Obtaining, evaluating, and communicating information Patterns Cause and effect Systems and system models	*Activity 3*—"Water Supply Case Studies" *Activity 4*—"Follow the Flow: Researching Your Water Supply" *Final Reading*—"The Most Precious Resource"

Possible Misconceptions and Barriers to Learning

Students may have a very limited understanding of where their household water comes from and are likely to be particularly uninformed about how groundwater is used as a drinking water supply. They may have difficulty understanding how groundwater can flow underground, particularly if they have a limited understanding of soil and bedrock. For example, many students will visualize underground rivers flowing through caves, which is most often not the case.

Assessment Outcomes

Students should be able to

1. diagram and describe the processes by which water is cycled through the hydrosphere and is stored in freshwater reservoirs that humans can tap.
2. describe the unique qualities of water that make it so important to living organisms.
3. model and explain the concept of watershed and describe how surface water is collected and managed for community water supplies.
4. model and describe how water is stored in groundwater aquifers and how this water is extracted from the ground for human use. They should also be able to explain why the extraction of water at too high a rate can cause the water table to drop and aquifers to become depleted.
5. research and communicate information about community water supplies from around the world, demonstrating an understanding of how variations in climate and physiography can affect the amount of freshwater available in a particular area. They should be able to identify and explain potential threats to surface water and groundwater supplies related to drought, population growth and contamination.
6. research their local water supply, and describe and defend their personal perspective on measures that should be taken to protect their water.

Assessment Strategies

Students have a number of opportunities in this chapter to show their initial and developing understanding of Earth's water resources. By taking note of the answers given by students completing group work or working individually, you can determine pacing, identify which concepts need more or less emphasis, and gauge students' understanding of the content by the end of the chapter. The following table summarizes the formative and summative assessment opportunities.

The table also provides an alignment between the student assessment outcomes and the assessment items at the end of the chapter. You should determine ahead of time which of these assessment opportunities you will evaluate formally (assign a grade) and which you will evaluate more informally. In general, the *Consider* and *Investigate* sections provide opportunities for formative assessment, and the *Process* section provides opportunities for summative assessment.

Opportunities	Information Gathered
Consider	
Brainstorming	Students' understandings from prior science classes of the ways water is involved in Earth's processes, such as weather, photosynthesis, and the rock cycle Students' initial understandings of the nature of water, importance of water to their daily lives, and the possibility that water could become scarce in their community Students' current knowledge of where their household water comes from
About the Reading— "Water Running Dry"	Students' understandings of the factors that can put a strain on water supplies and their initial ideas about what they would do if they had difficulty obtaining water
Analysis for *Task 1*— How Much Water Do You Use?	Students' abilities to accurately estimate their own water use, make comparisons to people in other parts of the world, and analyze the reasons for any differences Students' ideas about the minimum amount of water they require for their personal use
Analysis for *Task 2*— Thinking Beyond the Bathwater: Your Water Footprint	Students' understandings of how they use water indirectly when they consume food grown on farms elsewhere and use products made by industry Students' understandings of the reasons water usage varies from state to state and from one region of the world to another, and of how water scarcity elsewhere can affect them locally
Investigate	
Activity 1—"Reservoir Roulette: A Journey Through the Water Cycle"	Assessment Outcome 1 (Assessment items 1, 2, 4)
About the Reading— "The Unique Qualities of Water"	Assessment Outcome 2 (Assessment item 3)
Activity 2—"Where's the Drinking Water?" Part A: "Modeling a Watershed"	Assessment Outcome 3 (Assessment items 5–8)
Activity 2—"Where's the Drinking Water?" Part B: "Groundwater Model"	Assessment Outcome 4 (Assessment items 9–11)
About the Reading: "Capturing the Good Water"	Assessment Outcomes 3 and 4 (Assessment items 5–11)
Activity 3—"Water Supply Case Studies"	Assessment Outcome 5 (Assessment items 12–15)
Activity 4—"Follow the Flow: Researching Your Water Supply"	Assessment Outcome 6 (Assessment items 14, 15)
Address the Challenge	Students' abilities to synthesize the key concepts covered in this chapter
Process	
Share	Students' abilities to communicate their understandings of the key concepts covered in this chapter
Discuss	Students' abilities to recognize how they may be affected by water scarcity in other parts of the world, their appreciations of the dependence of other living organisms on an adequate water supply, and their ideas about how technology might affect the availability of water to communities
Assessment	Students' understandings of the range of concepts presented throughout the chapter; these questions can be used in class, for homework, or as a quiz at the end of the chapter

Scope and Sequence

The following is provided to help with your lesson planning. Adjust it according to the needs and interests of your classroom, and whether you assign readings as homework or complete them in class.

WEEK			DAY		PREVIEW
1	Consider		1	Introduce chapter, and discuss *Brainstorming* questions.	Students brainstorm about Earth processes that involve water, reinforcing the importance of water to the functioning of all of Earth's systems. They think about the importance of water in their daily lives and the possibility that water could become scarce in their community. They diagram their ideas of where their household water comes from.
			2	*What's the Story?*—"Water Runs Dry." Discuss *About the Reading* questions.	*What's the Story:* Students read a story about a community in Tennessee that ran out of water. They think about the factors that could strain water supplies and about what they would do if they had difficulty obtaining water.
			3	*Task 1*—"How Much Water Do You Use?"	*Task 1—Students estimate their personal daily water use. They think about why people in the United States typically use more water than people in other parts of the world.*
			4	*Task 2*—"Thinking Beyond the Bathwater." Introduce *Address the Challenge.*	*Task 2*—Students think about the ways they indirectly consume water that is used to grow their food and produce products that they use. They study data about the amount of water involved in manufacturing various products and how water use varies from state to state and from one region of the world to another. They think about how they depend on water being readily available in other parts of the world.
2	Investigate	Gather Knowledge	5	*Activity 1*—"Reservoir Roulette: A Journey Through the Water Cycle."	*Activity 1*—Students review pathways that a water molecule can take when cycling through Earth's systems. They think about the points in the water cycle where humans can access freshwater and about the ways that humans may affect this freshwater supply.
			6	*Activity 1*—Have students discuss their journeys and discuss *Analysis* questions.	
			7	*Reading*—"The Unique Qualities of Water." Discuss *About the Reading* questions.	
			8	*Activity 2*—"Where's the Drinking Water?" Part A: "Modeling a Watershed"	*Activity 2*—Part A: Students use models to investigate the principle sources of drinking water within Earth's systems. They model how surface water collects within watersheds, forming valuable surface water reservoirs, and think about how factors such as the size of a watershed can affect the availability of water.
			9	*Activity 2*—"Where's the Drinking Water?" Part B: "Groundwater Model"	*Activity 2*—Part B: Students model how groundwater collects in aquifers and is tapped with water wells. They think about the factors that affect the availability of groundwater supplies in a region.
			10	*Activity 2*—Discuss Part B Analysis questions. *Reading*—"Capturing the Good Water." Discuss *About the Reading* questions.	
3			11	*Activity 3*—"Water Supply Case Studies." Introduce, begin student research.	*Activity 3*—Students are assigned individual case studies about community water supplies in China, Japan, Brazil, Cyprus, Canada, Kenya, and Australia. They research and share what they have learned about how these communities obtain their water and the challenges that they face.
			12	*Activity 3*—Continue student research, and prepare students to share findings.	
			13	*Activity 3*—Share findings, discuss *Analysis* questions.	
			14	*Activity 4*—"Researching Your Water Supply." Introduce, begin student research.	*Activity 4*—Students design and follow a research strategy to learn about their water supply. As well as from Internet and library sources, they get information from local experts and state and federal personnel to determine where their water comes from and potential threats to their local supply.
			15	*Activity 4*—Student research.	
4		Address the Challenge	16	Write report	*Address the Challenge*—Students synthesize their research findings and write a report about their local water supply.

WEEK		DAY		PREVIEW
4	**Process**	17	*Share* findings. *Discuss* questions.	*Share*—Students share their findings about their local water source. They discuss and debate whether and what measures should be taken to protect their water supply. *Discuss*—Students review what they have learned by discussing their personal and local connections to water supply problems in other parts of the world, and how technology development can affect the availability of water supplies.
	Review	18	*Final Reading* and *Review*	
	Assessment	19	*Summative Assessment*	

Materials and Preparation

Note: All reproducible pages (Student Sheets, Literacy Supplements, and Resource Supplements) and many images from the student book can be found in the Teacher Resources as PDFs or slide presentations.

You may choose to use the following optional Literacy Supplements:

- Literacy Supplement 2.1: *Anticipation Guide* for "Life's Blood—Seeking Water from the Earth"
- Literacy Supplement 2.2: *Science Fact Triangle* for "Water Running Dry"
- Literacy Supplement 2.3: *Science Fact Triangle* for "The Unique Qualities of Water"
- Literacy Supplement 2.4: *Three-Level Reading Guide* for "Groundwater Model: Background"

Prior to *Task 1*—"How Much Water Do You Use?"

1. Gather the materials listed below.

FOR EACH STUDENT

- (optional) Resource Supplement 2.1: *Calculating How Much Water You Use*
- access to a calculator*

*not included in LAB-AIDS equipment package

Prior to *Activity 1*—"Reservoir Roulette: A Journey Through the Water Cycle"

1. Gather the materials listed below.

FOR EACH GROUP OF STUDENTS

- 1 set of Water Cycle Cards (11 Travel Cards and 8 Reservoir Cards)
- 1 Reservoir Roulette spinner
- 1 set of markers
- access to a calculator*
- poster paper*

FOR EACH STUDENT

- 1 Student Sheet 2.1: *A Molecule's Journey Through the Water Cycle*

*not included in LAB-AIDS equipment package

Prior to *Activity 2*—"Where's the Drinking Water?"

Part A: Modeling a Watershed

1. Gather the materials listed below.

FOR THE TEACHER

- 1 stick of modeling clay (to be made into small pieces, one for each group)
- 1 bottle of blue food coloring
- pitcher(s)* with water* (see Step 2 below)
- means of projecting* the following images (see Step 3 below)
  - Map of Major U.S. Rivers
  - Sample Map of Water Flow Within the Model
  - Map of the Mississippi Watershed Sub-Basins

FOR EACH GROUP OF STUDENTS

- 1 LAB-AIDS Watershed Tray
- 1 pipet
- 2 red/blue pencils
- small piece of modeling clay

*not included in LAB-AIDS equipment package

2. To prepare the blue-colored water for students to use with their models, place 10 drops of food coloring into ~250 mL of water. (They will need this for both Parts A and B of the activity.)

3. The images can be displayed directly from the slide presentation for Chapter 2, or if desired, can be printed onto transparency film and used with an overhead projector.

Part B: Groundwater Model

1. Gather the materials listed below.

FOR THE CLASS
- supplies of red sand, white sand, gravel, silt, clay
- pitcher(s) of blue colored water* (see Part A)

FOR EACH GROUP OF STUDENTS
- 1 clear cylindrical bottle
- 2 30-mL graduated cups
- 1 magnifier
- 1 3-mL pipet

FOR EACH STUDENT
- 1 red/blue pencil
- Student Sheet 2.2: *Groundwater Modeling*

*not included in LAB-AIDS equipment package

Prior to Activity 3—*Water Supply Case Studies*

1. Gather the materials listed below.

FOR THE CLASS
- (optional) large world map*
- presentation materials*, such as overhead transparencies and a projector, poster paper, and markers.

FOR EACH STUDENT
- Student Sheet 2.3 a, b, c, d, e, or f: *Case Studies* (see Step 3 below)

*not included in LAB-AIDS equipment package

2. Arrange for access to the Internet and/or library resources for student research.

3. Each student will need to receive only one of the six Student Sheets 2.3 a–f because students will be divided into six (or more) teams, with each team researching one of the case studies.

Prior to Activity 4—*Follow the Flow: Researching Your Water Supply*

1. Gather the materials listed below.

FOR THE CLASS
- (optional) access to Internet-enabled computer* or research materials* (see Step 2 below)
- (optional) telephones* (see Step 3 below)

FOR EACH STUDENT
- (optional) Resource Supplement 2.2: *Developing a Research Strategy*

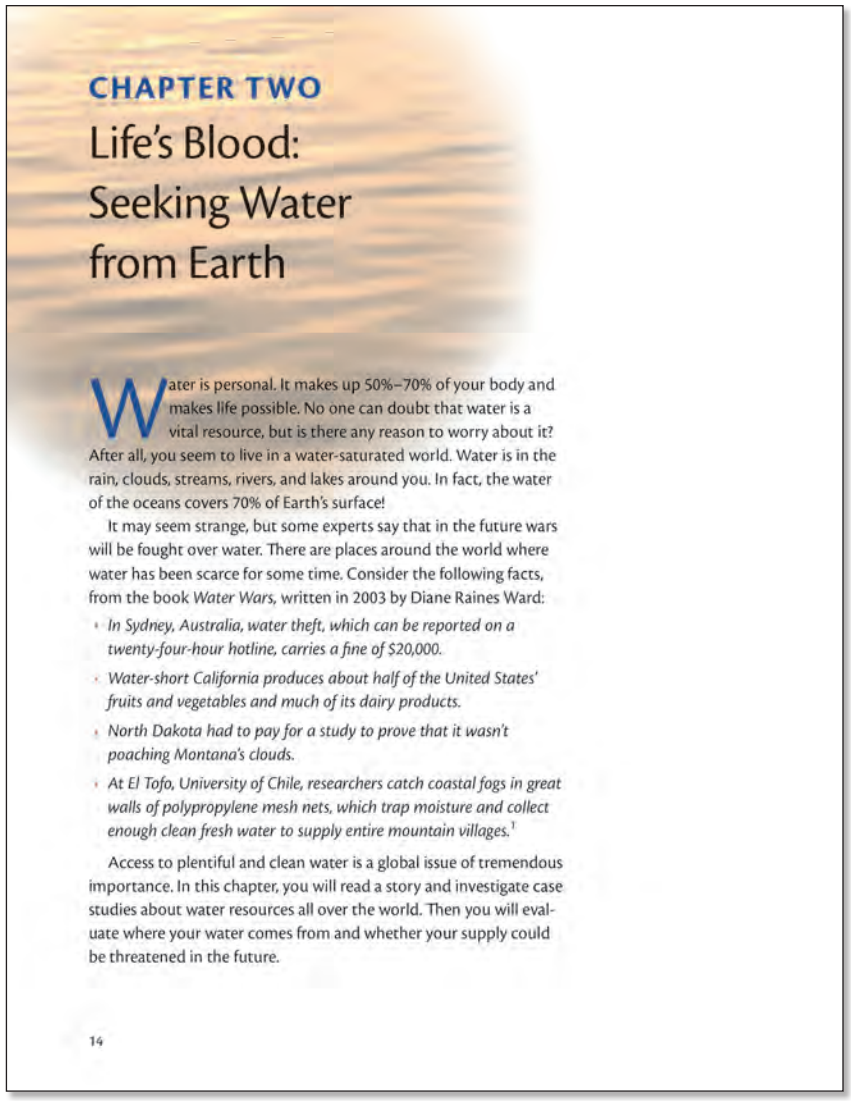
*not included in LAB-AIDS equipment package

2. Gather resources for students to use when researching their local water supply, such as phone books, and state, local, and regional maps, access to the Internet and/or library resources and possibly e-mail communications. Local water studies may be available.

3. (optional) Arrange, if possible, to have an expert, such as a person with the local government or water supply company, come to speak to your class and answer students' questions. You may want to identify certain people in your community who could serve as resources. If so, familiarize them with your project, and arrange times for them to be available for students to contact.

4. (optional) Arrange, if possible, for students to have access to a telephone for communication with local experts.

5. (optional) You might ask an expert from the school, such as the school secretary or administrative assistant, to come to your class and discuss proper business etiquette.



CHAPTER TWO

Life's Blood: Seeking Water from Earth

Water is personal. It makes up 50%–70% of your body and makes life possible. No one can doubt that water is a vital resource, but is there any reason to worry about it? After all, you seem to live in a water-saturated world. Water is in the rain, clouds, streams, rivers, and lakes around you. In fact, the water of the oceans covers 70% of Earth's surface!

It may seem strange, but some experts say that in the future wars will be fought over water. There are places around the world where water has been scarce for some time. Consider the following facts, from the book *Water Wars*, written in 2003 by Diane Raines Ward:

- *In Sydney, Australia, water theft, which can be reported on a twenty-four-hour hotline, carries a fine of $20,000.*
- *Water-short California produces about half of the United States' fruits and vegetables and much of its dairy products.*
- *North Dakota had to pay for a study to prove that it wasn't poaching Montana's clouds.*
- *At El Tofo, University of Chile, researchers catch coastal fogs in great walls of polypropylene mesh nets, which trap moisture and collect enough clean fresh water to supply entire mountain villages.*[1]

Access to plentiful and clean water is a global issue of tremendous importance. In this chapter, you will read a story and investigate case studies about water resources all over the world. Then you will evaluate where your water comes from and whether your supply could be threatened in the future.

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Consider

LITERACY SUPPLEMENT 2.1 *Anticipation Guide* for "Life's Blood—Seeking Water from the Earth"

Before starting the chapter, distribute a copy of 2.1, *Anticipation Guide* for "Life's Blood—Seeking Water from Earth" and have students use the "Before" column to mark whether they agree (Y) or disagree (N) with each statement. Make sure students keep there completed copies because at the end of the chapter they will revisit this, complete the "After" column, and reflect upon any changes in their understanding that occurred.

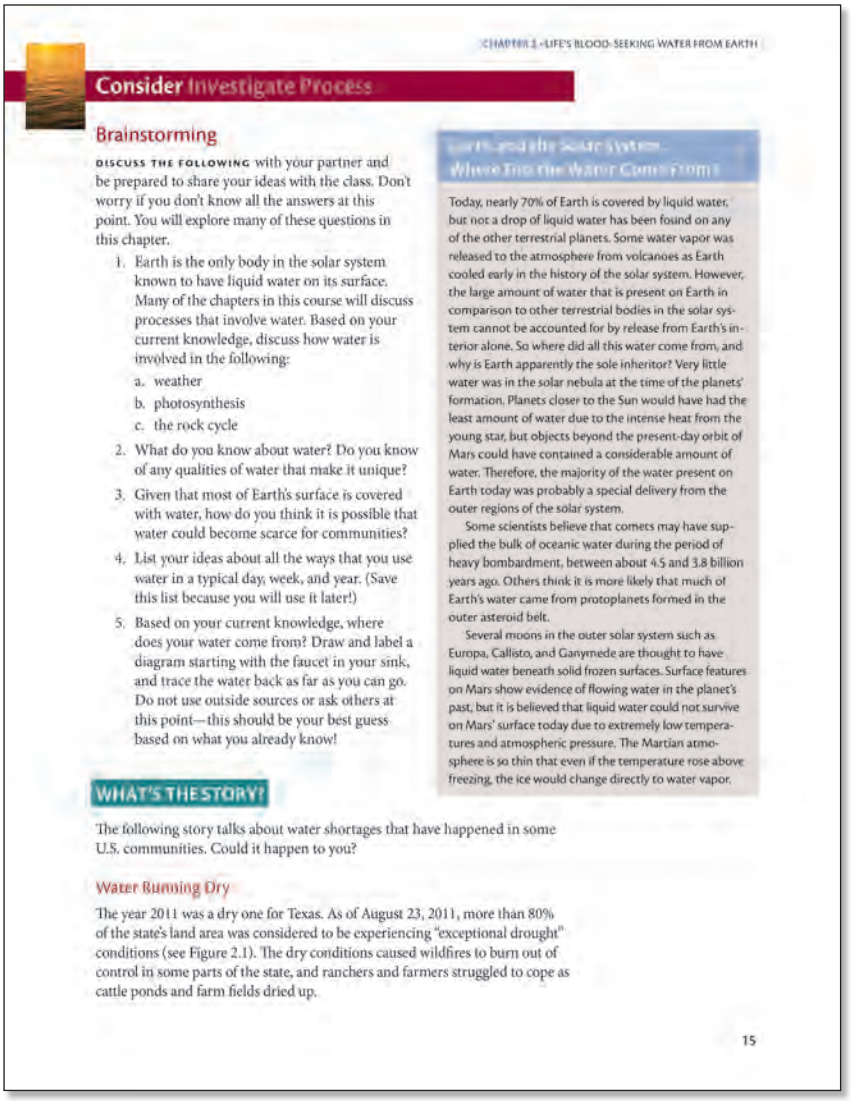
Purpose

Students gain an appreciation of their own dependence on a plentiful, clean water supply and explore their initial understanding of where their water comes from.

Possible Responses to *Brainstorming*

The goal of the brainstorming is to get students thinking about ideas related to this chapter and to do so with energy and spontaneity. You may question students further to push their thinking. However, the answers that are provided here are a reference for teachers, not a key to be used for correcting answers at this time. You can save the students' responses and refer to them again at the end of the chapter to help students see that their thinking is changing or becoming richer.

1. Earth is the only body in the solar system known to have liquid water on its surface. Many of the chapters in this course will discuss processes that involve water. Based on your current knowledge, discuss how water is involved in the following:
   a. weather. *Answers will vary. Students may mention rain as a weather process involving water or say that as weather gets hotter, water evaporates from the surface at a higher rate. Some may discuss the connection between large amounts of rainfall and flooding. They may say that when drought conditions exist, water supplies can become scarce.*
   b. photosynthesis. *Students should have learned in prior science classes that plants use the energy in sunlight to convert water and carbon dioxide into carbohydrates (which provide energy to the plant and make up the plant tissue) and oxygen.*
   c. the rock cycle. *Students may remember from prior science classes that water is involved in the weathering and erosion of exposed rock and the transport and deposition of rock particles (gravel, sand, and mud). They may be aware that water is also intimately involved in plate tectonic processes.*



CHAPTER 2 • LIFE'S BLOOD: SEEKING WATER FROM EARTH

Consider Investigate Process

Brainstorming

DISCUSS THE FOLLOWING with your partner and be prepared to share your ideas with the class. Don't worry if you don't know all the answers at this point. You will explore many of these questions in this chapter.

1. Earth is the only body in the solar system known to have liquid water on its surface. Many of the chapters in this course will discuss processes that involve water. Based on your current knowledge, discuss how water is involved in the following:
   a. weather
   b. photosynthesis
   c. the rock cycle
2. What do you know about water? Do you know of any qualities of water that make it unique?
3. Given that most of Earth's surface is covered with water, how do you think it is possible that water could become scarce for communities?
4. List your ideas about all the ways that you use water in a typical day, week, and year. (Save this list because you will use it later!)
5. Based on your current knowledge, where does your water come from? Draw and label a diagram starting with the faucet in your sink, and trace the water back as far as you can go. Do not use outside sources or ask others at this point—this should be your best guess based on what you already know!

Where Did the Water Come From?

Today, nearly 70% of Earth is covered by liquid water, but not a drop of liquid water has been found on any of the other terrestrial planets. Some water vapor was released to the atmosphere from volcanoes as Earth cooled early in the history of the solar system. However, the large amount of water that is present on Earth in comparison to other terrestrial bodies in the solar system cannot be accounted for by release from Earth's interior alone. So where did all this water come from, and why is Earth apparently the sole inheritor? Very little water was in the solar nebula at the time of the planets' formation. Planets closer to the Sun would have had the least amount of water due to the intense heat from the young star, but objects beyond the present-day orbit of Mars could have contained a considerable amount of water. Therefore, the majority of the water present on Earth today was probably a special delivery from the outer regions of the solar system.

Some scientists believe that comets may have supplied the bulk of oceanic water during the period of heavy bombardment, between about 4.5 and 3.8 billion years ago. Others think it is more likely that much of Earth's water came from protoplanets formed in the outer asteroid belt.

Several moons in the outer solar system such as Europa, Callisto, and Ganymede are thought to have liquid water beneath solid frozen surfaces. Surface features on Mars show evidence of flowing water in the planet's past, but it is believed that liquid water could not survive on Mars' surface today due to extremely low temperatures and atmospheric pressure. The Martian atmosphere is so thin that even if the temperature rose above freezing, the ice would change directly to water vapor.

WHAT'S THE STORY?

The following story talks about water shortages that have happened in some U.S. communities. Could it happen to you?

Water Running Dry

The year 2011 was a dry one for Texas. As of August 23, 2011, more than 80% of the state's land area was considered to be experiencing "exceptional drought" conditions (see Figure 2.1). The dry conditions caused wildfires to burn out of control in some parts of the state, and ranchers and farmers struggled to cope as cattle ponds and farm fields dried up.

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2. What do you know about water? Do you know of any qualities of water that make it unique? *Answers will vary. Students may point out that, unlike most substances, water expands when it solidifies (freezes) rather than shrinks. They may be aware that many other substances dissolve well in water. They will read more about the unique qualities of water in Investigate.*

3. Given that most of Earth's surface is covered with water, how do you think it is possible that water could become scarce for communities? *Students' responses will give you an initial idea of their understanding of where their water resources are. They should know that most of the water on the surface of Earth is salt water in the oceans, which they cannot drink. They should also know that some areas have dry climates and receive very little rainfall. There are also variations in rainfall from year to year, and some areas experience drought conditions. Some students may have had experiences with water shortages. If so, probe their understanding of why these water shortages occurred.*

Teaching Strategies

You may want to do a quick demonstration at this point to emphasize the very small proportion of Earth's water that is accessible freshwater. Fill a 4-liter bucket full of water and say that it represents all the water in the world. Then scoop out a teaspoon of that water, and point out that this is the proportion of Earth's water that is freshwater available for people to use.

Teaching Strategies

You may want students to work with a partner initially to diagram where their water comes from. Circulate and let them do the thinking. Rather than correct them if they don't have something right, ask them questions to get them to think about whether what they have drawn makes sense. For example, if they think that their water comes from an underground tank, ask them if they have ever seen anyone filling this tank.

If your students all get their water from a similar source, you can have the class do some brainstorming about this, drawing on all of their ideas and observations. After students think about it on their own for awhile, you can ask for a volunteer to draw a diagram on the board or on a transparency projected in front of the class. Let other students come up and correct this diagram as they see fit. You should facilitate this, only asking questions from time to time to push their thinking further.

4. List your ideas about all the ways that you use water in a typical day, week, and year. (Save this list because you will use it later!) *Students are likely to list drinking, bathing, cooking, washing clothes, watering lawns, swimming, and other domestic or recreational activities.*

5. Based on your current knowledge, where does your water come from? Draw and label a diagram starting with the faucet in your sink, and trace the water back as far as you can go. Do not use outside sources or ask others at this point—this should be your best guess based on what you already know! *Some students will be surprised at how little they know about where their water comes from. If they have a groundwater supply, you may observe that they think the water comes from underground tanks or rivers. They may be reluctant to recognize that their water touches the dirt.*

What's the Story?

Water Running Dry

This story describes droughts in Texas and a community in Tennessee that completely ran out of water. Have students read the story and answer the *About the Reading* questions that follow. Then discuss the questions as a class.

LITERACY SUPPLEMENT 2.2

Responses to *Science Fact Triangle* for "Water Running Dry"

TOP LEVEL

MIDDLE LEVEL

BOTTOM LEVEL

MIDDLE LEVEL

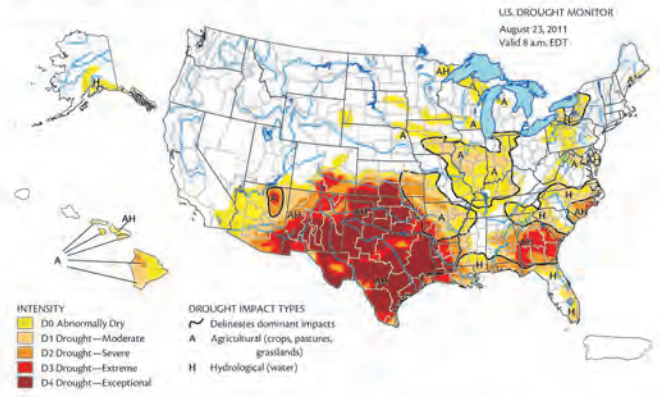

Table: Drought Severity Classification

CATEGORY	DESCRIPTION	POSSIBLE IMPACTS
D0	Abnormally Dry	Going into drought: Short-term dryness slowing planting, growth of crops, or pastures. Coming out of drought: Some lingering water deficits; pastures or crops not fully recovered.
D1	Moderate Drought	Some damage to crops and pastures; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested.
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed.
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions.
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies.

FIGURE 2.1
Map showing areas of the United States that were experiencing drought conditions as of August 23, 2011. The table explains the possible impacts associated with each drought severity level.[1]

Even parts of the United States that thought they would never run out of water have experienced severe shortages. In May 2008, the southeastern United States was in the midst of a prolonged drought, as shown on the map in Figure 2.2.

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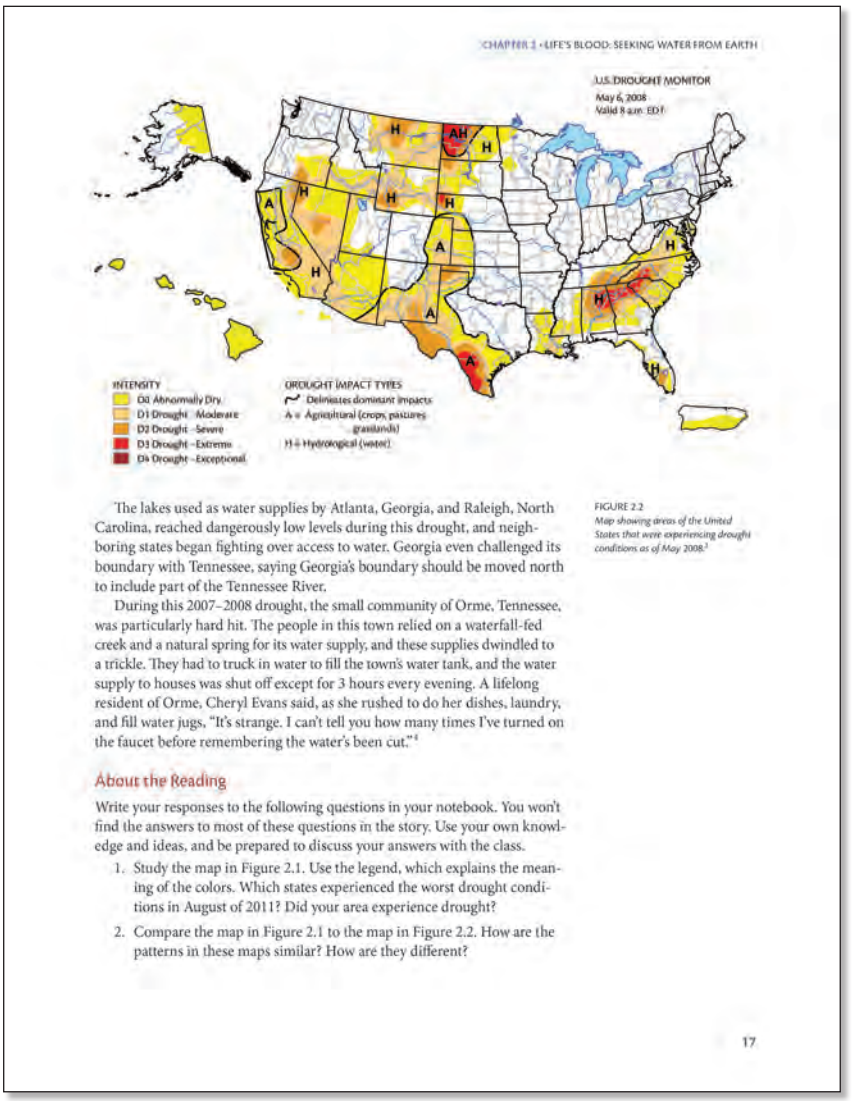
Responses to *About the Reading,* "Water Running Dry"

1. Study the map in Figure 2.1. Use the legend, which explains the meaning of the colors. Which states experienced the worst drought conditions in August of 2011? Did your area experience drought?
   Students should observe that a

2. Compare the map in Figure 2.1 to the map in Figure 2.2. How are the patterns in these maps similar? How are they different?
   Students should notice that

3. Have you or anyone in your family experienced drought? If so, what were some of the effects on people's lives?

4. *Answers will range from*



CHAPTER 2 • LIFE'S BLOOD: SEEKING WATER FROM EARTH

U.S. DROUGHT MONITOR
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INTENSITY
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional

DROUGHT IMPACT TYPES
Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)

The lakes used as water supplies by Atlanta, Georgia, and Raleigh, North Carolina, reached dangerously low levels during this drought, and neighboring states began fighting over access to water. Georgia even challenged its boundary with Tennessee, saying Georgia's boundary should be moved north to include part of the Tennessee River.

During this 2007–2008 drought, the small community of Orme, Tennessee, was particularly hard hit. The people in this town relied on a waterfall-fed creek and a natural spring for its water supply, and these supplies dwindled to a trickle. They had to truck in water to fill the town's water tank, and the water supply to houses was shut off except for 3 hours every evening. A lifelong resident of Orme, Cheryl Evans said, as she rushed to do her dishes, laundry, and fill water jugs, "It's strange. I can't tell you how many times I've turned on the faucet before remembering the water's been cut."[4]

FIGURE 2.2
Map showing areas of the United States that were experiencing drought conditions as of May 2008.[3]

About the Reading

Write your responses to the following questions in your notebook. You won't find the answers to most of these questions in the story. Use your own knowledge and ideas, and be prepared to discuss your answers with the class.

1. Study the map in Figure 2.1. Use the legend, which explains the meaning of the colors. Which states experienced the worst drought conditions in August of 2011? Did your area experience drought?
2. Compare the map in Figure 2.1 to the map in Figure 2.2. How are the patterns in these maps similar? How are they different?

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4. If you were not able to obtain water as you do now and you had to find it yourself, where would you go to get it? How far would you have to go?
   Answers will vary

Teaching Strategies

You might also want to ask students who in their household would be responsible for getting their water if they had to find it themselves? What effects would they expect this to have on their family?

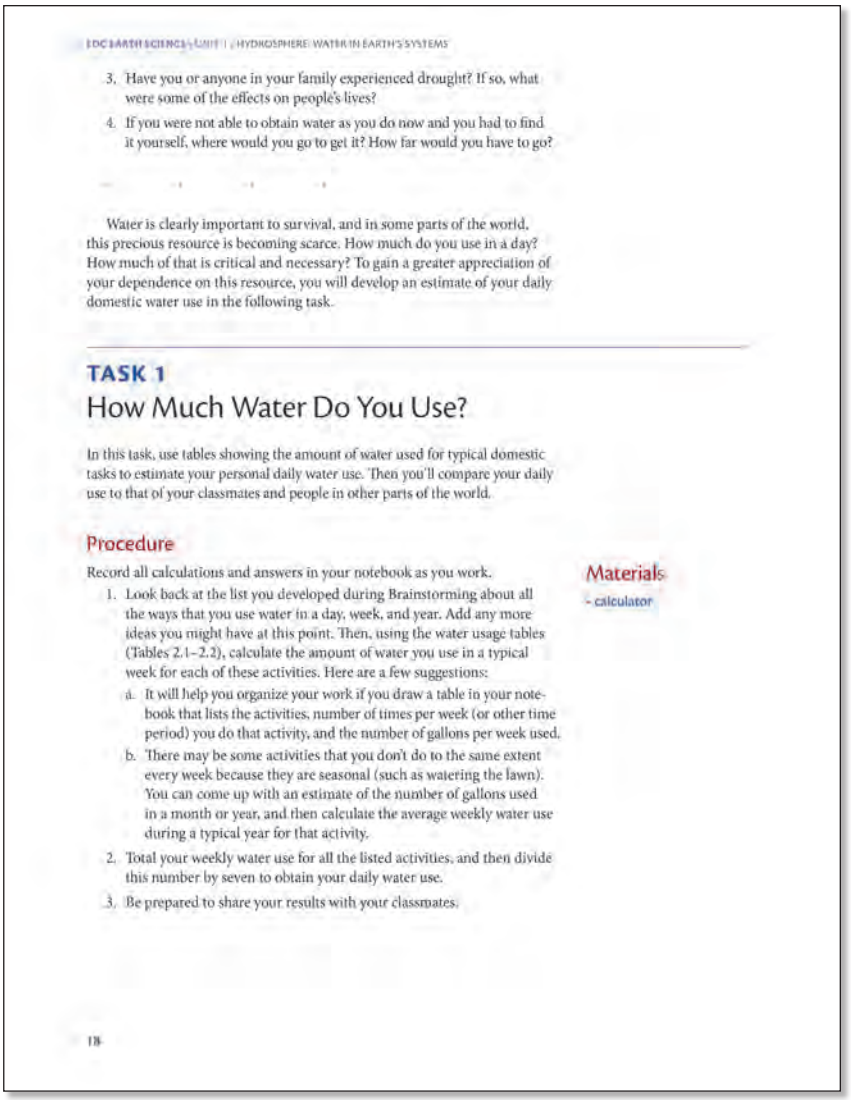
TASK 1

How Much Water Do You Use?

To gain an appreciation for their own dependence on water, students estimate their daily water use.

Facilitating *Task 1:* "How Much Water Do You Use?"

- Before students begin, explain to them that their goal is to estimate, based on the water usage tables in their books, their daily water use for domestic purposes (drinking, washing, and so on). To improve the accuracy of their estimate, they will think through and calculate the amount of water they use in one week (because their water use may vary some from one day to another). Then they will divide their weekly use by seven to obtain an estimate of daily use.
- You may want to help students come up with the appropriate format for a table for recording their calculations. The table should list the activities, number of times per day (or other time period) they do that activity, and the gallons per day used. There should also be a row at the bottom of the table for weekly and daily totals. Alternatively, you could pass out Resource Supplement 2.1: *Calculating How Much Water You Use* for them to use.
- Have students start by revisiting the list of ways they use water that they developed for Question 4 in the Brainstorming, and add to this list as appropriate (Table 2.1: Typical Rate of Water Use for Everyday Activates and Table 2.2: Typical Amount of Water Used Each Time for Certain Activities in the student book may give them more ideas). Then they should use the water usage tables to develop an estimate of their water use.
- When students have finished estimating their water use, have them share their results. For example, you could have them write their estimates on a table on the board. Discuss possible reasons for any differences you notice in these estimates.
- Have students write answers to the Analysis questions, and then discuss them as a class.



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3. Have you or anyone in your family experienced drought? If so, what were some of the effects on people's lives?
4. If you were not able to obtain water as you do now and you had to find it yourself, where would you go to get it? How far would you have to go?

Water is clearly important to survival, and in some parts of the world, this precious resource is becoming scarce. How much do you use in a day? How much of that is critical and necessary? To gain a greater appreciation of your dependence on this resource, you will develop an estimate of your daily domestic water use in the following task.

TASK 1

How Much Water Do You Use?

In this task, use tables showing the amount of water used for typical domestic tasks to estimate your personal daily water use. Then you'll compare your daily use to that of your classmates and people in other parts of the world.

Procedure

Record all calculations and answers in your notebook as you work.

1. Look back at the list you developed during Brainstorming about all the ways that you use water in a day, week, and year. Add any more ideas you might have at this point. Then, using the water usage tables (Tables 2.1–2.2), calculate the amount of water you use in a typical week for each of these activities. Here are a few suggestions:
   a. It will help you organize your work if you draw a table in your notebook that lists the activities, number of times per week (or other time period) you do that activity, and the number of gallons per week used.
   b. There may be some activities that you don't do to the same extent every week because they are seasonal (such as watering the lawn). You can come up with an estimate of the number of gallons used in a month or year, and then calculate the average weekly water use during a typical year for that activity.
2. Total your weekly water use for all the listed activities, and then divide this number by seven to obtain your daily water use.
3. Be prepared to share your results with your classmates.

Materials

- calculator

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Responses to *Analysis* for Task 1: How Much Water Do You Use?

1. According to a report written by the World Water Council in 2000, people in North America use an average of 92 gallons (348 liters) of water per day for domestic purposes. How did your estimate compare with this value? If your estimate was different, think about why and describe some possible reasons. *Students may recognize that*

Teaching Strategies

You may want to take an alternative approach to this activity and have students develop and implement a plan for measuring their water use for a week. They will need to come up with a strategy for measuring the flow rates of faucets, shower heads, and garden hose nozzles, and use these flow rates to calculate the number of gallons used. They can do this by running a faucet and filling a jug for a period of time, and then measuring the amount of water in the jug.

Encourage students to consider how they can apply geometry to measure the water level in the toilet tank. If they measure the length and width of the tank, and open it up to measure the depth of the tank, they can determine the volume of water used by each flush and then convert it to gallons per flush (1 cubic foot of water = 7.48 gallons (28 liters).

There are also various online water-consumption calculators students can use, like the one at csgnetwork.com/waterusagecalc.html.

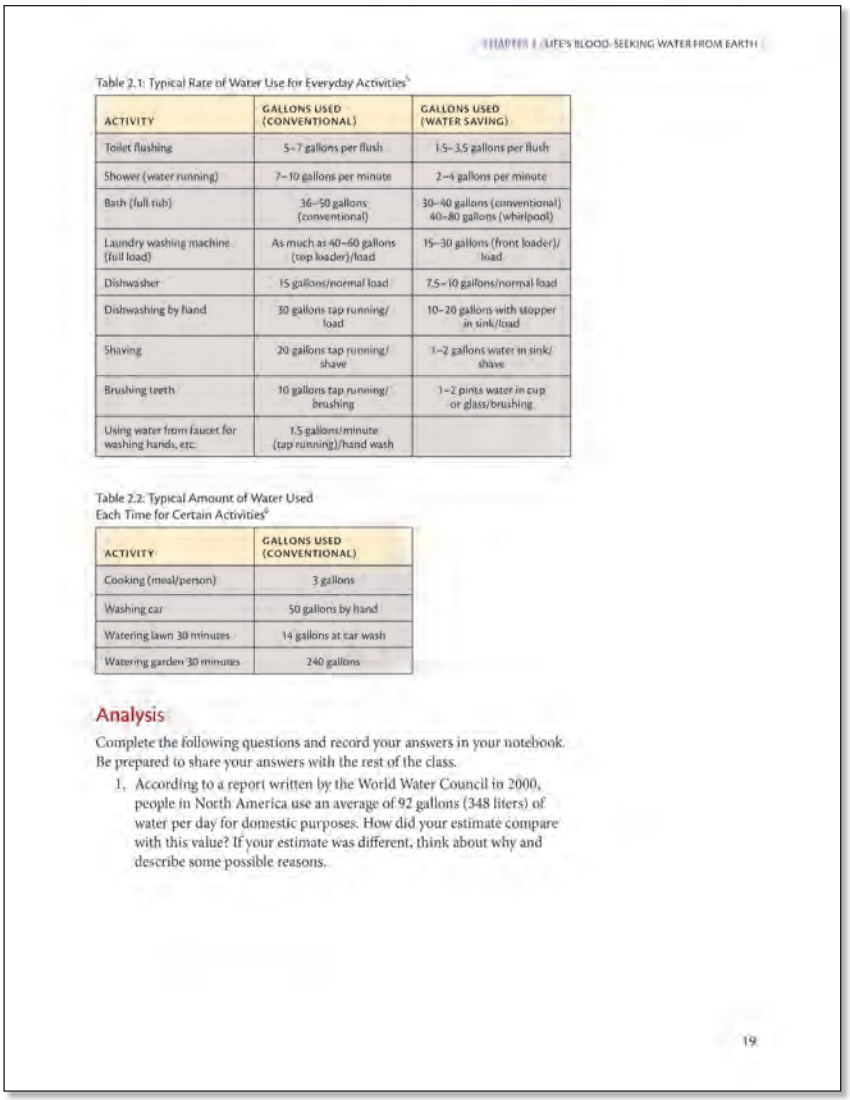

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Table 2.1: Typical Rate of Water Use for Everyday Activities[5]

ACTIVITY	GALLONS USED (CONVENTIONAL)	GALLONS USED (WATER SAVING)
Toilet flushing	5–7 gallons per flush	1.5–3.5 gallons per flush
Shower (water running)	7–10 gallons per minute	2–4 gallons per minute
Bath (full tub)	36–50 gallons (conventional)	30–40 gallons (conventional) 40–80 gallons (whirlpool)
Laundry washing machine (full load)	As much as 40–60 gallons (top loader)/load	15–30 gallons (front loader)/load
Dishwasher	15 gallons/normal load	7.5–10 gallons/normal load
Dishwashing by hand	30 gallons tap running/load	10–20 gallons with stopper in sink/load
Shaving	20 gallons tap running/shave	1–2 gallons water in sink/shave
Brushing teeth	10 gallons tap running/brushing	1–2 pints water in cup or glass/brushing
Using water from faucet for washing hands, etc.	1.5 gallons/minute (tap running)/hand wash	

Table 2.2: Typical Amount of Water Used Each Time for Certain Activities[6]

ACTIVITY	GALLONS USED (CONVENTIONAL)
Cooking (meal/person)	3 gallons
Washing car	50 gallons by hand
Watering lawn 30 minutes	14 gallons at car wash
Watering garden 30 minutes	240 gallons

Analysis

Complete the following questions and record your answers in your notebook. Be prepared to share your answers with the rest of the class.

1. According to a report written by the World Water Council in 2000, people in North America use an average of 92 gallons (348 liters) of water per day for domestic purposes. How did your estimate compare with this value? If your estimate was different, think about why and describe some possible reasons.

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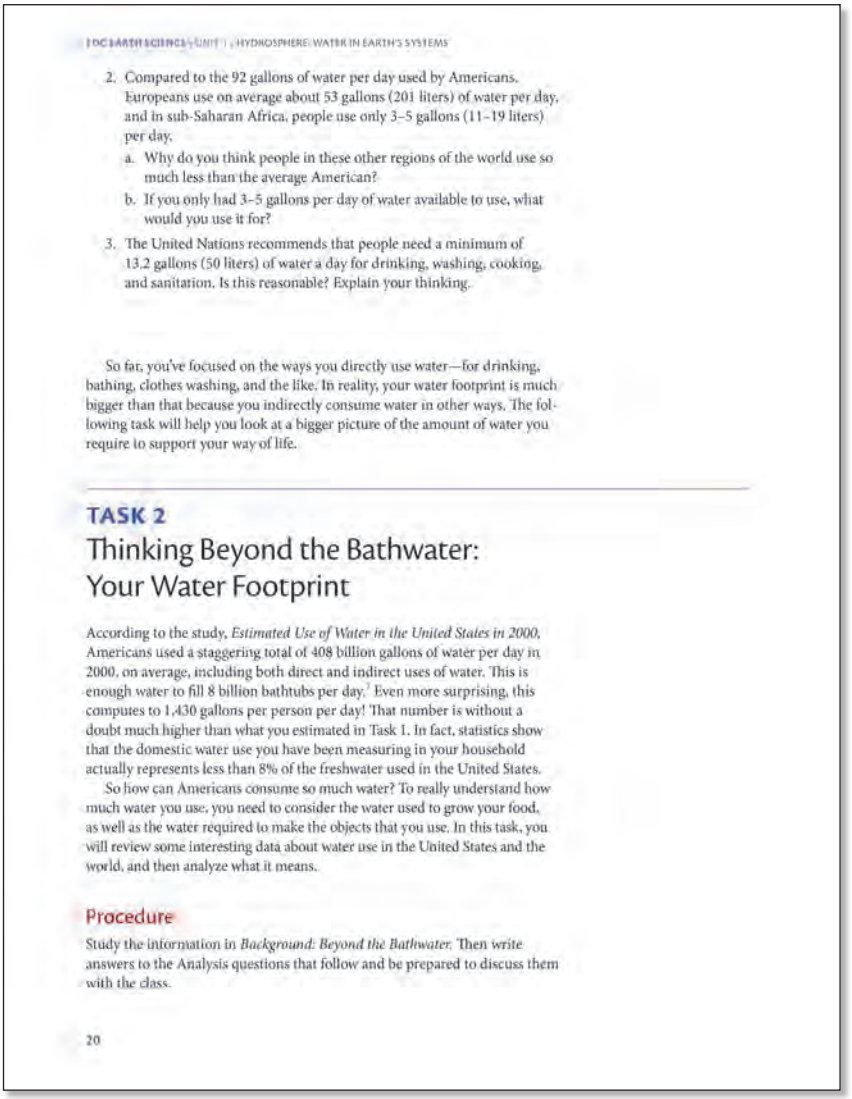
2. Compared to the 92 gallons of water per day used by Americans, Europeans use on average about 53 gallons (201 liters) of water per day, and in sub-Saharan Africa people use only 3–5 gallons (11–19 liters) per day.
   a. Why do people in these other regions of the world use so much less than the average American?
   Answers will vary. It will be
   b. If you only had 3–5 gallons per day of water available to use, what would you use it for?
   Answers will vary. Students

3. The United Nations recommends that people need a minimum of 13.2 gallons (50 liters) of water a day for drinking, washing, cooking, and sanitation. Is this reasonable? Explain your thinking.
Students should compare



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2. Compared to the 92 gallons of water per day used by Americans, Europeans use on average about 53 gallons (201 liters) of water per day, and in sub-Saharan Africa, people use only 3–5 gallons (11–19 liters) per day.
   a. Why do you think people in these other regions of the world use so much less than the average American?
   b. If you only had 3–5 gallons per day of water available to use, what would you use it for?
3. The United Nations recommends that people need a minimum of 13.2 gallons (50 liters) of water a day for drinking, washing, cooking, and sanitation. Is this reasonable? Explain your thinking.

So far, you've focused on the ways you directly use water—for drinking, bathing, clothes washing, and the like. In reality, your water footprint is much bigger than that because you indirectly consume water in other ways. The following task will help you look at a bigger picture of the amount of water you require to support your way of life.

TASK 2

Thinking Beyond the Bathwater: Your Water Footprint

According to the study, *Estimated Use of Water in the United States in 2000*, Americans used a staggering total of 408 billion gallons of water per day in 2000, on average, including both direct and indirect uses of water. This is enough water to fill 8 billion bathtubs per day.[1] Even more surprising, this computes to 1,430 gallons per person per day! That number is without a doubt much higher than what you estimated in Task 1. In fact, statistics show that the domestic water use you have been measuring in your household actually represents less than 8% of the freshwater used in the United States.

So how can Americans consume so much water? To really understand how much water you use, you need to consider the water used to grow your food, as well as the water required to make the objects that you use. In this task, you will review some interesting data about water use in the United States and the world, and then analyze what it means.

Procedure

Study the information in *Background: Beyond the Bathwater*. Then write answers to the Analysis questions that follow and be prepared to discuss them with the class.

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TASK 2

Thinking Beyond the Bathwater: Your Water Footprint

In this task, students think beyond their direct use of water for domestic purposes and explore the ways that they indirectly create a demand for water.

Facilitating *Task 2*—"Thinking Beyond the Bathwater: Your Water Footprint"

- Have students read the introduction to this task and review Table 2.3: Water Used to Produce Various Products and Figures 2.2–2.4 in their student books.
- Have students write the answers to the Analysis questions, and then go over the answers as a class.

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Background: Beyond the Bathwater

Have you ever considered the water that is used to produce the products you use and consume? Table 2.3 shows the estimated amount of water it takes to make some typical foods and other products.

Agriculture places the largest demand on freshwater resources. Approximately 40% of the freshwater used in the United States is for irrigation. Water is also used in industry and mining, for cooling in thermoelectric power plants, to water livestock, and for a variety of commercial purposes. Figures 2.3 and 2.4 show the estimated total water withdrawn (by state) for irrigation and industrial use during 2000. Figure 2.5 shows water usage patterns for general regions of the world.

(Continued on the following page)

Table 2.3: Water Used to Produce Various Products[8]

PRODUCT	AMOUNT OF WATER REQUIRED TO PRODUCE
One cup of coffee	37 gallons
One cup of milk	62 gallons
¼ pound beef burger	660 gallons
One pound of rice	449 gallons
One pound of wheat	132 gallons
One board foot of lumber	5.4 gallons
One pound of plastic	24 gallons
One gallon of paint	13 gallons
One pound of wool or cotton	101 gallons
One refined barrel of crude oil	1,851 gallons
One ton of cement	1,360 gallons
One ton of steel	62,600 gallons
One automobile	36,000 gallons

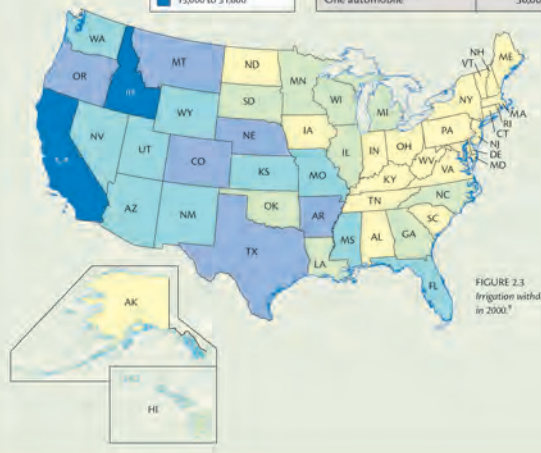


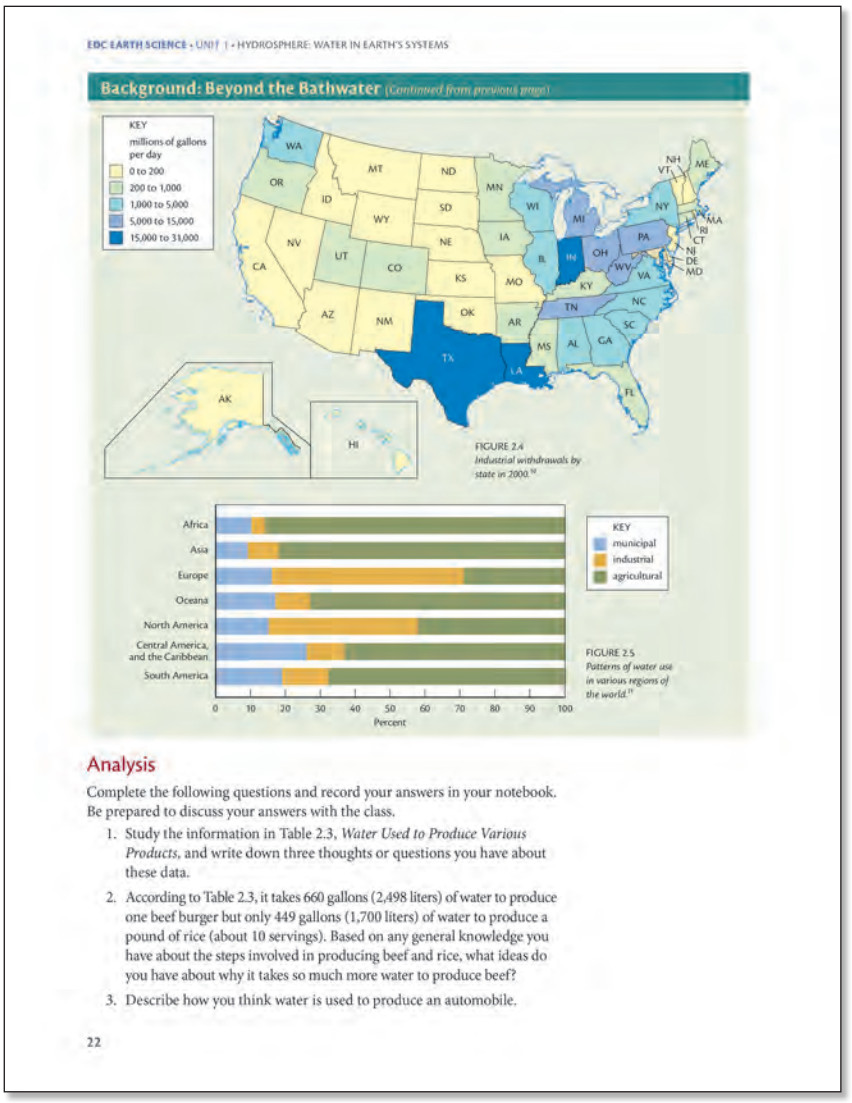
FIGURE 2.3
Irrigation withdrawals by state in 2000.[9]

Responses to *Analysis* for "Thinking Beyond the Bathwater: Your Water Footprint"

1. Study the information on Table 2.3: Water Used to Produce Various Products and write down three thoughts or ques-tions you have about these data. *Answers will vary. Students may*

2. According to Table 2.3, it takes 660 gallons (2,498 liters) of water to produce one beef burger but only 449 gallons (1,700 liters) of water to produce a pound of rice (about 10 servings). Based on any general knowledge you have about the steps involved in producing beef and rice, what ideas do you have about why it takes so much more water to produce beef?
Students should recognize

3. Describe how you think water is used to produce an automobile.
Students might recognize



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Background: Beyond the Bathwater *(Continued from previous page)*

FIGURE 2.4
Industrial withdrawals by state in 2000.[10]

FIGURE 2.5
Patterns of water use in various regions of the world.[11]

Analysis

Complete the following questions and record your answers in your notebook. Be prepared to discuss your answers with the class.

1. Study the information in Table 2.3, *Water Used to Produce Various Products*, and write down three thoughts or questions you have about these data.
2. According to Table 2.3, it takes 660 gallons (2,498 liters) of water to produce one beef burger but only 449 gallons (1,700 liters) of water to produce a pound of rice (about 10 servings). Based on any general knowledge you have about the steps involved in producing beef and rice, what ideas do you have about why it takes so much more water to produce beef?
3. Describe how you think water is used to produce an automobile.

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4. Write three sentences about what the data in Figures 2.3 and 2.4 show about water usage for irrigation and industry in the United States. Based on your knowledge about different areas of the country, write down some reasons why you think these trends exist.
Answers will vary. Students may

5. According to statistics compiled by the United States Geological Survey (USGS), Texas, California, and Florida used more water than any other states in 2000. List possible reasons for the heavier water use in these states.
Students may speculate that

6. During 2012, a severe drought hit much of the midwestern United States, and there was concern that food prices would rise. Explain how a lack of water in regions of the U.S. could cause food prices in your grocery store to increase.
Students should recognize that

7. How did your state's water use for irrigation and industry compare with other states during 2000? Compare your state to another that used more or less water and try to explain why the water use was different.
Students' answers will reflect

8. Write two sentences that describe patterns of worldwide water usage depicted in Figure 2.5. Then explain why the patterns of water usage are different from one region of the world to another.
Students should note that

Science Background

Water Use and Climate

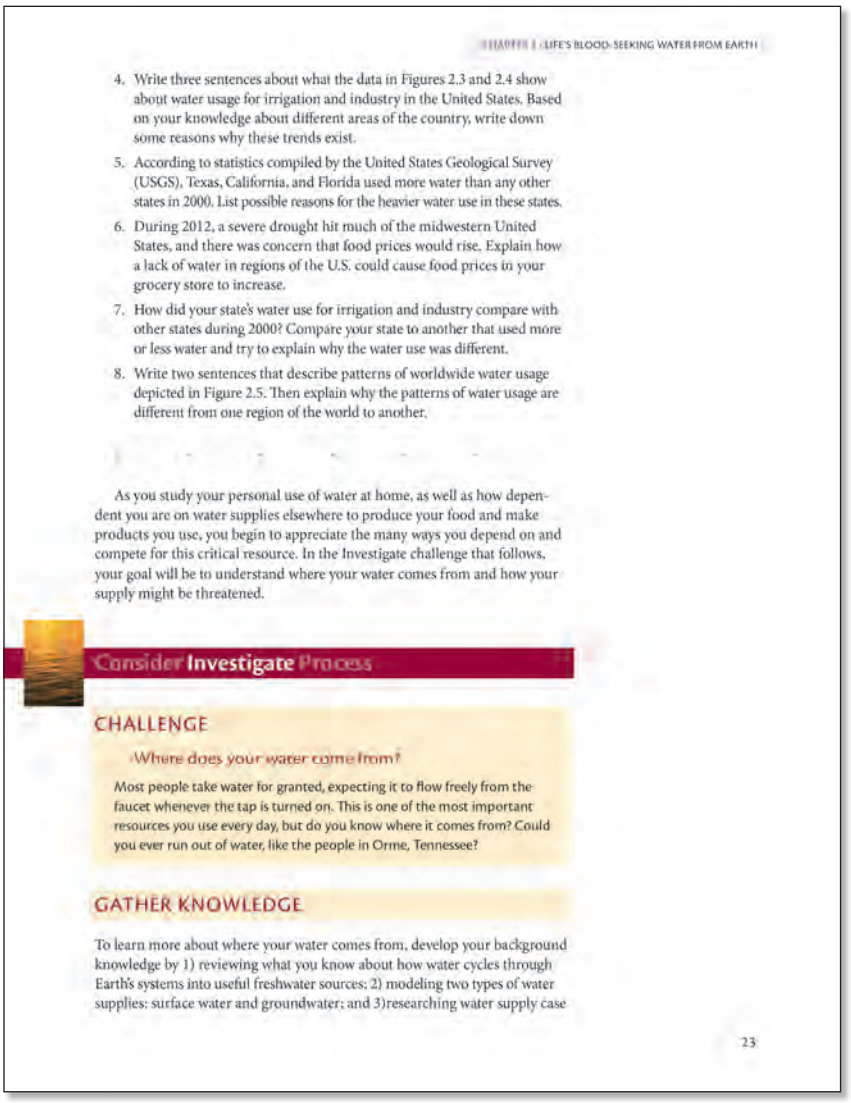
You may want students to consider how the following information from the USGS study about climate in 2000 may have affected water use in various states:

> The year 2000 was one of climatic extremes. Weather in the Midwest and Northeast was characterized by prolonged periods of cooler and wetter than normal conditions. During the summer months (June–August), precipitation was above average in 15 states throughout this region. The South and West experienced severe drought as a result of below-normal precipitation and above-normal temperatures. Alabama, Florida, Georgia, Louisiana, and Mississippi had the driest May–October period on record during 2000. Streams and reservoirs dropped to record low levels, and some cities imposed drought restrictions. The driest July–September period was recorded in Arkansas, Kansas, Louisiana, Mississippi, Oklahoma, and Texas. Much of the western United States also was in severe drought—including Arizona, Colorado, Idaho, Montana, New Mexico, Utah, and Wyoming. By August 2000, 36 percent of the United States was in severe to extreme drought, leading to widespread wildfires and other drought-related damages." (National Oceanic and Atmospheric Administration, 2001; U.S. Department of Agriculture, 2000).

Investigate

Purpose

Students are challenged to research where their water comes from and what are potential threats to their water supply.



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4. Write three sentences about what the data in Figures 2.3 and 2.4 show about water usage for irrigation and industry in the United States. Based on your knowledge about different areas of the country, write down some reasons why these trends exist.
5. According to statistics compiled by the United States Geological Survey (USGS), Texas, California, and Florida used more water than any other states in 2000. List possible reasons for the heavier water use in these states.
6. During 2012, a severe drought hit much of the midwestern United States, and there was concern that food prices would rise. Explain how a lack of water in regions of the U.S. could cause food prices in your grocery store to increase.
7. How did your state's water use for irrigation and industry compare with other states during 2000? Compare your state to another that used more or less water and try to explain why the water use was different.
8. Write two sentences that describe patterns of worldwide water usage depicted in Figure 2.5. Then explain why the patterns of water usage are different from one region of the world to another.

As you study your personal use of water at home, as well as how dependent you are on water supplies elsewhere to produce your food and make products you use, you begin to appreciate the many ways you depend on and compete for this critical resource. In the Investigate challenge that follows, your goal will be to understand where your water comes from and how your supply might be threatened.

Consider **Investigate** Process

CHALLENGE

Where does your water come from?

Most people take water for granted, expecting it to flow freely from the faucet whenever the tap is turned on. This is one of the most important resources you use every day, but do you know where it comes from? Could you ever run out of water, like the people in Orme, Tennessee?

GATHER KNOWLEDGE

To learn more about where your water comes from, develop your background knowledge by 1) reviewing what you know about how water cycles through Earth's systems into useful freshwater sources; 2) modeling two types of water supplies: surface water and groundwater; and 3)researching water supply case

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GATHER KNOWLEDGE

ACTIVITY 1

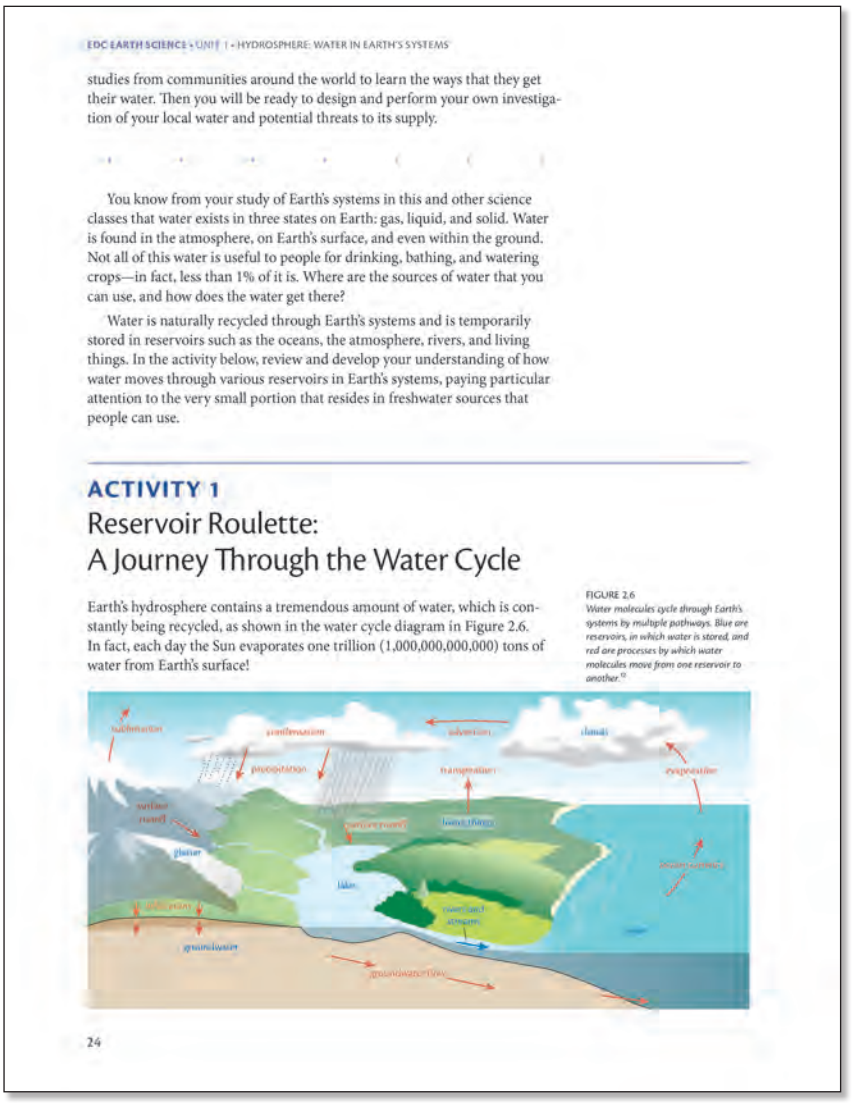
Reservoir Roulette: A Journey Through the Water Cycle

Students diagram the path of a molecule of water in various scenarios to review what they know about how water is cycled through the hydrosphere.

Science Background

When Did the Water Cycle Start?

Early in the history of the solar system, Earth formed from the collision of particles and debris from a supernova explosion. The many impacts that occurred created a great deal of heat, so the early Earth was completely molten. As Earth cooled, a hard, rocky crust formed on the surface. Eventually, as Earth cooled even more, water vapor in the atmosphere condensed and it rained. Water collected on the planet's surface and the early oceans formed. Since then, energy from the Sun has caused water to continually cycle among the atmosphere, land, and oceans.



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studies from communities around the world to learn the ways that they get their water. Then you will be ready to design and perform your own investigation of your local water and potential threats to its supply.

You know from your study of Earth's systems in this and other science classes that water exists in three states on Earth: gas, liquid, and solid. Water is found in the atmosphere, on Earth's surface, and even within the ground. Not all of this water is useful to people for drinking, bathing, and watering crops—in fact, less than 1% of it is. Where are the sources of water that you can use, and how does the water get there?

Water is naturally recycled through Earth's systems and is temporarily stored in reservoirs such as the oceans, the atmosphere, rivers, and living things. In the activity below, review and develop your understanding of how water moves through various reservoirs in Earth's systems, paying particular attention to the very small portion that resides in freshwater sources that people can use.

ACTIVITY 1

Reservoir Roulette: A Journey Through the Water Cycle

Earth's hydrosphere contains a tremendous amount of water, which is constantly being recycled, as shown in the water cycle diagram in Figure 2.6. In fact, each day the Sun evaporates one trillion (1,000,000,000,000) tons of water from Earth's surface!

FIGURE 2.6
Water molecules cycle through Earth's systems by multiple pathways. Blue are reservoirs, in which water is stored, and red are processes by which water molecules move from one reservoir to another.[1]

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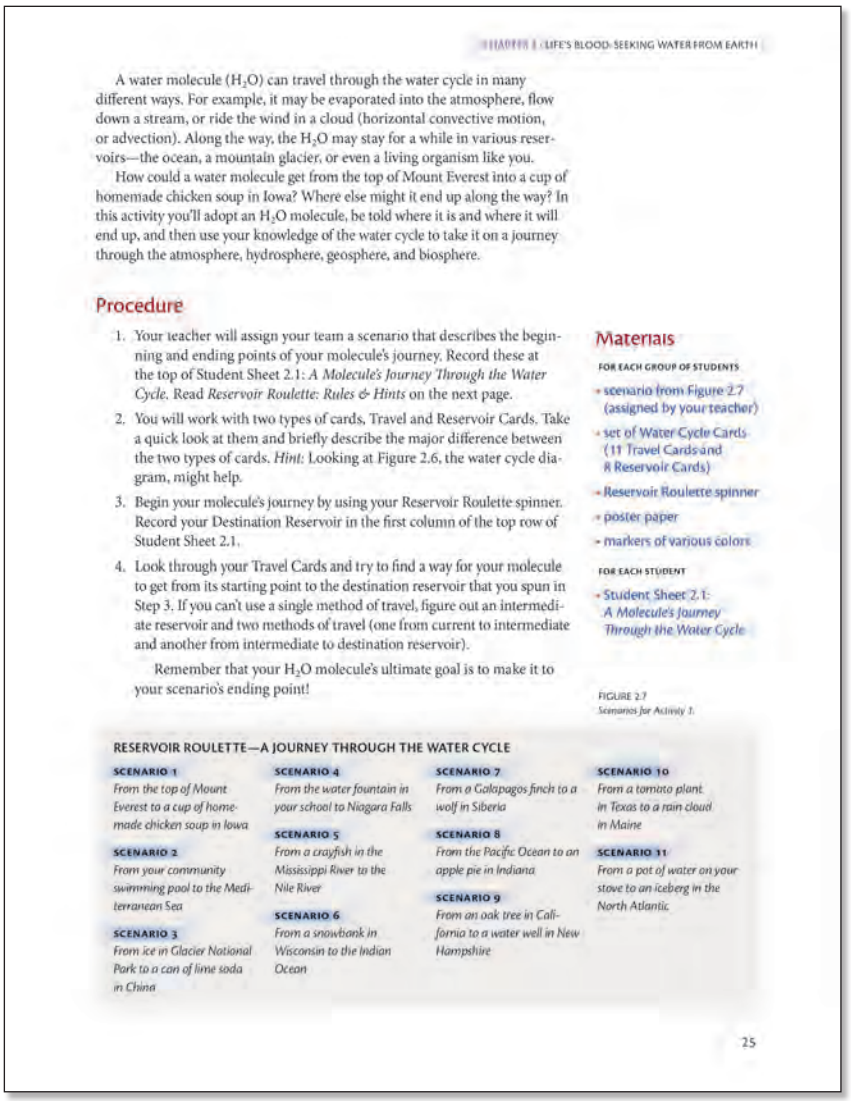
Facilitating *Activity 1*— "Reservoir Roulette"

- Divide the class into groups of two to four students, and pass out a set of Water Cycle Cards (11 Travel cards, 8 Reservoir cards), and a Reservoir Roulette spinner to each group.
- Distribute a copy of Student Sheet 2.1: *A Molecule's Journey through the Water Cycle* to each student.
- Assign one of the scenarios in Figure 2.7 in the student book to each group.
- Have students look at the Travel and Reservoir cards, and review the procedures and rules in their student book. As a class, model how they will use the spinner and chart the journey of a water molecule on Student Sheet 2.1 by going through a few examples.
- Have students proceed with the activity, filling in Student Sheet 2.1 until they reach their final destination. Circulate around the room as students do the activity, listening to see how well they understand the various water-cycle processes and reservoirs. Ask them to articulate why they selected particular Travel and Reservoir cards, encouraging them to use the information on the cards to help them make decisions.



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A water molecule (H_2O) can travel through the water cycle in many different ways. For example, it may be evaporated into the atmosphere, flow down a stream, or ride the wind in a cloud (horizontal convective motion, or advection). Along the way, the H_2O may stay for a while in various reservoirs—the ocean, a mountain glacier, or even a living organism like you.

How could a water molecule get from the top of Mount Everest into a cup of homemade chicken soup in Iowa? Where else might it end up along the way? In this activity you'll adopt an H_2O molecule, be told where it is and where it will end up, and then use your knowledge of the water cycle to take it on a journey through the atmosphere, hydrosphere, geosphere, and biosphere.

Procedure

1. Your teacher will assign your team a scenario that describes the beginning and ending points of your molecule's journey. Record these at the top of Student Sheet 2.1: *A Molecule's Journey Through the Water Cycle*. Read *Reservoir Roulette: Rules & Hints* on the next page.
2. You will work with two types of cards, Travel and Reservoir Cards. Take a quick look at them and briefly describe the major difference between the two types of cards. *Hint:* Looking at Figure 2.6, the water cycle diagram, might help.
3. Begin your molecule's journey by using your Reservoir Roulette spinner. Record your Destination Reservoir in the first column of the top row of Student Sheet 2.1.
4. Look through your Travel Cards and try to find a way for your molecule to get from its starting point to the destination reservoir that you spun in Step 3. If you can't use a single method of travel, figure out an intermediate reservoir and two methods of travel (one from current to intermediate and another from intermediate to destination reservoir).

Remember that your H_2O molecule's ultimate goal is to make it to your scenario's ending point!

Materials

FOR EACH GROUP OF STUDENTS

- scenario from Figure 2.7 (assigned by your teacher)
- set of Water Cycle Cards (11 Travel Cards and 8 Reservoir Cards)
- Reservoir Roulette spinner
- poster paper
- markers of various colors

FOR EACH STUDENT

- Student Sheet 2.1: *A Molecule's Journey Through the Water Cycle*

FIGURE 2.7
Scenarios for Activity 1.

RESERVOIR ROULETTE—A JOURNEY THROUGH THE WATER CYCLE

SCENARIO 1
From the top of Mount Everest to a cup of homemade chicken soup in Iowa

SCENARIO 2
From your community swimming pool to the Mediterranean Sea

SCENARIO 3
From ice in Glacier National Park to a can of lime soda in China

SCENARIO 4
From the water fountain in your school to Niagara Falls

SCENARIO 5
From a crayfish in the Mississippi River to the Nile River

SCENARIO 6
From a snowbank in Wisconsin to the Indian Ocean

SCENARIO 7
From a Galapagos finch to a wolf in Siberia

SCENARIO 8
From the Pacific Ocean to an apple pie in Indiana

SCENARIO 9
From an oak tree in California to a water well in New Hampshire

SCENARIO 10
From a tomato plant in Texas to a rain cloud in Maine

SCENARIO 11
From a pot of water on your stove to an iceberg in the North Atlantic

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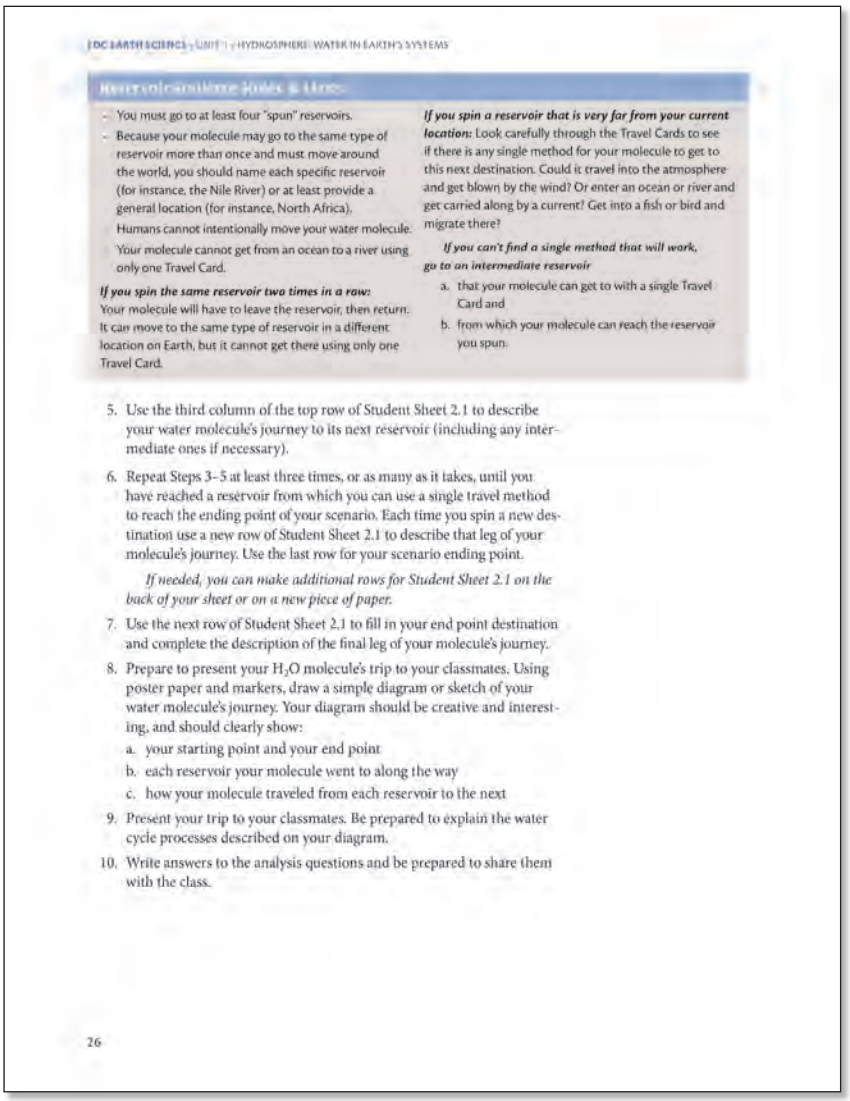
- When groups have completed Student Sheet 2.1 and reached their destinations, they should draw a diagram that describes the pathway their molecule of water took. They should label their diagram to show the reservoirs their molecule passed through, the processes by which it traveled, and any phase changes that the molecule underwent. It's possible that students (and you) may find at this point that some parts of the journey they envisioned during the activity didn't make sense. Encourage them to improve their water molecule journey in their diagram to make it more accurate.

- As students work, circulate around the class, and ask them to explain their diagrams. Also, ask them to explain the water-cycle terms they use to make sure they understand them.
- When all groups have finished their diagrams, have them share them with the rest of the class. Then develop a class diagram of the water cycle on the board, using all the terms on the Travel and Reservoir cards.



- You must go to at least four "spun" reservoirs.
- Because your molecule may go to the same type of reservoir more than once and must move around the world, you should name each specific reservoir (for instance, the Nile River) or at least provide a general location (for instance, North Africa).
- Humans cannot intentionally move your water molecule.
- Your molecule cannot get from an ocean to a river using only one Travel Card.

If you spin the same reservoir two times in a row: Your molecule will have to leave the reservoir, then return. It can move to the same type of reservoir in a different location on Earth, but it cannot get there using only one Travel Card.

If you spin a reservoir that is very far from your current location: Look carefully through the Travel Cards to see if there is any single method for your molecule to get to this next destination. Could it travel into the atmosphere and get blown by the wind? Or enter an ocean or river and get carried along by a current? Get into a fish or bird and migrate there?

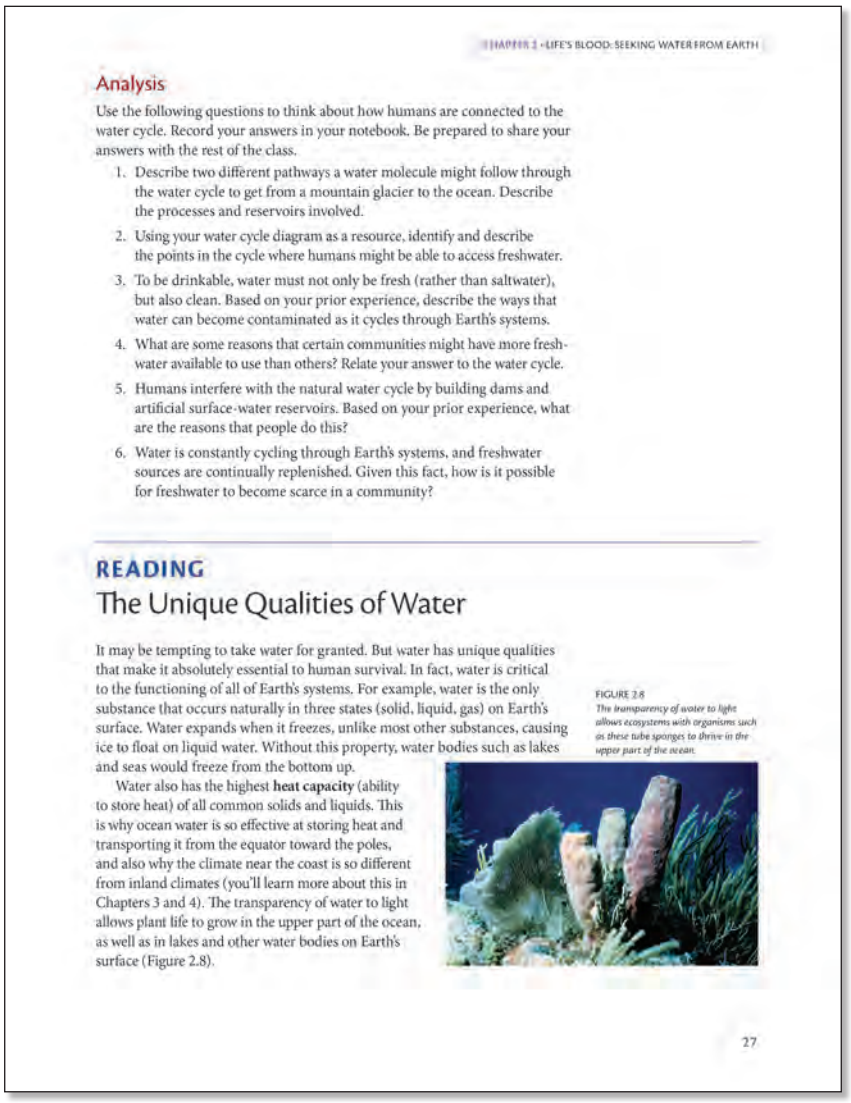
If you can't find a single method that will work, go to an intermediate reservoir

a. that your molecule can get to with a single Travel Card and
b. from which your molecule can reach the reservoir you spun.

5. Use the third column of the top row of Student Sheet 2.1 to describe your water molecule's journey to its next reservoir (including any intermediate ones if necessary).
6. Repeat Steps 3–5 at least three times, or as many as it takes, until you have reached a reservoir from which you can use a single travel method to reach the ending point of your scenario. Each time you spin a new destination use a new row of Student Sheet 2.1 to describe that leg of your molecule's journey. Use the last row for your scenario ending point.

   If needed, you can make additional rows for Student Sheet 2.1 on the back of your sheet or on a new piece of paper.
7. Use the next row of Student Sheet 2.1 to fill in your end point destination and complete the description of the final leg of your molecule's journey.
8. Prepare to present your H_2O molecule's trip to your classmates. Using poster paper and markers, draw a simple diagram or sketch of your water molecule's journey. Your diagram should be creative and interesting, and should clearly show:
   a. your starting point and your end point
   b. each reservoir your molecule went to along the way
   c. how your molecule traveled from each reservoir to the next
9. Present your trip to your classmates. Be prepared to explain the water cycle processes described on your diagram.
10. Write answers to the analysis questions and be prepared to share them with the class.

Responses to *Analysis* for *Activity* 1—"Reservoir Roulette"



CHAPTER 2 • LIFE'S BLOOD: SEEKING WATER FROM EARTH

Analysis

Use the following questions to think about how humans are connected to the water cycle. Record your answers in your notebook. Be prepared to share your answers with the rest of the class.

1. Describe two different pathways a water molecule might follow through the water cycle to get from a mountain glacier to the ocean. Describe the processes and reservoirs involved.
2. Using your water cycle diagram as a resource, identify and describe the points in the cycle where humans might be able to access freshwater.
3. To be drinkable, water must not only be fresh (rather than saltwater), but also clean. Based on your prior experience, describe the ways that water can become contaminated as it cycles through Earth's systems.
4. What are some reasons that certain communities might have more freshwater available to use than others? Relate your answer to the water cycle.
5. Humans interfere with the natural water cycle by building dams and artificial surface-water reservoirs. Based on your prior experience, what are the reasons that people do this?
6. Water is constantly cycling through Earth's systems, and freshwater sources are continually replenished. Given this fact, how is it possible for freshwater to become scarce in a community?

READING

The Unique Qualities of Water

It may be tempting to take water for granted. But water has unique qualities that make it absolutely essential to human survival. In fact, water is critical to the functioning of all of Earth's systems. For example, water is the only substance that occurs naturally in three states (solid, liquid, gas) on Earth's surface. Water expands when it freezes, unlike most other substances, causing ice to float on liquid water. Without this property, water bodies such as lakes and seas would freeze from the bottom up.

Water also has the highest **heat capacity** (ability to store heat) of all common solids and liquids. This is why ocean water is so effective at storing heat and transporting it from the equator toward the poles, and also why the climate near the coast is so different from inland climates (you'll learn more about this in Chapters 3 and 4). The transparency of water to light allows plant life to grow in the upper part of the ocean, as well as in lakes and other water bodies on Earth's surface (Figure 2.8).

FIGURE 2.8
The transparency of water to light allows ecosystems with organisms such as these tube sponges to thrive in the upper part of the ocean.

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1. Describe two different pathways a water molecule might follow through the water cycle to get from a mountain glacier to the ocean. Describe the processes and reservoirs involved.
   Answers will vary but

2. Using your water cycle diagram as a resource, identify and describe the points in the water cycle where humans might be able to access freshwater.
   Students should recognize

3. To be drinkable, water must not only be fresh (rather than saltwater), but also clean. Based on your prior experience, describe the ways that water can become contaminated as it cycles through Earth's systems.
   Students should recognize

4. What are some reasons that certain communities might have more freshwater available to use than others? Relate your answer to the water cycle.
   Students should understand that

   er.

5. Humans interfere with the natural water cycle by building dams and artificial surface-water reservoirs. Based on your prior experience, what are the reasons that people do this?
   Students may know that dams

6. Water is constantly cycling through Earth's systems, and freshwater sources are continually replenished. Given this fact, how is it possible for freshwater to become scarce in a community? *Students may say that a community could be located in an area that does not receive much precipitation. Some may also say that overuse in areas of dense population could deplete water supplies. They may also be aware that water can become contaminated and no longer safe to use.*

READING

The Unique Qualities of Water

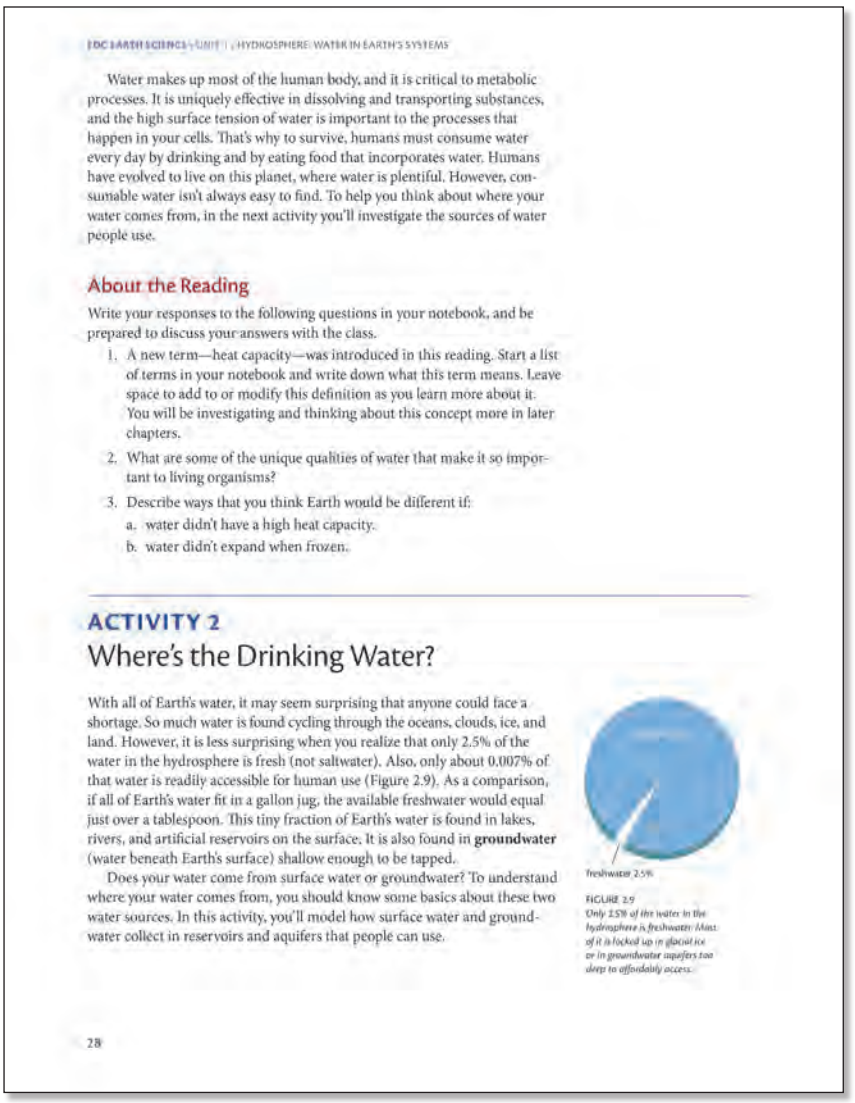
This reading describes the qualities of water that make it unique and essential to human survival. Have students complete the reading and prepare answers to the About the Reading questions. Then, discuss them as a class.

LITERACY SUPPLEMENT 2.3

Responses to *Science Fact Triangle* for "The Unique Qualities of Water"

Responses to About the Reading for "The Unique Qualities of Water"

1. A new term—**heat capacity**—was introduced in this reading. Start a list of terms in your notebook and write down what this term means. Leave space to add to or modify this definition as you learn more about it. You will be investigating and thinking about this concept more in later chapters.
   Students should create a vocabulary list for this chapter to help them learn the language of Earth Science.
2. What are some of the unique qualities of water that make it so important to living organisms?
   Water is the only substance that
3. Describe ways that you think Earth would be different if:
   a. water didn't have a high heat capacity.
      Students should recognize
   b. water didn't expand when frozen.
      Water bodies would



EDC EARTH SCIENCE • UNIT 1 • HYDROSPHERE: WATER IN EARTH'S SYSTEMS

Water makes up most of the human body, and it is critical to metabolic processes. It is uniquely effective in dissolving and transporting substances, and the high surface tension of water is important to the processes that happen in your cells. That's why to survive, humans must consume water every day by drinking and by eating food that incorporates water. Humans have evolved to live on this planet, where water is plentiful. However, consumable water isn't always easy to find. To help you think about where your water comes from, in the next activity you'll investigate the sources of water people use.

About the Reading

Write your responses to the following questions in your notebook, and be prepared to discuss your answers with the class.

1. A new term—heat capacity—was introduced in this reading. Start a list of terms in your notebook and write down what this term means. Leave space to add to or modify this definition as you learn more about it. You will be investigating and thinking about this concept more in later chapters.
2. What are some of the unique qualities of water that make it so important to living organisms?
3. Describe ways that you think Earth would be different if:
   a. water didn't have a high heat capacity.
   b. water didn't expand when frozen.

ACTIVITY 2

Where's the Drinking Water?

With all of Earth's water, it may seem surprising that anyone could face a shortage. So much water is found cycling through the oceans, clouds, ice, and land. However, it is less surprising when you realize that only 2.5% of the water in the hydrosphere is fresh (not saltwater). Also, only about 0.007% of that water is readily accessible for human use (Figure 2.9). As a comparison, if all of Earth's water fit in a gallon jug, the available freshwater would equal just over a tablespoon. This tiny fraction of Earth's water is found in lakes, rivers, and artificial reservoirs on the surface. It is also found in **groundwater** (water beneath Earth's surface) shallow enough to be tapped.

Does your water come from surface water or groundwater? To understand where your water comes from, you should know some basics about these two water sources. In this activity, you'll model how surface water and groundwater collect in reservoirs and aquifers that people can use.

FIGURE 2.9
Only 2.5% of the water in the hydrosphere is freshwater. Most of it is locked up in glacial ice or in groundwater aquifers too deep to affordably access.

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ACTIVITY 2

Where's the Drinking Water?

The modeling in this activity will help students understand the possible sources of their local drinking water supply.