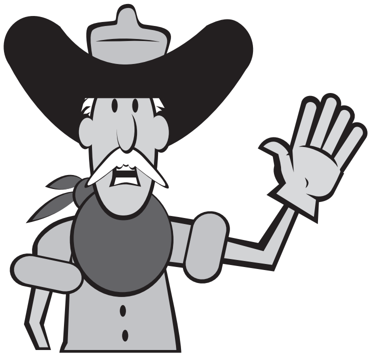

MAJOR RIVERS
TEXAS WATER EDUCATION PROGRAM

Teacher's Guide

Welcome to the revised edition of Major Rivers, a Texas Water Education Program for elementary students.

About Major Rivers

Major Rivers is designed to help fourth- and fifth-grade students learn about Texas' major water resources, how water is treated and delivered to their homes and schools, and how to care for their water resources and use them wisely.

The program's host, Major Rivers (named for the major rivers of Texas), and his horse Aquifer cover these topics in eight lessons that include a variety of activities in science, math, language arts, social studies, and other subjects. The teaching package includes student workbooks, pretest and posttest sheets, home information leaflets, handouts, and an introductory video. This Teacher's Guide shows how to use these materials and contains additional learning activities.

Most teachers complete the Major Rivers program over a two-week period, typically as part of their social studies and science curriculums.

The History of Major Rivers

LCRA began developing Major Rivers in 1984 as part of its water conservation activities in the lower Colorado River basin.

In 1987 LCRA hired Educational Development Specialists, a California-based curriculum company, to help develop the program. LCRA also assembled an advisory group of teachers, curriculum directors, water utility officials, and other officials from throughout the lower Colorado River basin to determine subject matter and educational requirements. Field tests of the program in 1988 throughout the lower Colorado River basin played a significant role in shaping the final version of the lessons and of Major Rivers' depiction as a crusty, dusty Texas cowboy.

LCRA also reached an agreement with the Texas Water Development Board, the Texas Department of State Health Services and the Texas Water Commission (now the Texas Commission on Environmental Quality) to distribute a statewide version of the program.

Formally launched in 1989, Major Rivers was an instant success. Students enjoyed the Major Rivers character as they learned about their water resources. Teachers appreciated a multidisciplinary program with a Texas focus that was correlated to state educational requirements. By the end of the 1990s, Major Rivers had reached more than 1 million fourth graders throughout Texas.

The program was revised in 1993 to include some additional activities and update the educational requirements correlation. In 2001, LCRA began work on a second revision, working with a curriculum consultant, LCRA staff, and a Teacher Advisory Committee to produce a new edition for teachers in the lower Colorado River basin. Statewide interest in the curriculum grew, and in 2003 LCRA, the Texas Water Development Board, many water providers, and water management entities throughout the state began work on a new statewide version. In 2008 and 2011, the program was revised to keep Major Rivers current with the latest Texas learning standards and the 2007 State Water Plan. In addition, the student materials for the Major Rivers program are available in both English and Spanish-language versions. As part of a three-year review plan, Major Rivers was revised in 2017 to keep its content current with Texas Essential Knowledge and Skills (TEKS) objectives and the current State Water Plan (http://www.twdb.texas.gov/waterplanning/swp/index.asp).

What's New in Major Rivers

The new edition of Major Rivers has the look and feel of the prior program, with these additions and improvements:

- Updated internet links
- Continued correlation with Texas Essential Knowledge and Skills (TEKS) and State of Texas Assessments of Academic Readiness (STAAR™) objectives.

We hope you enjoy using this new, improved Major Rivers.

Acknowledgments

LCRA would like to thank these people for their hard work:

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TEACHING MAJOR RIVERS

Water in Texas is as important to our lives as the air we breathe. Yet our water supply is not always reliable in many parts of the state. Further, as our population continues to grow, greater and greater demands are placed on this limited resource. So it is important that we be aware of water — where it comes from, how our actions impact its quality, how we treat it, how much we use, and how we can use it wisely.

The Major Rivers Water Education Program is intended to help fourth-grade to fifth-grade students throughout Texas learn how we get and use water, how important it is for us to conserve water, and how to keep it clean. This program contains teacher and student materials focused on specific instructional objectives.

Objectives

The instruction in the program focuses on seven specific learning objectives:

1. **Water in Texas**
   Students will become aware of the importance of water to Texas.
2. **The Water Cycle**
   Students will identify the various steps in the water cycle — precipitation, surface runoff, infiltration, evaporation, and condensation.
3. **Texas Water Supply and Water Planning**
   Students will identify basic facts about the water supply in Texas. This includes regional differences in rainfall, the amount of water supplied by surface water and groundwater, and the state's major rivers and aquifers. Students also will understand the importance of water planning and identify water management strategies used to ensure adequate water supply.
4. **Watersheds and River Basins**
   Students will understand the concepts of river basins and watersheds and be able to identify their river basin and local watershed. Students will learn how the sediments that reach the Texas coastal bays are transported by river systems. Students will create changes in a simulated streambed to evaluate the effects on water flow rates and directions.
5. **How Our Water Use Affects Our World**
   Students will identify various uses of water, including municipal, agricultural, industrial, recreational, and electric generation. Students will differentiate between point-source and nonpoint-source pollution. Students will recognize that most water pollution is caused by human activity within the watershed.
6. **Water Treatment and Distribution**
   Students will identify the steps and processes of the water distribution system in Texas — wells and reservoirs, pipelines, water and wastewater treatment plants, septic systems, and recycled water.
7. **Using Water Efficiently**
   Students will review which home water activities use the most water. They will identify water conservation practices both inside and outside the home, and assess their individual water conservation practices.
8. **Review and Posttest**
   Students will exhibit an understanding of the importance of water to Texas.

These objectives define important knowledge and skills related to water and support many of the Texas Education Agency's TEKS. A chart showing the program correlations to the TEKS is on pages viii-xiv.

Instructional Planning

Procedures for each lesson are in this Teacher's Guide. The Teacher Resource CD-ROM contains the electronic version of the Teacher's Guide, lesson worksheets, individual lessons and other resources. Alternatively, worksheets or the Teacher's Guide may be printed by using the files in the Teacher Resource CD-ROM. Each lesson usually can be completed in one or two class periods. Some lessons will take more or less time, depending on the pace of instruction and student interest. In most lessons, suggestions are provided for optional extension and enrichment activities that can help expand the outcomes of the program.

Materials

The program contains all the basic teacher and student materials needed for instruction. Additional materials are listed with each lesson. Included with the Major Rivers educational components are:

- Teacher's Guide including these handouts:
  - The Water Cycle
  - Texas Average Annual Rainfall
  - Major River Basins
  - Major Texas Coastal Bays
  - Regional Water Planning Groups
  - Water Treatment and Distribution
- Teacher Resource CD-ROM including an electronic version of the Teacher's Guide
- Introductory Video DVD
- Program Evaluation Sheet
- Originals of the following:
  - Pretest
  - Posttest
  - Groundwater and Surface Water Student Data Sheet
  - Regional Water Planning Groups Worksheet
  - Major River Basins in Texas Worksheet
  - Streambed Simulation Student Data Sheet
  - Frankie the Fish Data and Observation Sheet
  - Water Treatment Laboratory Worksheet
  - Lawn Watering Laboratory Worksheet
  - Don't Be Clueless Worksheet
  - Wa-Ter Your Choices? Cards
  - Review Worksheets
  - Water Puzzles
- 30 copies of the following:
  - Student Workbook (available in English- and Spanish-language versions)
  - Home Information Leaflet (available in English- and Spanish-language versions)

Other Materials Needed — Listed by Lesson

The following are comprehensive lists of materials needed to complete each activity and exercise in the Major Rivers curriculum that are not included with a teacher set. The activities and exercises are designed to use as many readily available household supplies as possible. Prior to each lesson you may want to request assistance with gathering materials from the students and their parents. Once a set of materials is gathered it can easily be reused with proper care and cleaning.

LESSON 1

- Cups
- Water
- Computer with TV connection/LCD or computer projector

For Change of Temperature Effects Investigation:

- Plates
- Clock
- Fan (to simulate wind)

LESSON 2

For student laboratory activities on water cycle:

- 3 or 4 different types of soil (clay, potting soil, sand, crushed gravel, etc.)
- 2 identical jars or glasses
- Tape
- Food coloring
- Bowl of ice water
- Water
- 3 to 4 two-liter clear soda bottles per group
- Liquid measuring cup
- Scissors
- Cotton cloth or nylon hose

For student water cycle demonstration:

- 4 eight-ounce clear plastic cups per group
- Plastic wrap
- Water
- Rubber bands
- Liquid measuring cups
- Watch or clock with a second hand

LESSON 3

- Scheduled time in computer lab or classroom
- Computer with Internet access and TV connection/LCD or computer projector
- Map colors or colored pencils

For groundwater/surface water demonstration:

- Small aquarium or 1-gallon pickle jar
- Aquarium gravel or pea gravel
- Glass jar or drinking glass
- Overhead projector
- Watering can
- Meat baster

For soil stratification investigation:

- 3 or 4 different types of soil (clay, potting soil, sand, crushed gravel, etc.)
- Water
- 1 two-liter clear soda bottle per student pair
- Liquid measuring cup
- Scissors
- Plastic wrap or modeling clay

For Water Coursing Through History:

- Large bucket (The bucket should hold several gallons of water. The amount of water in the bucket should be visibly reduced when five spongefuls of water are removed.)
- Containers (Bowls or milk cartons with the tops cut off, 1 for each student.)
- Metric graduated cylinders
- 17 large household sponges (Cut 3 of the sponges into fourths, 5 into thirds, 5 into halves, and leave the last 4 whole. Increase or decrease the number of sponges to fit the number of students. Pieces of absorbent terry cloth can be substituted.)
- Various colors of food coloring or washable paints (Put several drops of food coloring of any color on all the sponges and sponge pieces just before passing out the sponge pieces.)
- Markers
- Poster board

For Water Baseball (optional):

- Group sets of 12 pieces of paper cut in 2 x 3 inch pieces

LESSON 4

- Map colors
- Scheduled time in computer lab or classroom
- Computer with Internet access and TV connection/LCD or computer projector

For impact of water flow on water systems investigation:

- Meter tape measures
- Fine soil
- Sand
- Pebbles or fine gravel
- Rocks, bricks and/or wood blocks
- Ping-Pong balls, corks, or foam peanuts
- Water source with ability to vary flow (water hoses)
- Stop watches or watches with second hands
- Playground area, stream table, or aluminum roasting pan with diatomaceous earth

LESSON 5

- Thermometers
- Optional:
  - Scheduled time in computer lab or classroom
  - Computer with Internet access and TV connection/LCD or computer projector

For Frankie the Fish activity:

- Aquarium (optional)
- 3-liter soda bottles with top cut off
- Black permanent marker
- Graduated cylinder and measuring spoons
- Pitchers with water
- String
- Water
- White poker chips
- Yellow sponges
- Washers
- Hot-glue gun
- Ruler
- Soil
- Brown sugar
- Molasses
- Detergent
- Shredded paper
- Scissors
- Food coloring – red and yellow

LESSON 6

Optional:

- Scheduled time in computer lab or classroom
- Computer with Internet access and TV connection/LCD or computer projector

For Water Treatment Lab:

The following list of materials will be enough for four groups.

- 4 small (4-ounce) plastic cups (such as an applesauce cup) containing 1 tablespoon alum (can be purchased at any grocery store.)
- 4 two-liter soda bottles containing 750 mL (24 ounces or 3 cups) water mixed with 230 mL (8 ounces or 1 cup) of garden dirt (Label these: "Source Water" or "Surface Water.") ***[Note: Mix water to soil in a 3:1 ratio.]***
- 4 clean two-liter soda bottles, cut in half without tops, labeled "Aeration"
- 4 clean two-liter clear soda bottles, cut in half without tops, labeled "Coagulation"
- 4 clean two-liter soda bottles, cut in half with tops labeled "Filtration"
- 4 rubber bands
- 4 stirring sticks
- 4 small pieces of old stockings or cheesecloth
- 4 eight-ounce plastic cups filled with gravel
- 4 eight-ounce plastic cups filled with sand
- 4 metric rulers
- 4 graduated cylinders or measuring spoons
- 4 stop watches or watches with a second hand

LESSON 7
3 x 3 inch pieces of blue, yellow, and red paper for each student

For the Lawn Watering Laboratory:
- Student handout for Lawn Watering Laboratory
- Stopwatches (enough for every group of three students to have one)
- Lawn sprinkler and hose
- ***[Note: Use a spray-type sprinkler with a high precipitation rate (volume per minute) that covers at least a 10 x 10 foot square area. Rotating and oscillating sprinklers tend to have lower precipitation rates.]***
- Large graduated cylinders
- Small, medium, and large-sized flat-bottomed, straight-sided containers (small 4 x 4 inch plastic container, 8 x 8 inch foil baking pan and 9 x 13 inch baking pan)
- Ruler to measure inches and centimeters
- Student worksheets
- Blank sheet of paper
- Pencils, pens
- Masking tape
- Clipboard (one per group)

For Don't Be Clueless Investigation:
- Student handout for Don't Be Clueless investigation
- Metric rulers/measuring tapes
- Shovel
- Graph paper
- Computer with Internet access for research

LESSON 8
No other materials are needed.

ADDITIONAL RESOURCES

Asimov, Isaac. *The Ocean Book*, Wiley.
Bellamy, David. *The River*, Clarkson Porter.
Cherry, Lynn. *A River Ran Wild*, Harcourt.
Cole, Joanna. *The Magic School Bus at the Water Works*, Scholastic.
Cole, Joanna. *The Magic School Bus, Wet All Over,* Scholastic.
Cole, Joanna. *The Magic School Bus on the Ocean Floor*, Scholastic.
Drutman, Ava. *Water*, Good Apple.
French, Vivian. *Why the Sea is Salty*, Harcourt.
Jacobs, Francine. *Sam the Sea Cow*, Walker and Company.
Goldish, Meish. *Science Poems and Songs for Young Learners*, Scholastic.
Molengraft, Lisa. *Oceans*, Instructional Fair.
Murphy, Bryan. *Experiments with Water*, Scholastic.
Peters, Lisa. *Water's Way*, Scholastic.
The Earth Group. *50 Simple Things Kids Can Do to Save the Earth*, Andrews and McMeel.
Using Water Series, Scholastic.

U.S. Geological Survey Water Science School
http://water.usgs.gov/edu/

U.S. Geological Survey – La Ciencia del Agua para Escuelas (Spanish-language version of the USGS educational resources including a glossary)
http://water.usgs.gov/gotita/

TEXAS WATER DEVELOPMENT BOARD (TWDB) RESOURCES

Home page
http://www.twdb.texas.gov

Major Rivers
http://www.twdb.texas.gov/conservation/education/kids/MajorRivers/index.asp

Know Your Texas Water (a resource for teachers and other adults to learn about Texas water resources and the State Water Plan)
http://www.twdb.texas.gov/conservation/education/kids/KnowYourTexasWater/index.asp

TWDB Kids (animations and games for K–8 grade on Texas water resources)
http://www.twdb.texas.gov/conservation/resources/educational-resources.asp

Raising Your Water IQ (a water conservation curriculum for middle school)
http://www.twdb.texas.gov/conservation/education/kids/RaisingYourWaterIQ/index.asp

Water IQ: Know Your Water (Texas water conservation awareness campaign)
http://www.wateriq.org/

Correlation of the Major Rivers Lessons with the Texas Essential Knowledge and Skills (TEKS) and the State of Texas Assessments of Academic Readiness (STAAR™)

The Texas State Board of Education establishes the curriculum and assessment standards for Texas public schools. The curriculum standards for students in Texas are the Texas Essential Knowledge and Skills (TEKS). For student assessment, the State of Texas Assessments of Academic Readiness (STAAR™) is in place.

For the 2017 version of Major Rivers, the lessons are correlated to the TEKS for Grades 4 and 5 in the tables below.

The full text version of the current TEKS can be found on the Texas Education Agency website at http://tea.texas.gov/curriculum/teks/. The full text version of the STAAR™ assessments can be found at http://tea.texas.gov/student.assessment/staar/.

Note: The streamlined science TEKS had not been approved or implemented by the time of the printing of this revision.

110.15 ENGLISH LANGUAGE ARTS AND READING, GRADE 4

Grade 4 / Content Area	§110.15. English Language Arts and Reading				
Strand	Reading	Writing	Oral and Written Conventions	Research	Listening and Speaking
Lesson 1	1	18 c	20 c		27 a,b 28 29
Lesson 2	1 11 a,b,c,d 13 a,b	18 c	20 c		27 a,b 28 29
Lesson 3	1 11 a,b,c,d 13 a,b	18 c	20 c		27 a,b 28 29
Lesson 4	1 11 a,b,c,d 13 a,b	18 c	20 c	23 a,b 24 a,b,c	27 a,b 28 29
Lesson 5	1 11 a,b,c,d 13 a,b	18 c	20 c		27 a,b 28 29
Lesson 6	1 11 a,b,c,d 13 a,b	18 c	20 c		27 a,b 28 29
Lesson 7	1 11 a,b,c,d 13 a,b	18 c	20 c		27 a,b 28 29
Lesson 8	1 11 a,b,c,d 13 a,b	18 c	20 c		27 a,b 28 29

110.16 ENGLISH LANGUAGE ARTS AND READING, GRADE 5

Grade 5 / Content Area	§110.16. English Language Arts and Reading				
Strand	Reading	Writing	Oral and Written Conventions	Research	Listening and Speaking
Lesson 1	1	18 c	20 c		27 a,b,c 28 29
Lesson 2	1 11 a,b,c,d,e 13 a,b	18 c	20 c		27 a,b,c 28 29
Lesson 3	1 11 a,b,c,d,e 13 a,b	18 c	20 c		27 a,b,c 28 29
Lesson 4	1 11 a,b,c,d,e 13 a,b	18 c	20 c	23 a,b 24 a	27 a,b,c 28 29
Lesson 5	1 11 a,b,c,d,e, 13 a,b	18 c	20 c		27 a,b,c 28 29
Lesson 6	1 11 a,b,c,d,e 13 a,b	18 c	20 c		27 a,b,c 28 29
Lesson 7	1 11 a,b,c,d,e 13 a,b	18 c	20 c		27 a,b,c 28 29
Lesson 8	1 11 a,b,c,d,e 13 a,b	18 c	20 c		27 a,b,c 28 29

112.15 SCIENCE, GRADE 4			
Grade 4			
Content Area	§112.15. Science		
Strand	Scientific Investigation and Reasoning	Matter and Energy	Earth and Space
Lesson 1	1 a,b 2 a 3 a	5 b	8 b
Lesson 2	1 a,b 2 a,b,c,d,f 3 a	5 b	8 b
Lesson 3	1 a,b 2 b,d,f 3 a		7 a,b
Lesson 4	1 a,b, 2 b,c,d,f 3 a		7 a,b
Lesson 5	1 a 2 b,c,d,f 3 a		7 c
Lesson 6	1 a 2 a,b,c,d,f 3 a		7 c
Lesson 7	1 a,b 2 a,b,c,d,f 3 a		7 c
Lesson 8	1 b 3 a		8 b

Note: The streamlined science TEKS had not been approved or implemented by the time of the printing of this revision.

112.16 SCIENCE, GRADE 5

Grade 5 / Content Area	§112.15. Science			
Strand	Scientific Investigation and Reasoning	Matter and Energy	Earth and Space	Organisms and Environments
Lesson 1	1 a,b 2 a 3 a	5 a	8 b	
Lesson 2	1 a 2 a,b,c,d,f,g 3 a,c	5 a	8 b	
Lesson 3	1 a,b 2 b,c,d,f,g 3 a,c		7 a,b	9 c
Lesson 4	1 a,b 2 b,c,d,f,g 3 a,c		7 a,b	
Lesson 5	1 a 2 b,c,d,f 3 a,c			9 c
Lesson 6	1 a 2 a,b,c,d,f,g 3 a,c			9 c
Lesson 7	1 a,b 2 a,b,c,d,f 3 a			9 c
Lesson 8	1 a 3 a		8 b	

Note: The streamlined science TEKS had not been approved or implemented by the time of the printing of this revision.

113.6 SOCIAL STUDIES, GRADE 4

Grade 4 / Content Area	§113.6. Social Studies	
Strand	Geography	Social Studies Skills
Lesson 1	8 c	
Lesson 2		21 b,e 22 a,b,c,e 23 a
Lesson 3	6 b 9 a	21 b,e 22 a,b,c,e 23 a
Lesson 4	6 b	21 b,e 22 a,b,c,e 23 a
Lesson 5	7 a 9 a,b	22 a,b,c,e 23 a
Lesson 6	9 c	22 a,b,c,e 23 a
Lesson 7		22 a,b,c,e
Lesson 8		

113.7 SOCIAL STUDIES, GRADE 5	
Grade 5	
Content Area	§113.7 Social Studies
Strand	Social Studies Skills
Lesson 1	9 b 24 b 25 e 26 a
Lesson 2	24 b 25 e 26 a
Lesson 3	24 b 25 e 26 a
Lesson 4	9 b 24 b 26 a
Lesson 5	24 b 25 e 26 a
Lesson 6	24 b 25 e 26 a
Lesson 7	24 b 25 e 26 a
Lesson 8	24 b 25 e

114.2 LANGUAGES OTHER THAN ENGLISH, ELEMENTARY	
Elementary Content Area	§114.2, Languages Other Than English, Elementary
	School districts are strongly encouraged to offer languages other than English in elementary grades.
Lesson 1	Spanish language version of student materials available
Lesson 2	Spanish language version of student materials available
Lesson 3	Spanish language version of student materials available
Lesson 4	Spanish language version of student materials available
Lesson 5	Spanish language version of student materials available
Lesson 6	Spanish language version of student materials available
Lesson 7	Spanish language version of student materials available
Lesson 8	Spanish language version of student materials available

115.6 HEALTH EDUCATION, GRADE 4	
Grade 4	
Content Area	§115.6. Health Education
Strand	Influencing Factors
Lesson 1	
Lesson 2	
Lesson 3	6 a,b
Lesson 4	
Lesson 5	6 a,b
Lesson 6	6 a,b
Lesson 7	6 a,b
Lesson 8	6 a,b

115.7 HEALTH EDUCATION, GRADE 5	
Grade 5	
Content Area	§115.6. Health Education
Strand	Influencing Factors
Lesson 1	
Lesson 2	
Lesson 3	6 a, b
Lesson 4	
Lesson 5	6 a, b
Lesson 6	6 a, b
Lesson 7	6 a, b
Lesson 8	

126.7 TECHNOLOGY APPLICATIONS, GRADES 3-5	
Grades 3 – 5	
Content Area	§126.7 Technology Applications
Strand	Digital Citizenship
Lesson 1	
Lesson 2	
Lesson 3	5 a, b, c
Lesson 4	5 a, b, c
Lesson 5	5 a, b, c
Lesson 6	5 a, b, c
Lesson 7	5 a, b, c
Lesson 8	5 a, b, c

Message:
Although it may appear that Texas has plenty of water, the fact is the state has faced water challenges throughout history. Without water, people, animals, and plants could not live. Water is a valuable resource that we should not take for granted.

Time Requirements:
Two class periods

Objective:
Students will become aware of the importance of water to Texans.

Materials:
- Cups
- Water
- Pretest (see Appendix 1)
- Program evaluation sheet
- Major Rivers Introductory Video DVD
- TV with DVD connection
- Major Rivers Student Workbook

For Change of Temperature Effects Investigation:
- Ice cubes
- Plates
- Clock
- Fan (to simulate wind)

Procedures:

A. Administer pretest (see Appendix 1).
- Tell students that for the next two weeks they will be learning how we get and use water in Texas.
- Explain to students that they are going to take a pretest. The pretest will show how much they already know about water. Tell students it is all right if they do not know some of the answers. They will learn the answers during the program.
- Pass out a copy of the pretest to each student.
- Give students time to mark their answers.
- Collect the pretests. Tell students that they will be learning the correct answers during the next couple of weeks.
- Later, score the students' pretest, using the answer key on pages 4 and 5 of this guide. Record the scores on the program evaluation sheet.

B. Lead students in an examination and discussion of water and its properties.
- Give each student a cup of water.
- Use the following questions to generate a discussion of water. Possible student answers are shown in parentheses.

1. What color is water?
   (Water is colorless.)
2. What is the taste of water?
   (Water is tasteless.)
3. What does water smell like?
   (Water has no smell.)
4. What would happen if you put your cup of water in a freezer?
   (It would turn to ice. It would become solid instead of liquid.)
5. What would happen if you boiled the water in your cup?
   (It would turn into steam, which is water vapor. It would become a gas instead of a liquid.)
6. What do you use water for every day?
   (We use water for drinking, cooking, bathing, washing dishes, washing clothes, brushing teeth, watering plants, fighting fires, etc.)
7. How much of our bodies do you think is made up of water?
   (More than two-thirds of our bodies is water.)
8. Why is water important to us?
   (People and animals need water to drink. Plants need water to make them grow. Without water, people, animals, and plants could not live.)

C. Have students read Water in Texas, page 2 in Student Workbook. (See page 2 of Teacher's Guide.)
- Tell students that they will be learning about water from a special character named Major Rivers. Show students the picture of Major Rivers on the cover of a Student Workbook.
- Give each student a workbook. Tell students that they will be working in these workbooks for the next two weeks.

- Have students turn to page 2 in their workbooks. Call on individual students to take turns reading aloud.
- Use the following questions to generate a discussion.
  1. Why is it important that we do not waste water?
     (There is only so much water and there are more and more people in Texas all the time. In some years, when there is very little rain, we have even less water.)
  2. How do you think water gets to your faucet?
     (Answers will vary. Tell students that they will soon be learning exactly how water gets to their homes.)
  3. What would happen if one day you turned on your faucet and no water came out?
     (Answers will vary.)

D. Play the Major Rivers video.

- Inform students they are going to see a video in which Major Rivers tells them about water in Texas.

  [Note: The video is 8:33 minutes long.]
- Ask if any of the students can explain why the character is named Major Rivers.
  (Much of the water we use in Texas comes from "major rivers.")

- Ask students to pay attention to the name of Major Rivers' horse, and ask them why they think Major Rivers gave his horse the name Aquifer.
  (Aquifer is the name of his horse because more than half of the water we use in Texas comes from aquifers. Aquifers are underground sources of water.)
- Show the video.

  Topics addressed:
  1. Comparison of water availability in early Texas and today
  2. Historical accounts of rivers prior to river authorities
  3. Purpose(s) of reservoirs
  4. Water treatment and wastewater treatment
  5. Water conservation in Texas

- Use the following questions to discuss the video.
  1. How did people get their water in the olden days?
     (People would dip their buckets into a river to get water; or they would dig a well to get water that was stored underground.)
  2. How do we get our water today?
     (We still get our water from rivers and from groundwater wells, but for most people water utilities get the water and send it to them through pipelines. They turn on a tap, and out comes the water.)
  3. Where does most of the water come from in the area where we live?
     (Answers will vary.)
  4. Why do river authorities, groundwater districts, and other water districts manage water in Texas?
     (When it rained a lot, the rivers would flood. These floods killed people and destroyed animals, crops, and buildings. Other times, when it rained very little, rivers would dry up to a trickle and wells would go dry, so that no one had enough water. Even if rivers and aquifers did not flood or dry up naturally, they could dry up because people took out too much water.)
  5. How do river authorities, groundwater districts and other water districts manage water?
     (Some river authorities built dams on the riv-

ers. The dams hold the water back and keep the river from flooding the land. The dams also created lakes, called reservoirs, which store water for the people of Texas. Other river authorities, groundwater conservation districts, and water districts were created to keep track of how much water is used and, if necessary, restrict water use during droughts to prevent rivers and aquifers from drying up.)

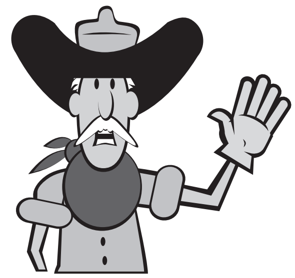
6. What else are the dams used for besides managing floods and storing water?
   (The floodgates on some dams can be opened so that the water rushes out to turn big turbine-generators that produce electricity.)
7. What happens to the water in the river, reservoirs, or wells before it comes into our homes?
   (The water is sent to water treatment plants, where dirt is taken out, and chlorine or another chemical is added to kill germs.)
8. What happens to wastewater when it goes down our drain?
   (In some areas, mainly rural, wastewater goes into a septic system where it slowly seeps back into the ground or is sprayed into the air to evaporate after it has been treated. In other areas, wastewater travels through pipelines to a wastewater treatment plant, where the water is cleaned, then pumped back into a river or into the ground. Wastewater can also be reused or recycled for irrigating landscapes and other uses.)
9. Why do we need to use water wisely?
   (The population of Texas is growing and more people need to use water, but there is a limited supply of water on Earth.)
10. What are some ways we use water wisely?
    (We can turn the water off while we are brushing our teeth; we can take quick showers; we can use a timer on our hose when using the sprinkler to irrigate the lawn, etc.)

E. Investigation of effects of temperature changes on the frozen state of water

- Give each student an ice cube.
- Have students develop a research question and conduct an experiment to investigate the physical properties of water. For example:
  1. How long does it take for an ice cube to melt?
  2. Does moving air (wind) increase or decrease the rate of melting?
  3. Does an ice cube melt faster in a cup of water or on a plate?
  4. How does the distance from a light bulb affect the rate at which an ice cube melts?

Optional Extension and Enrichment Activities:

- Have students write stories about Major Rivers and Aquifer. Suggested titles might be "Seeing Texas With Major Rivers and Aquifer," or "Major Rivers Saves Water."
- Read one of the legends of "Pecos Bill" and discuss the concept of a legend. Have students write a legend about Major Rivers and Aquifer as they ride through Texas teaching people about water. The legends can be turned into skits or plays to be acted out for the class.
- Allow students to look through old magazines for pictures of water use. Cut the pictures out and make a collage of water use on the bulletin board. You may want to divide the bulletin board into categories such as Water for Fun, Water that Works for Us, or Water in the Home, Water at Work, Water at School, etc.
- Have students write stories about a day their town had no water.
- Have students research a current or historic Texas water issue. Students can make presentations on their research to the class.
- Have students research how a windmill works and why they were important to Texas in the past. Students can make a model of a windmill or present the information that they have learned about windmills to the class.



Name ________________________________

PRETEST

MAJOR RIVERS
TEXAS WATER EDUCATION PROGRAM

PART A: The Water Cycle
Directions: Circle the letter of the word that best completes each sentence.

1. Water falls to earth as either rain or snow. This is called ______________________.
   a) surface runoff b) infiltration c) precipitation

2. Some water on the ground flows into rivers, lakes, and oceans. This is called ______________________.
   a) condensation b) evaporation c) surface runoff

3. Some water soaks into the ground. This is called ______________________.
   a) infiltration b) precipitation c) condensation

4. The sun heats water on the ground and changes it into vapor. The vapor rises into the sky. This is called ______________________.
   a) evaporation b) precipitation c) infiltration

5. Vapor cools, forms clouds, and changes back into water. This is called ______________________.
   a) infiltration b) condensation c) precipitation

PART B: Texas Water Supply
Directions: Circle the letter of the word that best completes each sentence.

6. Most large cities in Texas are in the ______________________ half of the state where there is more water.
   a) eastern b) northern c) western

7. The river that supplies Austin, our capital city, is the ______________________.
   a) Sabine b) Colorado c) Trinity

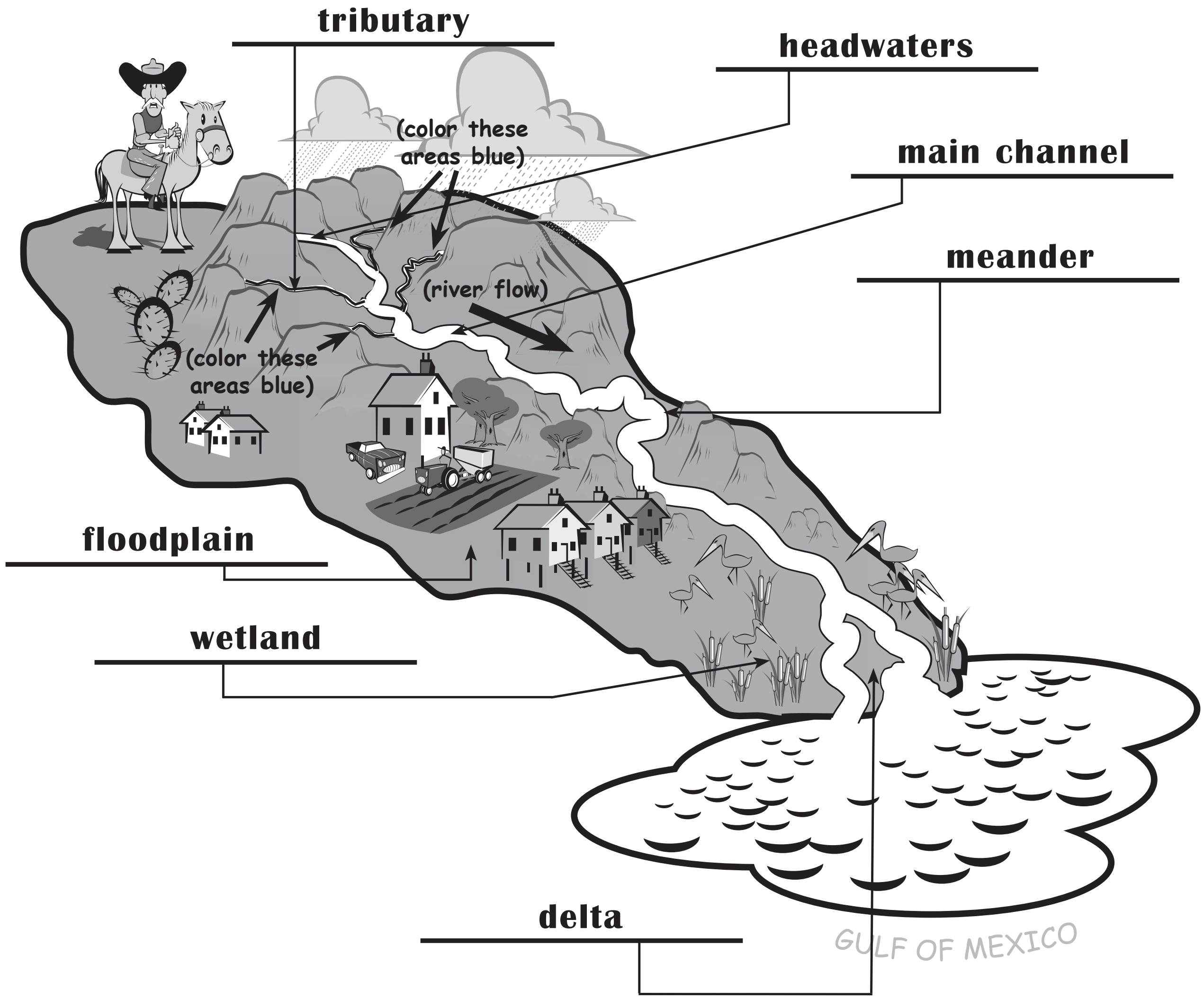
8. An underground layer of gravel, sand, or rocks that is filled with water is called ______________________.
   a) a reservoir b) an aquifer c) a lake

9. The river between Texas and Mexico is the ______________________.
   a) Red b) Brazos c) Rio Grande

10. More than half of the water used in Texas comes from ______________________.
    a) the ocean b) rivers c) aquifers

PART C: What is a Watershed?

Directions: Put the following words in the correct blank to label the watershed: tributary, floodplain, meander, headwaters, wetland, delta, and main channel. Color the tributaries that flow into the main river blue. Place an arrow showing the direction of the river's flow.



PART D: Water Treatment and Distribution

Directions: Match the words on the left with their definitions on the right. Write the correct letter in the blank space.

__d__ water treatment plant	a) place where surface water is stored
__b__ wastewater treatment plant	b) place where sewage is cleaned
__e__ recycled water	c) carries water to homes and businesses
__c__ pipeline	d) place where water is cleaned and made safe to drink
__a__ reservoir	e) wastewater that is cleaned and reused

PART E: Using Water Efficiently

Directions: Look at each group of activities that use water. Place an X next to the activity in each group that uses the most water in a year.

__X__ flushing the toilet	_____ using the faucet	_____ washing clothes	_____ using the faucet
_____ washing dishes	__X__ watering the lawn	__X__ watering the lawn	__X__ flushing the toilet
_____ drinking water	_____ taking a shower	_____ drinking water	_____ washing the car

LESSON ONE VOCABULARY AND RESOURCES

Vocabulary:

Water – A colorless, odorless, tasteless liquid having a melting point of 0°C (32°F) and a boiling point of 100°C (212°F). Water can take the forms of ice (solid) or steam (vapor). Water is the most commonly found substance on earth and is present in many other substances, including all organic tissues, and it is the most universal of solvents.

Resources:

Curtis, Neil and Michael Allaby. (1993). *Visual Fact Finder: Planet Earth*. Kingfisher Books: New York.

Hathorn, Libby. (1995). *The Wonder Thing*. Penguin Books: Australia LTD.

Message:
We only have a limited amount of water on Earth. The same drops of water keep moving in a pattern from the earth to the sky and back to the earth again as rain or snow. We are using the same water that the cavemen and dinosaurs used!

Time Requirements:
Three class periods

Objective:
Students will identify the various steps in the water cycle — precipitation, surface runoff, infiltration, evaporation, and condensation.

Materials:
- Student Workbook

For student laboratory activities on water cycle:
- 3 or 4 different types of soil (clay, potting soil, sand, crushed gravel, etc.)
- 2 identical jars or glasses
- Tape
- Food coloring
- Bowl of ice water
- Water
- 3 to 4 two-liter clear soda bottles per group
- Liquid measuring cup
- Scissors
- Cotton cloth or nylon hose

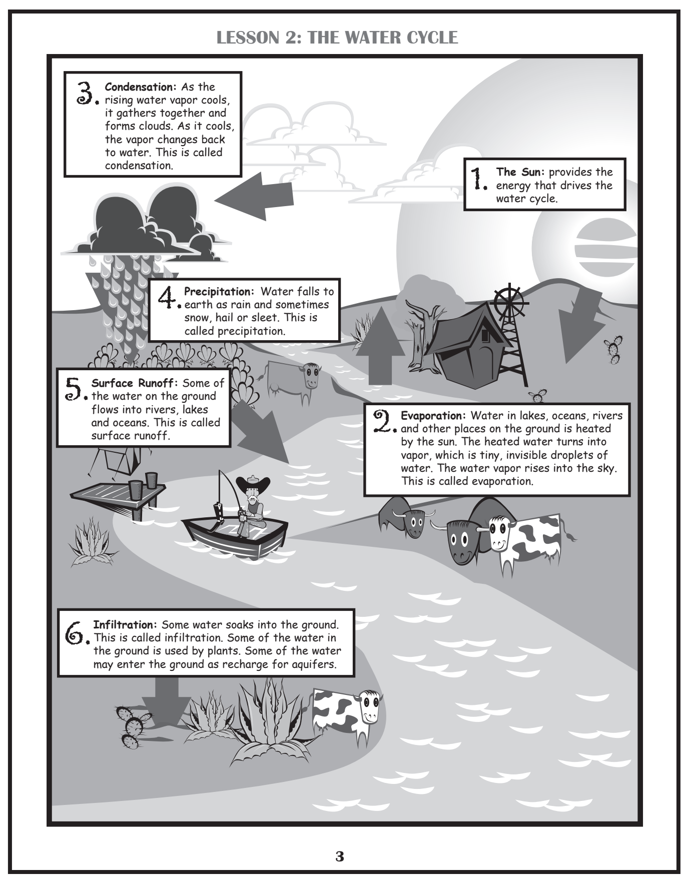
For student water cycle demonstration:
- 4 eight-ounce clear plastic cups per group
- Plastic wrap
- Water
- Rubber bands
- Liquid measuring cups
- Watch or clock with a second hand

Procedures:

A. Students read and discuss The Water Cycle, page 3 in Student Workbook.

- Explain that we have only a limited amount of water and that the same drops keep moving in a pattern from the earth to the sky and then back to the earth again as rain or snow.
- Have individual students read aloud each stage (numbers 1 to 6) of the water cycle.
- Use the following questions to discuss the water cycle.

1. After it rains, where do you see water on the ground?
(Water is in puddles on the ground; water flows down the street gutters.)
2. What is the source of energy for Earth?
(The sun is the source of energy for Earth. *There would be no life on Earth without the sun.)*
3. How does water get back into the ground?
(Water can soak into dirt and into lawns. But it cannot soak into pavement or cement, like streets or sidewalks.)



4. What happens to the water that does not soak into the ground?
   (Some of it runs off into rivers, lakes and oceans. Water that stays on the ground evaporates.)
5. What happens to water that evaporates?
   (It turns to vapor, goes into the sky, and forms clouds.)

   [Note: You might point out that only the water evaporates, leaving behind dirt and other dissolved substances. That is why we can keep using the same water over and over again.]
6. Why does rain come out of clouds?
   (Clouds are made up of water vapor. When the vapor gets cold enough, it changes back to water and falls out of the clouds as rain.)
7. What role does the sun play in the water cycle?
   (The sun heats water on the surface of the Earth, causing it to change from a liquid to a vapor.)

B. Present and review vocabulary, using the Water Cycle handout.
Vocabulary: condensation, evaporation, infiltration, porous, precipitation, surface runoff, vapor. Definitions are included with resources at the end of this lesson.

C. Learn and sing water cycle song: Sing to the tune of "If You're Happy and You Know It … ."
Water travels in a circle, yes it does.
Water travels in a circle, yes it does.
It goes up as evaporation.
Forms a cloud as condensation.
Falls to the ground as precipitation, yes it does!

D. Student water cycle demonstration
- Measure 120 mL (1/2 cup) of water and place in an eight-ounce cup.
- Cover the cup with plastic wrap.
- Put the cup in sun or under light source.
- Observe and record observations at 15-minute intervals for 45 minutes to one hour.
- Based on your observations, label Part A on page 4 of the student book to indicate the various stages of the water cycle. (1. Evaporation, 2. Condensation, 3. Precipitation).
- Discuss students' observations and answers for Part A using the answer key in the Teacher's Guide (page 10).

IMPORTANT: Students with incorrect answers should erase or cross out their answers and write in the correct answers.

E. Review vocabulary.
- List the steps in the water cycle on the chalkboard: precipitation, surface runoff, infiltration, evaporation and condensation.
- Call on individual students to define a term and to explain its part in the water cycle.

- Erase the terms from the chalkboard. Then read the definition for each term and have individual students tell what part of the water cycle you are describing.

  Water falling to earth as rain or snow.
  (Precipitation)

  Water flowing along the ground into rivers, lakes, and oceans.
  (Surface runoff)

  Water soaking into the ground.
  (Infiltration)

  Water changing into vapor and rising into the air.
  (Evaporation)

  Water vapor changing back into liquid.
  (Condensation)

F. Student laboratory activities on water cycle

- **Evaporation.** Have a student exhale on the chalkboard so that a spot of moisture is created. Circle the spot and have students watch it disappear *(evaporate)*.

- **Evaporation and condensation.** Have a student put a drop of colored water in the bottom of a glass or jar. Place an identical glass or jar upside down over the first one, sealing the two together with tape. When the drop has disappeared, ask students what happened to the drop of water. *(The drop evaporated and turned into vapor. This also helps to demonstrate that when water evaporates, the dissolved substances are left behind)* Have students put the container in ice water until the drop of water reappears. Ask students why it came back. *(The water vapor cooled, causing it to condense into liquid.)*

- **Infiltration.** In small groups, have students cut the bottoms off of three or four plastic soda bottles with adult supervision. Using a rubber band, secure a piece of cotton cloth (or nylon hose) over the mouth of each bottle. (Plastic cups with nail holes punched in the bottoms also can be used.) Turn the bottle upside down and fill each one with a different type of soil — sand, clay, loam, garden soil. Have students hypothesize which soil will allow the water to flow through the fastest and the slowest. Place a saucer or bowl under each bottle to catch any water that flows through. Hold the bottles up and pour one cup of water into one bottle at a time. Using a watch or a clock with a second hand, have students time how quickly or slowly water runs through different types of soil, and have them record their results. Have students measure the amount of water that collects in the container under each bottle to compare water retention of different soil types. Students can chart and/or graph data. Have students analyze and critique hypotheses based upon their data.

G. Student Workbook activity: Exercise 2: The Water Cycle, page 4. (See page 10 of Teacher's Guide.)

- Read the directions for Part A and Part B aloud to class. Be sure that students understand the directions; then allow them to work the exercise on their own.

- Correct the exercise as a class using the answer key on page 10 in the Teacher's Guide.

IMPORTANT: Students with incorrect answers should erase or cross out their answers and write in the correct answers.

Optional Extension and Enrichment Activities:

- Prepare a bulletin board. Have students draw or make cutouts of pictures depicting the water cycle and use them to make a bulletin board. Number each step in the cycle and place an envelope next to each number. Make cards with the following words on them: precipitation, surface runoff, infiltration, evaporation and condensation. Have students place the correct card in the envelope next to the number showing that stage of the cycle. A second set of cards with the definitions can then be matched to the terms.

- Have students write poems about some form of precipitation — rain, snow, fog, sleet, and hail. These may be in the form of a haiku, a cinquain, or a verse.

- Have students write a story of a drop of water, tracing its movements through the water cycle. They could have the drop move from one part of Texas to another, and from one body of water to another.

- Learn another water cycle song: Sing to the tune of "My Darling Clementine … ."

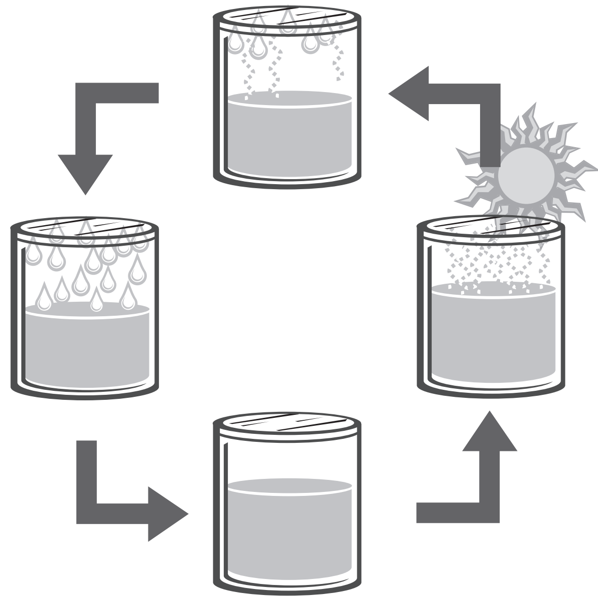
  "Evaporation, Condensation, Precipitation falling down.
  It is called the water cycle and it all goes round and round."

EXERCISE 2 ANSWER KEY

Part A

Directions: The picture below is a way of showing the water cycle. Fill in each blank space with the part of the water cycle being described.

The vapor rises, hits the lid of the cup and cools. Liquid water drops form on the lid. This is an example of **condensation**.



The liquid water drops fall from the lid into the cup.

This is an example of

precipitation.

The liquid water is heated by the sun and turns into vapor.

This is an example of

evaporation.

Water Source

Part B

Directions: Circle the letter of the word that best completes each sentence. Next, write the word on the blank line.

1. Water falls to earth as either rain or snow. This is called **precipitation**.
   a.) surface runoff   b.) infiltration   c.) precipitation

2. Some water on the ground flows into rivers, lakes and oceans. This is called **surface runoff**.
   a.) condensation   b.) evaporation   c.) surface runoff

3. Some water soaks into the ground. This is called **infiltration**.
   a.) infiltration   b.) precipitation   c.) condensation

4. Water on the ground gets heated and changes into vapor. The vapor rises into the sky. This is called **evaporation**.
   a.) evaporation   b.) precipitation   c.) infiltration

5. Vapor cools, forms clouds, and changes back into water. This is called **condensation**.
   a.) infiltration   b.) condensation   c.) precipitation

LESSON 2 VOCABULARY AND RESOURCES

Vocabulary:

Condensation – The process by which a gas or vapor changes to a liquid.

Evaporation – The process by which a liquid changes into vapor.

Infiltration – The process by which water soaks into the ground.

Porous – The description of a substance that allows water or air to pass through it.

Precipitation – Any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface.

Recharge – The process by which groundwater is added to an aquifer.

Surface runoff – Water from precipitation that flows over the ground surface and enters rivers, streams, creeks, lakes, or reservoirs.

Vapor – The gaseous state of a substance that is liquid or solid under ordinary conditions.

Water cycle – The natural pathway that water follows as it changes between liquid, solid and gaseous (vapor) states; cycle that moves and recycles water in various forms through the ecosphere. Also called the hydrologic cycle.

Resources:

Follow a Drip Through the Water Cycle: U.S. Geological Survey Water Science for Schools
http://water.usgs.gov/edu/followadrip.html

Leopold, Aldo. (1968). *A Sand County Almanac.* Oxford University Press: Oxford, England.

Project Learning Tree Environment Education Activity Guide. (2000). *Water Wonders*. American Forest Foundation. Washington D.C., pp. 142-147.

The Water Cycle for Kids: U.S. Geological Survey Water Science for Schools. Three levels available.
http://water.usgs.gov/edu/watercycle.html

Metric Equivalents for Standard Measurements:

Milliliters (mL)	Teaspoon (tsp.)	Tablespoon (Tbs.)	Fluid Ounce (oz.)	Cup (c.)
237	48	16	8	1
177	36	12	6	3/4
158	32	11	5	2/3
118	24	8	4	1/2
79	16	5	3	1/3
59	12	4	2	1/4
30	6	2	1	1/8
15	3	1	0.5	1/16
5	1			

Message:
The water Texans use comes from both rivers and aquifers. Rain is the main source of water for rivers and aquifers. The average amount of rainfall in Texas increases as you go from west to east. Weather patterns in Texas go in cycles of droughts and floods, so understanding and managing water resources is key to providing reliable water supplies. Water demand is expected to increase 20 percent from 18 million acre-feet in 2010 to nearly 22 million acre-feet per year in 2060 (an acre-foot is equal to 325,851 gallons). Conservation, reuse (recycled water), and desalination have become important water management strategies that can be used to meet water needs.

For background information on your region's water resources, try the "Know Your Water – A Texas-specific Web Quest" by going to the Texas Water Development Board's educational resources web page http://www.twdb.texas.gov/conservation/education/kids/KnowYourTexasWater/index.asp and selecting the "Know Your Texas Water" web quest link. This exercise is designed for adults. By completing this web quest, you will learn about your water planning region, your water supply source, the projected population growth for your region, future water needs projected for your region, and the current water management strategies planned to meet future needs. By using the local water resource information in your discussions with students, it will help them develop concrete understandings about how water is used statewide.

Objectives:
Students will identify basic facts about water supply in Texas, including:
- Regional differences in rainfall
- The amount of water supplied by surface water and groundwater
- The state's major rivers and aquifers
- The importance of water planning and water management strategies

Time Requirements:
Three class periods

Materials:
Student Workbook
- Texas Average Annual Rainfall handout
- Scheduled time in computer lab or classroom
- Computer with Internet access and TV connection/ LCD or computer projector
- Groundwater and Surface Water Student Data Sheet (enough copies for class)
- Regional Water Planning Groups handout
- Regional Water Planning Groups worksheets (enough copies for class)
- Map colors or colored pencils

For groundwater/surface water demonstration:
- Small aquarium or 1-gallon pickle jar
- Aquarium gravel or pea gravel
- Glass jar or drinking glass
- Overhead projector
- Watering can
- Meat baster

For soil stratification investigation:
- 3 or 4 different types of soil (clay, potting soil, sand, crushed gravel, etc.)
- Water
- 1 two-liter clear soda bottle per student pair
- Liquid measuring cup
- Scissors
- Plastic wrap or modeling clay

For Water Coursing Through History:
- Large bucket (The bucket should hold several gallons of water. The amount of water in the bucket should be visibly reduced when five spongefuls of water are removed.)
- Containers (Bowls or milk cartons with the tops cut off, one for each student.)
- Metric graduated cylinders
- 17 large household sponges (Cut 3 of the sponges into fourths, 5 into thirds, 5 into halves, and leave the last 4 whole. Increase or decrease the number of sponges to fit the number of students, keeping the ratio of sponges between water user groups the same. Alternatively, give some students more than one sponge or a proportionately larger sponge. Pieces of absorbent terry cloth can be substituted.)
- Various colors of food coloring or washable paints (Put several drops of food coloring of any color on all the sponges and sponge pieces just before passing out the sponge pieces.)
- Markers
- Poster board

- Water Coursing Through History poster (The Teacher Resource CD-ROM contains the Water Coursing Through History poster to print out for use in recording the volumes of water collected during this activity.)

For Water Baseball (optional):

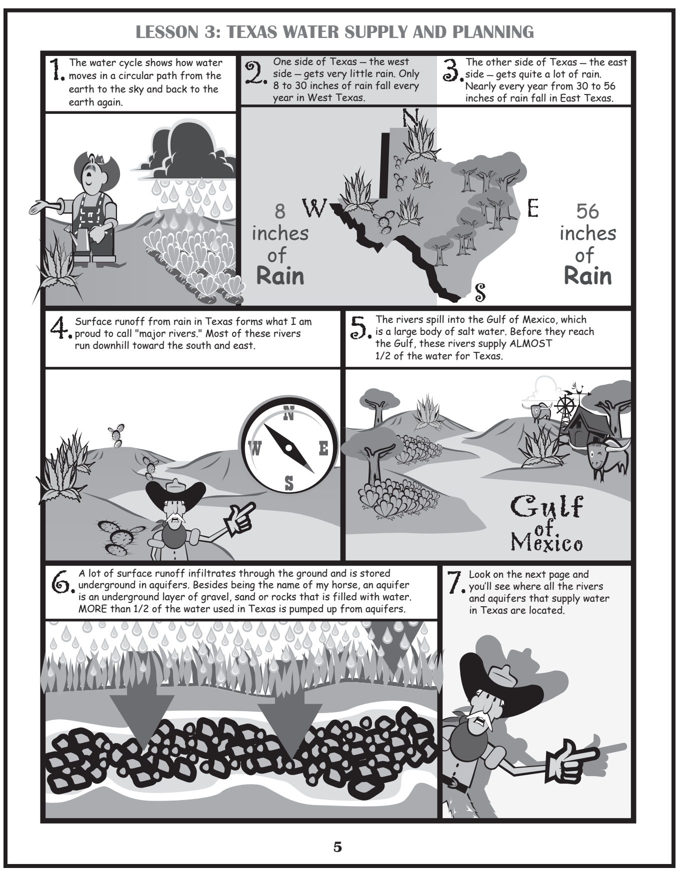
- Group sets of 12 pieces of paper cut in 2 x 3 inch pieces

Procedures:

A. Students will read and discuss Texas Water Supply from Student Workbook page 5.

1. Where does Texas get its supply of water?
   (Texas gets the water it uses from rivers and aquifers.)
2. What is an aquifer?
   (An aquifer is an underground layer of gravel, sand, and/or rocks that is filled with water.)
3. Which supplies more water for Texas, the rivers or the aquifers?
   (The aquifers supply more than one-half of the water for Texas.)

   [Note: To help pupils remember this, have them think of Major Rivers and his horse Aquifer. If they think of them as one unit, then Aquifer, the horse, is more than one-half the unit because he is bigger than Major Rivers; Major Rivers is smaller but is almost one-half the unit. Thus, aquifers supply more than one-half of the water for Texas and rivers supply almost one-half.]



4. Think back to the 1800s. Where do you think early Texans made their settlements and why?
   (More people settled in the eastern part of Texas, as there was more water available, a better climate, and the ability to travel by boat.)
5. Draw a vertical line down the middle of Texas on page 5 of your workbooks. Which part of Texas gets the most rain?
   (The eastern half of Texas gets the most rain.)
6. How would differences in rainfall patterns affect the way an area looks?
   (Answers will vary. Generally, areas that receive more rainfall appear greener and have more rivers and lakes. Areas that receive very little rain appear to be more brown [less vegetation] and have fewer rivers and lakes.)
7. Have you ever visited another part of Texas that looks different from where you live? Describe how it looked.
   (Answers will vary. Ask pupils to describe vegetation and climate.)

B. Study and discuss water supply map in Student Workbook. (See page 15 of Teacher's Guide.)

- Tell students to turn to pages 6 and 7 in their workbooks: Texas Water Supply and Planning.
- Explain to students that you are going to read a short description of a river in Texas, and they are to guess what river you are describing and find that river on their maps. You may want to have them circle the name of the river as each one is identified.

1. The Pueblo Indians called this river "Posage," which means "the river of great water." It is the longest river in Texas. It forms the border between Texas and Mexico and supplies both Texas and Mexico with water.
   (Rio Grande)
2. This river starts near Santa Fe, New Mexico and is actually a branch of the Rio Grande. Reservoirs along the river include Alamogordo and lakes McMillian, Avalon, and Red Bluff.
   (Pecos)

3. The name of this river means "nuts" in Spanish. It helps supply water to Corpus Christi in South Texas.
(Nueces)

4. This river originates at some springs in a downtown urban area. The river is famous for tourism at its "Riverwalk" in the city.
(San Antonio)

5. This river is named after a famous woman in the Christian faith of Mexico. It is joined by several other rivers — the Blanco, San Marcos, and San Antonio rivers — before it empties into San Antonio Bay.
(Guadalupe)

6. This river empties into the northern arm of Matagorda Bay and its name means "the cow" in Spanish.
(Lavaca)

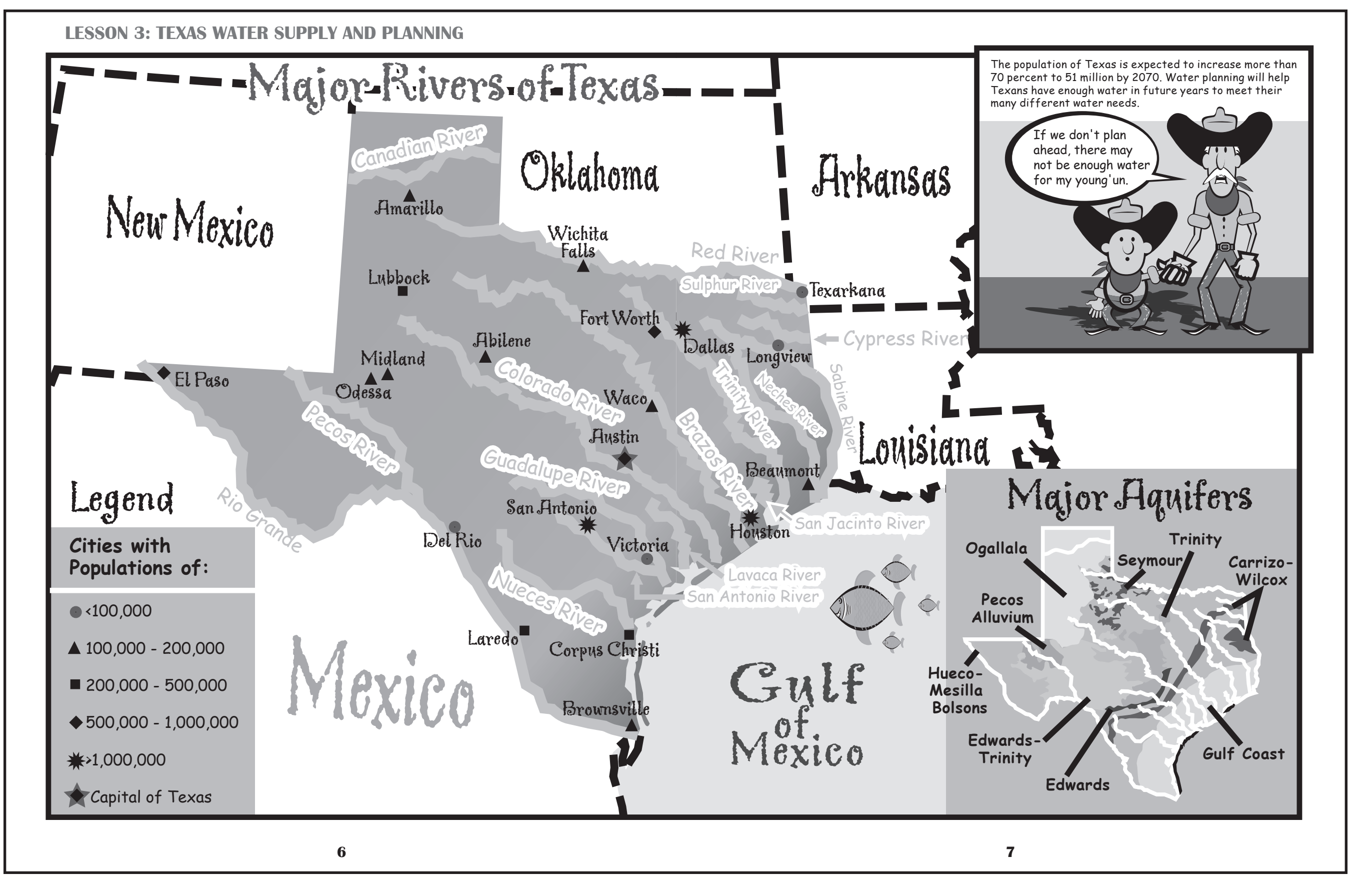
7. Its name is a Spanish word meaning "reddish." Six dams have been built on the river to manage flooding, store water, and provide electric power. The lakes created by the dams are Lake Buchanan, Inks Lake, Lake LBJ, Lake Marble Falls, Lake Travis, and Lake Austin. The capital of Texas is on this river.
(Colorado)

8. The original name of this river was "Brazos de Dios," which means "the arms of God." Important reservoirs on this river include Lake Whitney, Lake Possum Kingdom, Lake Waco and Belton Lake.
(Brazos)

9. This river contributes water to Lake Houston and Lake Conroe, which supply water to the cities of Houston and Galveston.
(San Jacinto)

10. Alonso de Leon named this river "La Santisima Trinidad." This river has more people, industries and large cities, including Dallas and Fort Worth, on its banks than any other river in Texas. The main lakes created on this river are Lewisville Lake, Lake Worth, Bridgeport Lake, Lake Benbrook, Lake Lavon, and Lake Ray Hubbard.
(Trinity)

11. This river passes to the east of Beaumont. The second largest lake in the state of Texas — Sam Rayburn Reservoir — is created by this river.
(Neches)



12. Its name comes from the Spanish word meaning "cypress." Part of this river forms the boundary between Texas and Louisiana. Two large reservoirs, Lake Tawakoni and the Toledo Bend Reservoirs, are on this river.
    (Sabine)
13. This river empties into the Red River near Shreveport. One reservoir on this river is Caddo Lake, which is partly in Texas and partly in Louisiana. It is the only natural lake in Texas!
    (Cypress)
14. This river joins the Red River in Arkansas. Lake Wright Patman, the major reservoir on the river, supplies water to both Texarkana, Texas, and Texarkana, Arkansas.
    (Sulphur)
15. This river begins in New Mexico and becomes the Texas-Oklahoma boundary. The river gets its name from a color. It has a high salt and mineral content.
    (Red)
16. This river flows across the Panhandle into Oklahoma. It contains the greatest amount of quicksand in the state. Major streams joining the river are Punta de Agua Creek, Big Blue Creek, and Palo Duro Creek.
    (Canadian)

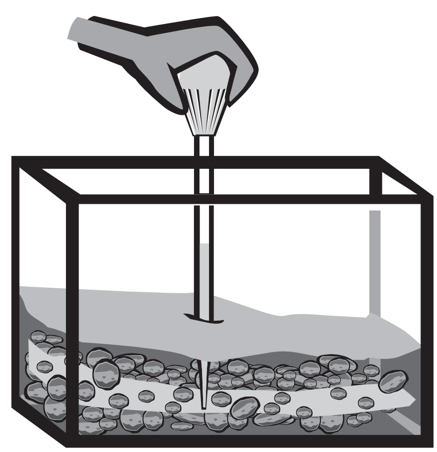
C. Study and discuss Major Aquifers in Texas found on the map in Student Workbook page 7 (See page 15 of Teacher's Guide).

- Introduce vocabulary: aquifer, groundwater, permeable, recharge, and water well. Definitions are included with the resources at the end of this lesson.
- Discussion – Identify Texas' Major Aquifers: Ogallala, Trinity, Edwards, Carrizo-Wilcox, Gulf Coast, Pecos Valley, Seymour, Hueco-Mesilla Bolsons, and Edwards-Trinity. Potential discussion questions:

1. Which aquifers have the students heard of?
   (Answers will vary, depending on where students live.)
2. What type of rock material make up these aquifers?
   (Ogallala, Hueco-Mesilla Bolsons, Seymour and Pecos Valley are a mixture of sand, gravel, clay, and silt; Trinity and Edwards are limestone; Carrizo-Wilcox is sand and gravel; Gulf Coast is sand.)
3. How does the water go underground?
   (It infiltrates the soil and rock and is stored underground in small spaces. Some rocks are more permeable than others.)
4. How does water get to the surface?
   (The water is either forced out of the ground naturally through springs, or it is pumped up through wells.)
5. When the water comes up to the surface, where does it go?
   (Water that comes to the surface through springs typically goes into rivers. Water pumped up can go to farmers, to cities for the people of the city to use, to industries, etc. Most groundwater is free of pollution.)
6. Is groundwater clean?
   (Yes — generally — but certain minerals such as calcium and iron may need to be removed before it is drinkable.)

D. Conduct a groundwater/surface water demonstration. *[Note: Activities D and E are similar in concept. Teachers may choose to conduct (or have students conduct) a demonstration (D) or have students conduct their own investigation (E).]*

- Make copies of the Groundwater and Surface Water Student Data Sheet (see page 25 of the Teacher's Guide.)
- Have students fill half of an aquarium or glass jar with gravel and build up the gravel slightly higher on one side than the other.
- Pour water from a watering can into the aquarium or jar to simulate rain. Pour enough water so that the gravel is saturated but not so that the water shows above the gravel.



- Ask students where the "rain" went.
  (The water is underground, in the spaces between the gravel.)
- Have students slowly pour more water on the ground until a "lake" forms over the lower ground.
- Ask students what stages of the water cycle have been demonstrated.
  (Precipitation: water falling to the earth. Infiltration: water soaking into the earth. Surface runoff: water flowing along the ground into a lake.)
- Have students insert the meat baster from the dry surface down to the water level to simulate the drilling of a well. Pump up some of the groundwater and place it in a glass or jar.

  [Note: Some gravel also may come up, but it will settle to the bottom in the glass or jar.]
- Ask students what would happen if you pumped out more water.
  (The lake would disappear, and the groundwater level would be lower, so you'd have to drill the well deeper.)

E. Investigation of soil stratification effect on groundwater/surface water supply

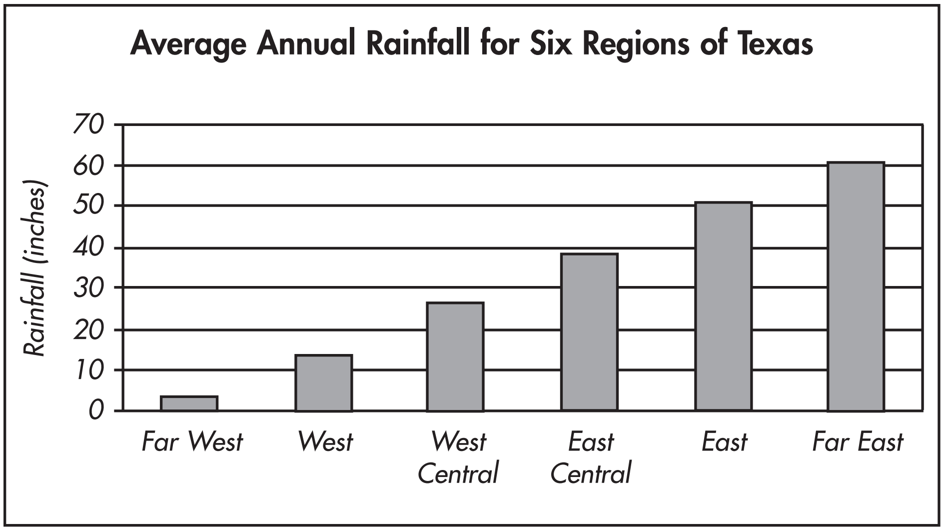
- Use a clear, 2-liter soda pop bottle with cap. Measure 15 cm (6 inches) up from the bottom and, using scissors, cut the bottle in half; you will use both halves. A small aquarium also can be used to create more elevation and varied layers of soil (strata) within the same model.
- Use at least 237 mL (1 cup) each of four different soil materials – potting soil, sand, clay, gravel – to create a geologic cross section of the earth. Plastic wrap or modeling clay can be used to create a barrier that water cannot cross between soil layers. Review the results of the infiltration lab done in the previous lesson. Allow students to decide how they will layer the soil material, and ask them to create an area that will store groundwater as well as surface water. Have students predict how the model will be affected by rain and predict the best place to drill a well. Ask students to think about how building hills and valleys affects how the model stores water.
- Slowly pour 237 mL (1 cup) of water into your bottle. Observe and record what happens to the water. Ask students where the "rain" went. *(The water is underground in the spaces between the gravel.)* How does it travel through the layers of soil (strata)?
  (Answers will vary.)
- Slowly pour water into your bottle until a "lake" forms over part of the top layer. Observe and record what happens to the water.
- Ask students what stages of the water cycle have been demonstrated.
  (Precipitation: water falling to the earth. Infiltration: water moving through porous layers of soil, rock, etc. Surface runoff: water flowing along the ground into a lake.)
- Have students insert a meat baster into dry ground down to the water level to simulate the drilling of a well. Pump up some of the groundwater and place it in a glass jar.

  [Note: Some gravel may also come up, but it will settle to the bottom in the glass or jar.]
- Ask students to measure the extracted water.
- Ask students what would happen if you pumped out more water.

  (The lake would disappear and the groundwater level would be lower, so you'd have to drill the well deeper.)

F. Contrasting Texas Regional Average Annual Rainfall

- Distribute the Texas Average Annual Rainfall handout.
  1. Ask students how the amount of rainfall differs as they move from west to east.
     (The amount of rain increases as they move from west to east in Texas. In the far west, El Paso County, only 8 inches of rain falls in an average year. In the far east, in Orange County, 56 inches of rain falls in an average year.)
  2. Point out where your town is located on the map. Ask students to tell you how much rain normally falls in their area.



3. Using the information on the handout, students will find the average rainfall in each of the six regional areas shown. Students will then construct a bar graph showing rainfall in Texas. (See example above.)
4. Study the map on pages 6 and 7 of your student book. Where are the largest population centers, in the east or the west and why? Use what you have learned about average rainfall in Texas and water supply to support your answer.

   (East — more available water and other natural resources, and more rainfall.)
5. Using the Texas Average Annual Rainfall handout, students should select a region of Texas, then research how the amount of precipitation impacts the occupations or the economy of the region. Students can create a poster or other product to share their information.

G. Water Coursing Through History

[Note: This activity is an adaptation of "Common Water" taken from Project WET Curriculum and Activity Guide. Additional information is listed in the lesson resources.]

- Fill a large bucket to the brim with water. Tell students that the bucket represents water stored in a reservoir, pond, or lake. Some communities depend on groundwater. If this is the case, the bucket represents water underground (and the sponges symbolize wells).
- Tell students they are going to simulate changes in a watershed over several time periods. Each 30-second round represents a time period (see Round Scenarios). In each round, students represent different water users; they may want to make nametags to identify their roles.
- For each round, students should position themselves an equal distance from the water source. At the beginning of the round, the students should fill their sponges with water from the reservoir (bucket). To represent water consumption, have them squeeze water out of the sponges into individual containers. Students can refill their sponges as often as they like during the round.
- At the end of each round, note how much water remains in the bucket. Have students measure the amount of water they have collected with a graduated cylinder and record the totals for each type of water user on a chart. Tell students to empty half of the water from their containers back into the bucket. This represents used water that makes it back to the reservoir (i.e., when it infiltrates through soil, when it is discharged from a factory, after it runs off the surface.) Students will notice that the water is colored. Inform them this represents sewage and runoff from urban and rural areas.
- Record students' comments about the amount of water used and the amount of waste materials generated; compare after each round. Fill the bucket to the brim with clean water before each round. This will represent the water source cleaning and replenishing itself over time.

Suggested distribution of sponges table:

- Round Scenarios: Read each scenario to the students to set the stage for the students to engage in the activities of "using water" for each round.

  Round 1: It is 200 years ago. Native Americans are the primary inhabitants of the watershed. A few homesteaders operate small farms and ranches. A priest has a small mission to serve the inhabitants.

  Round 2: During the past 100 years, the landscape has changed as many settlers have moved into the state and the Native Americans now reside on reservations, most of which were established outside the state. An abundance of rich land, wildlife, and natural resources have assisted some settlers with establishing large farms and ranches in the watershed. A small town with shops and residents supports the growing community.

  Round 3: In the years following World War II, the town continues to grow and a factory expands to employ many of the town residents. The factory makes cloth from the abundant natural fibers grown in the region. The growing community requires many community services such as hospitals, schools, churches, theaters, and stores. A power company provides the energy for electrical lights, machines, and the factory. Two farming areas supply milk, some food (meat, eggs, milk, grains, and vegetables) and fiber (cotton and wool) for the factory and the community.

  Round 4: It is the present. The town has continued to grow. The clothing factory has prospered but has mechanized many of the tasks formerly completed by workers. A new industry that makes household cleaning products has moved into the community. Many residents have built houses with lawns and gardens, but some live in large apartment buildings. Some families were able to keep their farms by using good land management practices. The power company continues to grow as more energy is needed to serve the expanding community. A new water recreational park has opened in the town.

- Lead the students in discussing the following aspects of the simulation:
  1. How was the quality and quantity of the water affected in each round?
     (Answers will vary.)
  2. Was the proportion of sponges that were distributed to community members appropriate? Explain answers.
     (Answers will vary but generally the larger water consumers were given larger sponge pieces. The larger the number of specific water users the more students represented that user group.)
  3. Did the roles in the simulation represent water users in their community?
     (Answers will vary.)

	1/4 sponge	**1/3 sponge**	**1/2 sponge**	**whole sponge**
Round 1 (200 years ago)	*2 students (settlers)*			
	1 student (priest)			
	1 student (rancher)			
	4 students (Native Americans)			
Round 2 (1890–1910)	*7 students (townspeople)*		*2 students (large farms)*	
			2 students (large ranches)	
Round 3 (after WWII 1946–1950)		*10 students (townspeople)*	*1 student (factory)*	*2 students (large farms)*
			3 students (community services)	*1 student (power plant)*
Round 4 (present)	*3 students (apartment residents)*	*15 students (townspeople)*	*2 students (factories)*	*2 students (large farms)*
			4 students (community services)	*1 student (power plant)*
				1 student (industry)

4. Did the amount of water collected by each user group reflect the size and number of sponges given to that group? Why or why not? *(Some groups may gather water more efficiently, e.g., walk faster, collect water from dripping sponges or squeeze more thoroughly.)*
5. How could the activity be adjusted to ensure enough water for all users? *(Students may suggest making fewer trips to soak their sponges or reducing the size of their sponges. They may suggest adding another bucket of water.)*
6. Where would the water for an additional bucket come from? How might other communities be affected? *(The first place the community might find additional water is with its own water users reducing their water use through conservation. The community may need to look to other water supplies, recycling water, or desalination (discussed later in the lesson) for additional water if it cannot be found through conservation.)*
7. What can communities do to make sure everyone has enough water? *(Have students brainstorm and then explain that communities can understand their water needs through water planning.)*

H. Regional Water Planning Groups

- Introduce vocabulary: conservation, desalination, rainwater harvesting, recycled water, Regional Water Planning Group, and water planning. Definitions are included with the resources at the end of this lesson.
- Explain that the Texas Water Development Board (TWDB) is the state agency that collects and shares all types of water information. The TWDB helps water users plan for the use and conservation of Texas' water. The TWDB also provides grants and loans (money) to plan, build or fix water supply systems, wastewater treatment plants, flood control structures, and agricultural water conservation projects.
- Explain that Regional Water Planning Groups were created to assist communities in developing plans for understanding and meeting water needs. Show students the handout map of Regional Water Planning Groups and hand out a copy of the Regional Water Planning Groups Map worksheet to each student (see page 26). Ask students to locate their county. Have students identify the Regional Water Planning Group that their county is in. Have the students use map colors or colored pencils to color in the counties that form their Regional Water Planning Group.
- Discussion Questions for Water Planning and Regional Water Planning Groups.
  1. Why is water planning important? *(If we do not plan ahead, we will not have enough water for everyone in the future, especially during droughts.)*
  2. What agency coordinates water planning in Texas? *(The Texas Water Development Board, or TWDB.)*
  3. What is regional water planning? *(The process that community leaders use to plan ways to conserve water supplies, meet future water supply needs, and respond to future droughts.)*
  4. Why do you think that Regional Water Planning Groups do not have the same number of counties? *(The Regional Water Planning Groups were created to help cities and counties with all types of water users. The counties in each group are based on common attributes shared by those counties, such as water supply sources and geographic areas.)*
- Discuss some alternative water management strategies that are important options to meet water needs. Brainstorm as to which of these might work best at your school or in your community:
  1. Do you use water? *(Water conservation is the implementation of practices that reduce water consumption and improve water use efficiency so that a water supply is made available for future or alternative uses. We'll learn more about conservation in Lesson 7.)*
  2. Do you have a water treatment plant? *(Treated, recycled water from a wastewater treatment plant is suitable for landscape and nonfood crop irrigation water use. We'll learn more about recycled water in Lesson 6.)*
  3. Do you live near a source of salt water? *(Desalination is the process of removing salt*

from groundwater or seawater to create drinking water.)

4. Do you live in an area that receives more than 20 inches of rainfall?
   (Rainwater harvesting is a method of collecting rainwater from rooftops in tanks to be used for watering outdoor plants.)

I. Play the TWDB's online Water Planner Game.

- In the computer lab or in the classroom, go to TWDB Kids http://www.twdb.texas.gov/kids. In this game, students will put into action a Texas water plan. They will learn about the different water user groups (agricultural, municipal, and industrial/commercial) and some tools that can be used to conserve water.
- Click on "The Water Planner Game."
- Play the game and learn about water planning for Texas.

J. Texas Water Supply Review: Water Baseball

- Conduct a review quiz. Tell pupils that they are going to play "water baseball."
- Divide the class into two teams. Explain that everyone on each team gets a turn at bat and that they can choose whether they want to try for a single, a double, or a triple. Each wrong answer is an out, and after three outs, the other team comes to bat.
- Draw a baseball diamond on the chalkboard. You can advance players around the bases with chalk marks on the board, or you might want to use some other marker taped to the board. When a pupil answers a question, move him or her to first, second, or third base, depending on whether a single, double, or triple question was answered. The first student on base advances only when another player on his/her team answers a question and "pushes" the first player to the next base. A player on third cannot come to home plate until another player reaches third. Score one point for the team each time a player reaches home plate.
- Choose the questions randomly from the single, double, and triple lists.

  [Note: An alternative way of playing this game is to simply alternate asking questions of each team and award points for each right answer — one point for singles, two points for doubles, and three points for triples.

  Another alternative is to have groups of students create a review round. Give each group the questions and answers from the singles, doubles, and triples sections. Give each group 12 two- by three-inch pieces of paper. Students should select 12 questions with answers from the lists. Students should write, "I have ____ (answer to a question)." Then write "Who has _____ (next question)." This pattern continues until all 12 questions and answers are used. The last question should lead back to the answer given by the first person. For example, "I have 'The West.' Who has 'Where do most of the rivers in Texas empty into?'" Groups should exchange sets of cards. Distribute the cards among members of the group. One student begins by reading his/her answer then his/her question. The student with the correct answer to that question then reads his/her question. This process continues until it completes the round of questions and answers.

  See page 24 for sample cards.]

- Questions for the Water Supply Review/Water Baseball and example cards for the review round are located on pages 23–24 of the Teacher's Guide.

K. Students complete and correct Exercise 3: Texas Water Supply and Planning, page 8. (See page 27 of Teacher's Guide.)

- Instruct students to turn to page 8 in their workbooks.
- Read the directions to Part A and Part B aloud to the class, and then allow students to work on the exercise individually. Ask students to try to do Part B without looking back to pages 6 and 7.
- Correct the exercise as a class using the answer key on page 27. Be sure to have students with incorrect answers erase or cross out their answers and indicate the correct answers.

Optional Extension and Enrichment Activities:

- Have students identify the river or aquifer that is used for water supply where they live. Identify how water gets to the river or aquifer that supplies their water (tributaries, aquifer recharge zone, etc.).
- Provide an opportunity for students to create a large map of Texas. Use magazine pictures to form a collage showing the regional differences within the state.

- Help students memorize the names of the rivers with the memory tool (mnemonic) below. The first letter of each capitalized word in the following sentence is the first letter in the name of the nine rivers discussed in the lesson.
- Have students contact their local water utility to investigate their population-to-water supply ratio (number of people to number of gallons of available water) and long-range water supply plans. Students should share their information through visual and oral presentations.
- Have students invent their own memory tool (mnemonic). See examples below.

"Texas Rivers and Creeks from North to South Supply Lakes and Reservoirs for Boating,

Texas	Rivers	Creeks	North	South	Supply	Lakes	Reservoirs	Boating
r	*i*	*a*	*e*	*a*	*a*	*a*	*e*	*r*
i	*o*	*n*	*c*	*n*	*b*	*v*	*d*	*a*
n		*a*	*h*		*i*	*a*		*z*
i	*G*	*d*	*e*	*A*	*n*	*c*		*o*
t	*r*	*i*	*s*	*n*	*e*	*a*		*s*
y	*a*	*a*		*t*				
	n	*n*		*o*				
	d			*n*				
	e			*i*				
				o				

Canoeing, Great Catches, and Playing on Nice Sunny Sundays."

Canoeing	Great	Catches	Playing	Nice	Sunny	Sundays
y	*u*	*o*	*e*	*u*	*a*	*u*
p	*a*	*l*	*c*	*e*	*n*	*l*
r	*d*	*o*	*o*	*c*		*p*
e	*a*	*r*	*s*	*e*	*J*	*h*
s	*l*	*a*		*s*	*a*	*u*
s	*u*	*d*			*c*	*r*
	p	*o*			*i*	
	e				*n*	
					t	
					o	

Questions for Texas Water Supply Review (Part J – page 21):

Singles

1. Which part of Texas is the driest?
   (The west)
2. Where do most of the rivers in Texas empty into?
   (The Gulf of Mexico)
3. Which part of Texas is the wettest?
   (The east)
4. Where does Texas get its water?
   (From rivers and aquifers)
5. What is an aquifer?
   (An area of gravel, sand, or rocks underground that contains water)
6. Name one aquifer.
   (Ogallala, Trinity, Carrizo-Wilcox, Edwards, Gulf Coast, Hueco-Mesilla Bolsons, Pecos Valley, Seymour, or Edwards-Trinity)
7. What is water vapor?
   (Tiny, invisible droplets of water; water in its gas state)
8. What is rain, snow, hail, and sleet called?
   (Precipitation)
9. What is water called that flows from the ground into rivers, lakes, and oceans?
   (Surface runoff)
10. What is it called when water soaks into the ground?
    (Infiltration)
11. What is it called when water changes into vapor?
    (Evaporation)
12. What is it called when water vapor changes back into a liquid?
    (Condensation)
13. What is recharge?
    (Water that infiltrates through the soil to be stored in an aquifer)

Doubles

1. What is precipitation?
   (Water that falls to earth as rain, snow, sleet, or hail)
2. What is surface runoff?
   (Water on the ground that flows into rivers, lakes, and oceans)
3. What is infiltration?
   (Water soaking into the ground)
4. What is evaporation?
   (Water that gets heated, turns to vapor and rises into the air)
5. What is condensation?
   (Water vapor cools and changes back into liquid water)
6. How much of its water does Texas get from rivers?
   (Almost half)
7. How much of its water does Texas get from aquifers?
   (More than half)
8. Which river supplies water to both Texas and Mexico?
   (Rio Grande)
9. Which river supplies our capital city with water?
   (Colorado)
10. Which river forms a border between Texas and Louisiana?
    (Sabine)
11. Which river forms the Texas-Oklahoma border?
    (Red)
12. Name two aquifers.
    (Ogallala, Trinity, Carrizo-Wilcox, Edwards, Gulf Coast, Hueco-Mesilla Bolsons, Pecos Valley, Seymour, or Edwards-Trinity)
13. Which river flows across the Panhandle into Oklahoma?
    (Canadian)
14. Which river supplies water to both Texarkana, Texas, and Texarkana, Arkansas?
    (Sulphur)
15. Which river contributes water to Lake Houston and Lake Conroe?
    (San Jacinto)
16. What is it called when water infiltrates through soil to be stored in an aquifer?
    (Recharge)

Triples

1. How much rain falls in the east part of Texas?
   (30 to 60 inches)
2. How much rain falls in the west part of Texas?
   (8 to 30 inches)
3. Which river is the longest in Texas?
   (Rio Grande)
4. Which river means "reddish" in Spanish?
   (Colorado)
5. Which river starts near Santa Fe?
   (Pecos)
6. Which river supplies Corpus Christi?
   (Nueces)
7. Which river has the Blanco and San Marcos rivers as tributaries?
   (Guadalupe)
8. Which river supplies water to Dallas and Fort Worth?
   (Trinity)
9. Which aquifers are made of limestone?
   (Trinity and Edwards)
10. Which aquifer is under the High Plains in the Panhandle?
    (Ogallala)
11. Which aquifer is the farthest south in Texas?
    (Gulf Coast)
12. Which river empties into the Red River near Shreveport?
    (Cypress)
13. Which river supplies Sam Rayburn Reservoir — Texas' second largest lake?
    (Neches)
14. Which rivers empty into Matagorda Bay?
    (Lavaca and Colorado)
15. Which aquifers are made of a mixture of sand, grave, clay, and silt?
    (Ogallala, Hueco-Mesilla Bolsons, Seymour and Pecos Valley)

To create a round:

- Pick a group of questions from above and write the question from one question and the answer from the previous question. The first card should have the answer to the last question. Do not number the cards. Follow the directions on page 21. Sample cards appear below.

Start Card
Answer: The west
Question: Where do most rivers in Texas empty into?

Answer: The Gulf of Mexico
Question: Which part of Texas is the wettest?

Answer: The east
Question: Which part of Texas is the driest?

Name______________________________________

Groundwater and Surface Water Student Data Sheet

Procedure and Questions

1. Fill an aquarium or glass jar half-full with gravel and build up the gravel slightly higher on one side than the other.

2. Pour water from a watering can into the aquarium or jar to simulate rain. Pour enough water so that the gravel is saturated but not so that the water shows above the gravel.

3. Where did the "rain" go?

   ____

4. Slowly pour more water on the ground until a "lake" forms over the lower ground.

5. What stages of the water cycle have been demonstrated?

   ____

   ____

   ____

6. Insert the meat baster from the dry surface down to the water level to simulate the drilling of a well. Pump up some of the groundwater and place it in a glass or jar.

Analysis and Conclusions

7. How did the pumping of water from the well affect the lake?

   ____

8. How would pumping of water affect this well and other wells or springs that draw water from this aquifer?

   ____

9. How could you adjust your experiment to simulate a drought (less precipitation than normal)?

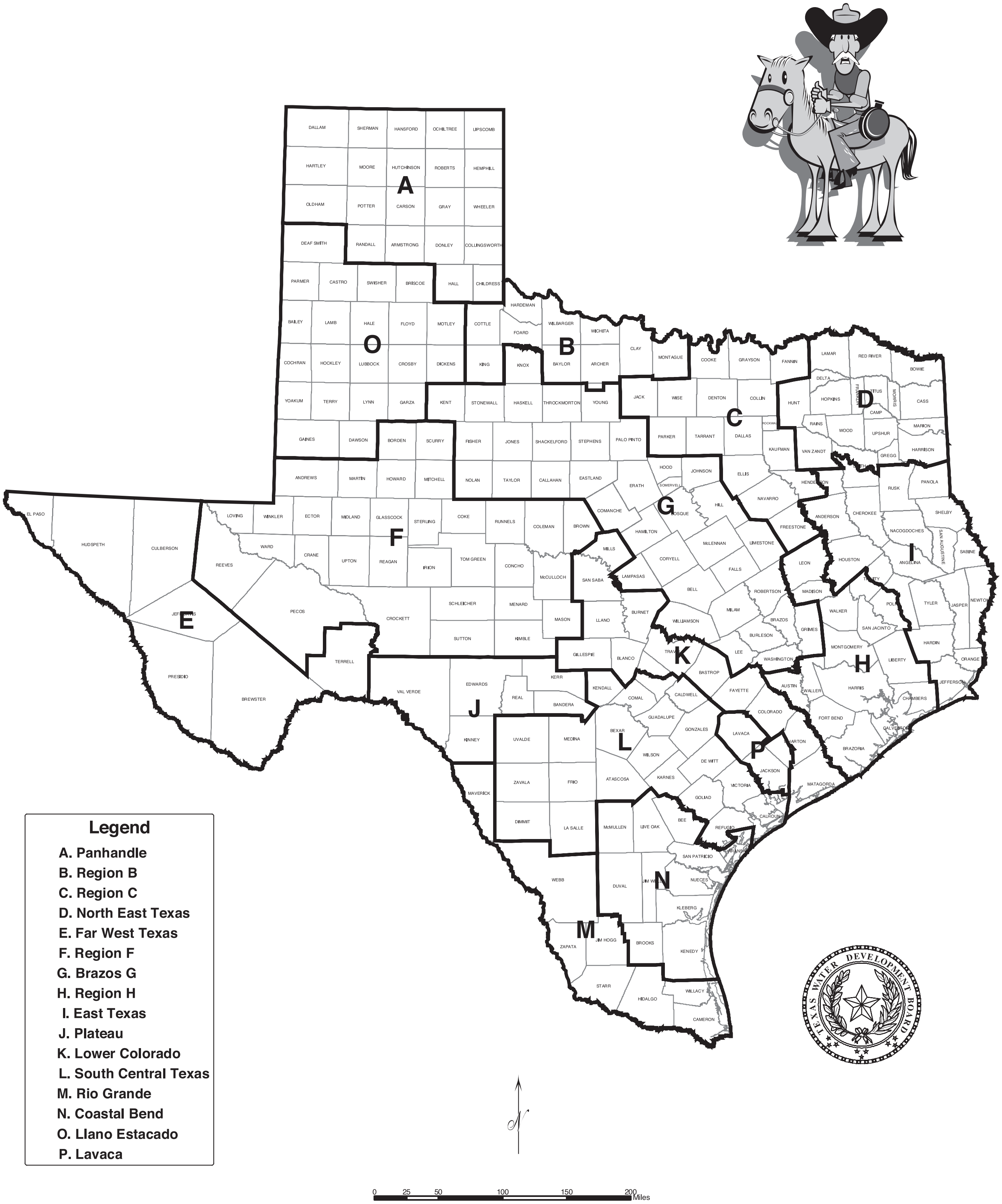
   ____

   ____

For use with Lesson 3, Activity D.

Name_______________________________________

Regional Water Planning Groups



For use with Lesson 3, Activity H.

EXERCISE 3 ANSWER KEY

Part A

Directions: Circle the letter of the word that best completes each sentence. Next, write the word on the blank line.

1. An underground layer of gravel, sand, or rocks that is filled with water is called **an aquifer**.
   a.) a reservoir b.) an aquifer c.) a lake

2. The area of Texas that receives the most rain is the **east**.
   a.) east b.) north c.) west

3. Almost **one-half** of the water we use in Texas comes from rivers.
   a.) one-half b.) none c.) all

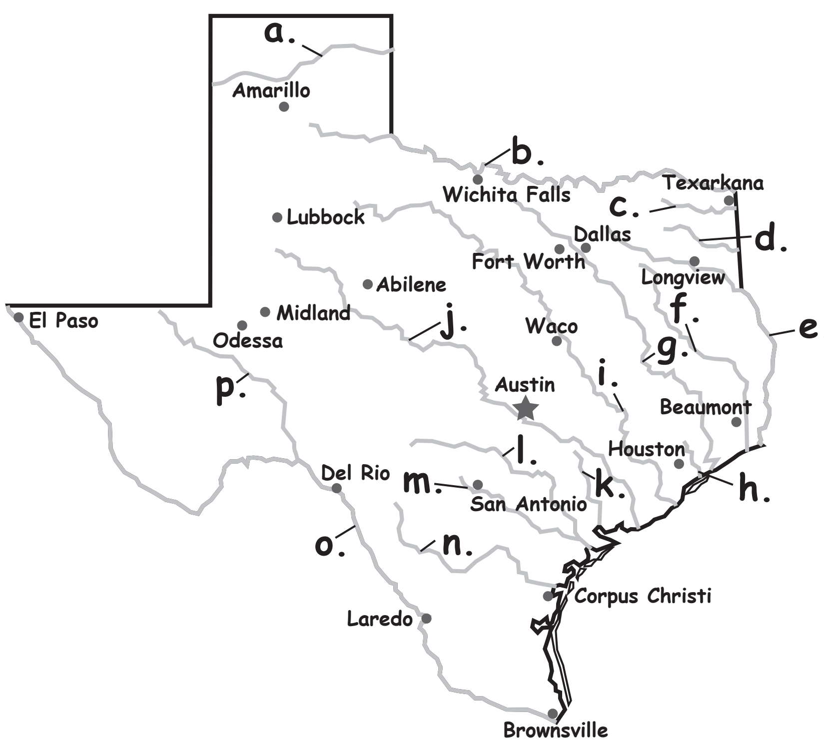
4. The river that supplies Austin, our capital city, is the **Colorado**.
   a.) Rio Grande b.) Colorado c.) Trinity

5. The rivers in Texas all flow to the southeast and empty into the **Gulf of Mexico**.
   a.) Matagorda Bay b.) Gulf of Mexico c.) Yucatan Peninsula

6. **Water planning** is the process that community leaders use to prepare for future water needs.
   a.) Building dams b.) Bottling water c.) Water planning

Part B

Directions: Next to the name of each river, write its letter shown on the map. Try not to look back at pages 6 and 7. The first one has been done for you.



i 1. Brazos River
a 2. Canadian River
j 3. Colorado River
d 4. Cypress River
l 5. Guadalupe River
k 6. Lavaca River
f 7. Neches River
n 8. Nueces River
p 9. Pecos River
b 10. Red River
o 11. Rio Grande
e 12. Sabine River
m 13. San Antonio River
h 14. San Jacinto River
c 15. Sulphur River
g 16. Trinity River

LESSON 3 VOCABULARY AND RESOURCES

Vocabulary:

Aquifer – An underground layer of soil, rock, sand, or gravel that contains groundwater.

Conservation – The act of conserving. The protection, preservation, management or restoration of natural resources such as water. Conservation includes practices that reduce water consumption and improve water use efficiency so that a water supply is made available for future or alternative uses.

Desalination – Removing salt from groundwater or sea water to create drinking water.

Groundwater – Water contained underground in rock layers and soil that supplies wells and springs.

Permeable – Something that water and air can penetrate or pass through. See also "porous" (Lesson 2).

Rainwater harvesting – A method of collecting rainwater from rooftops in tanks to be used for watering outdoor plants.

Recharge – Some of the water that flows across ground surface (surface runoff) infiltrates through the soil and rock and eventually reaches an aquifer, where it replenishes or recharges the groundwater supply.

Recycled water – Wastewater that has been treated so that it can be used again. This is also known as reclaimed water or reused water.

Regional Water Planning Group – Community leaders from large geographic areas (regions) create plans to decide how to conserve water supplies, meet future water supply needs, and respond to future water shortages.

Water management strategy – A specific plan to increase water supply or maximize existing supply to meet a specific need.

Water planning – Determining how much water is available in rivers and aquifers and how much is currently used by water users, then projecting the amount of water that will be needed to satisfy water users' needs in the future.

Water user groups – Groups who need and use water for the same purposes, such as cities or all of the farms or all of the industries in a county.

Water well – A deep hole or pipe sunk or drilled into an aquifer to obtain water.

Resources:

Clifford, Nick. (1996). *The Incredible Earth*. Dorling Kindersley: London.

Schwalbaum, W. Jesse. (1997). *Understanding Groundwater*. Nova Science Publishing, Inc.: Commack.

Texas Water Development Board's Interactive Water Data Mapping website
http://www.twdb.texas.gov/mapping/index.asp

Texas Water Development Board's Kids website: Surface Water/Groundwater and Water Planner interactive modules
http://www.twdb.texas.gov/conservation/education/kids/interactiveModules/index.asp

The Groundwater Foundation Kid's Corner
http://www.groundwater.org/kids

Water Coursing Through History (Part G of Lesson 3) adapted from - Higgins, Susan; Kesslheim, Alan; and Robinson, George. (1995). "Common Water." Project Wet Curriculum & Activity Guide. The Watercourse and the Council for Environmental Education: Montana State University, Bozeman, Montana, pp.232-237.

Metric Equivalents for Standard Measurements:

Milliliters (mL)	Teaspoon (tsp.)	Tablespoon (Tbs.)	Fluid Ounce (oz.)	Cup (c.)
237	48	16	8	1
177	36	12	6	3/4
158	32	11	5	2/3
118	24	8	4	1/2
79	16	5	3	1/3
59	12	4	2	1/4
30	6	2	1	1/8
15	3	1	0.5	1/16
5	1			

Message:
Historically, watersheds and river basins have determined where people live and work. In some communities, residents get their water from wells in aquifers, while other communities and water users depend on surface water from rivers, lakes, and reservoirs.

Objectives:
Students will understand the concepts of river basins and watersheds. They will also be able to identify their river basin and local watershed.

Students will create changes in a simulated stream bed to evaluate the effects on water flow rates and directions.

Time Requirements:
Three class periods

Materials:
- Student Workbook
- Handout of the Major River Basins of Texas
- Handout of the Major Coastal Bays of Texas
- Major River Basins of Texas worksheet (enough copies for class)
- Map colors
- Scheduled time in computer lab or classroom
- Computer with Internet access and TV connection/ LCD or computer projector

For impact of water flow on water systems investigation:
- Streambed Simulation Student Data Sheet (enough copies for class)
- Meter tape measures
- Fine soil
- Sand
- Pebbles or fine gravel
- Rocks, bricks and/or wood blocks
- Ping-Pong balls, corks, or foam peanuts
- Water source with ability to vary flow (water hoses)
- Stop watches or watches with second hands
- Playground area, stream table, or aluminum roasting pan with diatomaceous earth

Procedures:

A. Introduce students to surface water hydrology with river basins and watersheds.

- Introduce vocabulary: dam, drought, flood, floodplain, headwaters, main channel, meander, reservoir, river basin, surface water, delta, tributary, watershed, water source, and wetlands. Definitions are included with the resources at the end of this lesson.
- Use the following questions to discuss the terms "watershed" and "river basin."
  1. What is a watershed?
     (The land that water flows across on its way to a stream, river, or lake. The landscape is made up of many interconnected watersheds.)
  2. How large are watersheds?
     (All watersheds are different — they can vary in size from a few city blocks to millions of acres.)
  3. What is an example of a watershed nearby?
     (Answers will vary — perhaps there is a creek near the school, or behind a student's home, or a nearby pond.)
  4. What is a river basin?
     (Runoff from small watersheds join together, and their combined areas become larger watersheds called river basins.)
  5. How many river basins are there in Texas?
     (Texas has 23 major river basins.)
  6. What is the name of the river basin you live in?
     (Answers will vary – see next step.)
- Distribute the Major River Basins of Texas handout and a copy of the Major River Basins of Texas worksheet (see page 37) to each student.
- Read the following story, pausing at indicated points to ask the students to locate specific areas on their Major River Basins of Texas worksheet or handout.

  Howdy! Major Rivers here again to tell you a story about the rivers of Texas. These major rivers are as varied as the regions of this great state. Yes siree, they flow down mountains and hills, across prairies, and through forests to create magnificent landscapes by watering, draining, and weathering the land. As they meander across Texas, they move southeasterly at their own pace from the higher elevations in the west to the lowest elevation (sea level) at the Gulf of Mexico. ***[Have students locate the Gulf of Mexico.]***

Rain and other forms of precipitation provide water for surface runoff that drains across the land to creeks, streams, and smaller tributary rivers. These creeks, streams, and tributaries form the headwaters for our major rivers. (You young cowpokes already learned about springs that flow from aquifers and often provide cool, clean water for these waterways.) The land that water drains across to form these smaller waterways is called a watershed. Lots of small watersheds combined form river basins for the major rivers of Texas. Some of these river basins are decorated with moss-draped bayous, like those in East Texas, while others boast of cool, spring-fed, limestone-bedded rivers in the Edwards Plateau. Some flow from the rain and snow-fed creeks in the Trans-Pecos Mountains and high plains of the Texas Panhandle, while the Rio Grande flows past steep-walled canyons that separate the Texas and Mexico border. Well now, partners, do you know which of these river basins you live in? ***[Have students locate the county you are in. (You might want to place a dot where your school's city is located.) Then have students determine which river basin their city or county is in. Have students color in their river basin with map colors or colored pencils.]***

My story begins with the Rio Grande, a river that begins in the mountains of Colorado, weaves its way across New Mexico forming the southern boundary of Texas, and finally ends its long journey at the Gulf of Mexico. Way back yonder, transplanted New Mexico Indians who were fleeing the Spanish during the 1680 Pueblo Revolt established the two oldest villages in Texas, Ysleta and Socorro, downstream of El Paso on the Rio Grande. These people were skilled in making beautiful jewelry, pottery, baskets, and robes. Through the years more and more people settled along the banks of the Rio Grande not only in Texas but also in Colorado and New Mexico. Settlers needed water for their livestock, crops, and to drink, cook, wash clothes, and bathe. Evaporation from the hot, dry climate combined with the water used by the settlers greatly reduced the amount of water flowing in the river channel before it reached the settlement of Presidio, just north of the Big Bend in the Rio Grande in West Texas. But don't you worry your little heads about this; the Rio Grande gets a new life from the Conchos and other small streams flowing out from the mountains of northern Mexico, so it keeps flowing to the southern tip of Texas. From missionaries to desperados, and from peacemakers to invaders, the Rio Grande has its stories to tell. ***[Have students identify the Rio Grande River basin.]***

Some folks say that the great American West begins along the banks of the Pecos River. Even though its water is known for its salty taste and distinct smell, weary travelers lucky enough to find its banks were happy to find and drink its water. In the mid-nineteenth century, Charles Goodnight and Oliver Loving pioneered a route through this dry rangeland that cattlemen used to move herds to market or to new ranges farther west and north. This route became known as the Goodnight-Loving Trail. ***[Have students identify the Pecos River (see Student Workbook).]***

If the cattlemen drove their herds north through the Texas Panhandle, they would cross other rivers such as the Canadian. For many months of the year the Canadian barely flows at all across the high, flat, dry plains of the Texas Panhandle, on a part of the land known as the Llano Estacado or Staked Plain. Some old timers say the name Staked Plain comes from yucca stalks that stick up on the high plains and remind people of stakes in a stockade. However dry the landscape can look, underground lies one of the largest, most productive aquifers in North America, the Ogallala. The surface area of the Ogallala is seven hundred by three hundred miles, stretches from Nebraska to Texas across eight states, and it has a capacity of three billion acre-feet. Whew wee, that is a lot of water! ***[Have students locate the Canadian River basin.]***

South and east of the Pecos is the Nueces River. Like the Pecos, the Nueces River is a welcome site in a dry land of mesquite, cactus, cattle, and oil. The rich resources of the river and its riparian woodland offered opportunities to build large cattle ranches in this South Texas range. The springs that fed limestone streambeds provided a valuable source of cool, clear water except in times of drought. ***[Have students locate the Nueces River basin.]***

Just as the Rio Grande forms the southern and western boundary of Texas, the Red and Sabine rivers form much of the northern and eastern borders of this great state. These rivers are less distinct today than they were when I was a young cowpoke. Dams that create huge reservoirs for the storage and management of water have widened their natural boundaries. Water from these rivers flows through rich blackland prairies where residents raise wheat and grain sorghum, cotton and corn, beef and dairy cattle, sheep and poultry. As the rivers flow toward their river mouths, they pass through the East Texas timberlands, an area very important to Texas' economy for its logging activities and timber products. ***[Have students locate the Red and Sabine river basins.]***

If you young'uns remember back to Lesson 3, we learned that it rains a lot more in the eastern half of Texas. Runoff from the rainfall creates a network of other rivers such as the Trinity, Sulphur, Cypress, Neches, and San Jacinto rivers. The higher amounts of rainfall along with lower elevations (closer to sea level) and flat topography form marshes and wetlands that provide rich habitat for native plants and animals. The marshes and wetlands also act as a sponge to filter out sediments and pollutants that are in the water. ***[Have students identify the Sulphur and Cypress river basins.]***

The Neches River usually waltzes slowly across the heart of East Texas, winding its way through tall pine and hardwood forests. It gently settles layers of silt and nutrients along the floodplain of the river making this land more fertile than the surrounding land. Caddo Indians settled on the banks of these East Texas rivers, fishing and farming the area, before the days of the French and Spanish explorers. Yes, siree, you better believe life began to change for the Native Americans when the Europeans arrived. Europeans built missions, settlements, forts and the Old San Antonio Road, known as El Camino Real. El Camino Real was a trade route that began in San Antonio with the Alamo and other Spanish missions on the banks of the San Antonio River and ended at Nacogdoches. Some say that Nacogdoches was the birthplace of the Texas War of Independence. Whether that be true or not, it's a fact that on the banks of the San Jacinto, Texans won their independence. ***[Have students identify the Neches and San Antonio river basins.]***

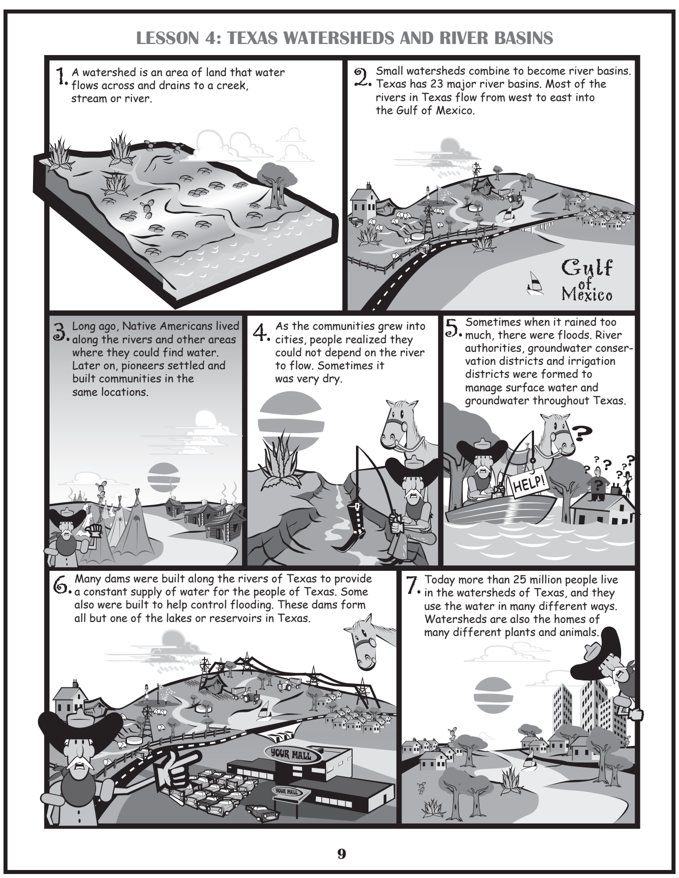
Today, the Trinity and San Jacinto rivers along with a number of bayous flow into Galveston Bay and are waterways for the Houston metro area, the heart of Texas commerce with its big ship channel and international harbor. Way back yonder, steamboats and flatboats were important means of transportation for settlers and products. Commerce from the lower Trinity River to the upriver settlements helped make Galveston, near the river's mouth, a major commercial center. Two of our other biggest commercial centers in Texas, Fort Worth and Dallas, lie on the banks of the upper Trinity. ***[Have students locate the Trinity and San Jacinto river basins.]***

During my Grandpappy's time about 200 years ago, Stephen F. Austin was given huge areas of land mainly in Central Texas called land grants. The Mexican government, who owned Texas in those days, wanted Mr. Austin to bring Anglo-Americans to Texas from the United States to help settle the land. Most of Austin's colonies were along the Colorado and Brazos rivers, but settlers had to cross other major rivers like the Trinity to get to these new settlements. As the settlers established their homes, they often settled near creeks, streams, and rivers for access to water sources. Sometimes this proved to be a perilous decision.

Stories of floods on Texas rivers are not tall tales like we Texans are often accused of spouting. Yep, way back on September 9 and 10, 1921, 38 inches of rain fell in a 24-hour period in a little town called Thrall on the San Gabriel River in the Brazos River basin. As frequent as not, a quiet little river can become a roaring, destructive, mile-wide force following sudden "cloudbursts." Springs in the Edwards Plateau with its beautiful rocky cliffs provide water for the Guadalupe River. This Texas Hill Country has little topsoil, and water can move very rapidly across the limestone channels, causing legendary flood conditions for the residents on the Guadalupe and Lavaca rivers. ***[Have students locate the Brazos, Colorado, and Guadalupe river basins.]***

The Lavaca marked the southwestern extent of Austin's colony. Most of the land was not settled until the 1840s and '50s when Bohemian/Czechoslovakian and German immigrants came to this fertile land rich in natural resources and diverse landscapes. The Lavaca and Navidad rivers cross three ecological regions: the blackland prairies, the post oak savannah, and the Gulf prairies and marshes. The fish, deer and other wildlife were abundant when Texas was young. In fact, Lavaca is Spanish for "cow" and refers to the many bison found in the river basin. Down through the years, it continued to be good for farming and cattle raising and is one of the three major milk-producing areas of Texas. Lands sake, how I do go on! ***[Have students locate the Lavaca and Navidad river basins.]***

Yes siree, we have used the major rivers of Texas for all sorts of things like fishing, washing, watering our stock and crops, transportation, and just plain fun, like those lazy summer picnics down at the swimming hole. Down through the years, I am ashamed to say that we have not always been kind to our rivers. As more people learned about the Texas grandeur, they came by the thousands, pushing the frontier farther and farther toward the headwaters of our great rivers. Towns grew up along the rivers and we poured waste into the rivers not thinking, or maybe not caring, what it meant to the people and wildlife below us in the watershed. The outlook for the health of the water in Texas began to look pretty bad for a while, but public attitude has begun to



change. Texans are working together to prevent water pollution. These efforts make Aquifer and old Major Rivers here real happy. We enjoy our Texas tales when they have a happy ending with a brighter future. You'll learn more about the types of pollution and how you can help prevent water pollution in Lesson 5.

- Ask the students which of the three choices they thought was the purpose for reading the story: 1) to gain information/be informed, 2) to solve a problem, or 3) to enjoy and appreciate? *(Answer: to gain information/be informed.)*

B. Students read in workbook: Texas Watersheds and River Basins, page 9.

- Have students turn to page 9 in their workbooks. Call on individual students to take turns reading text aloud. Use the following questions to generate a discussion.

1. How does a watershed work?
   (Rainfall that doesn't infiltrate into the soil runs off to the lowest point – the lowest point in most areas is a creek, stream, or river. All of the land where water drains to the same creek or stream is what makes up a watershed.)
2. What is a river basin and how does it work?
   (A river basin is the combination of many watersheds of all shapes and sizes that drain to the same river. The river basin acts like a giant watershed for the river.)
3. How did humans modify the environment of watersheds and river basins?
   (Humans built dams and reservoirs, pumped water from the rivers for irrigation and drinking, and they allowed waste to flow into the rivers.)
4. Why have dams been built on the rivers?
   (Dams have many purposes — some help manage and prevent flooding, some make reservoirs to help store water, and some do both. Dams are also used to generate electricity.)
5. What is a reservoir?
   (Reservoir is another word for a man-made lake — reservoirs are built to store water and manage flooding.)

6. What kinds of water uses are possible because of all the dams and reservoirs?
   (Cities send the water to residents for drinking, bathing, cooking, etc.; farmers use it for irrigation, and industries use it to make their products, etc.)

7. What are other ways people use the water in the river basins and reservoirs?
   (Recreational uses such as boating, water skiing, fishing, and sailing.)

8. How is water in the river basins and reservoirs managed?
   (River authorities, groundwater conservation districts and other types of water districts work together with cities and other water user groups to make sure there is enough water for everyone.)

9. Why is the color of the ocean water in Texas often brown instead of blue?
   (The movement of water in rivers wears away the rock, sediments, and soils and transports them downstream to the bays. In Texas, many rivers empty into the ocean. Give students the Major Coastal Bays of Texas handout. As you can see from the satellite image on the map, the sediments carried by the Texas rivers cause the water to look brown instead of blue or green.)

C. Students complete and correct Exercise 4: What is a Watershed? (See page 41 of Teacher's Guide.)
[Note: This exercise was adapted from the National Geographic Society Geography Action Rivers 2001 program. Additional information is listed in the lesson resources.]

- Instruct students to turn to page 10 in their workbooks.
- Read the directions aloud to the class, then allow students to work on the exercise individually or in pairs.
- Correct the exercise as a class using the answer key in the Teacher's Guide. Be sure to have students with incorrect answers erase or cross out their answers and indicate the correct answers.

D. Take an electronic tour of your watershed.
In the computer lab or in the classroom, link to the EPA's "Surf Your Watershed" website at http://cfpub.epa.gov/surf/locate/index.cfm.

- Locate your watershed by clicking the searchable map (top of page) or by entering your zip code (bottom center of page). ***[Note: using the zip code search will get you to your watershed quickly.]***
- Click on the link for the watershed closest to you in your zip code (most will only contain one).
- Scan through the information presented for your watershed and use the following questions to discuss your local watershed:
  1. Name one town or city in your watershed.
     (Answers will vary. See the map of the watershed on the right side of the page.)
  2. Name the county (counties) in your watershed.
     (Answers will vary. See the list under "Places Involving this Watershed" toward the bottom of the page.)
  3. Name the watersheds upstream and downstream of your watershed.
     (Answers will vary. See the list under "Places Involving this Watershed" toward the bottom of the page.)
- Allow students to explore the links listed for your watershed to come up with a list of facts about your watershed.

E. Impact of water flow on water systems
[Note: This investigation was adapted from the Investigating Water – Water Education Program for School Enrichment and 4-H Leaders. Additional information is listed in the lesson resources.]

Water is a powerful force even in a small stream or creek, especially during flood conditions. The goals of this investigation are for students to (1) simulate a "streambed" with natural flow conditions, (2) use the scientific method to test their hypothesis, (3) determine human impact on a natural system, and (4) observe changes in the streambed over time. Several options are available for making the simulated streambed. You can construct or purchase a streambed table; use a parking lot gutter, ditch, or similar location; or find an area on the school grounds where you can dig into the earth for groups of students to lay out their "streambeds." Students should place large rocks, bricks or pieces of wood in the middle and along the boundary of the "stream" to create changes in flow and direction. Students can change the flow of water to determine changes in direction and rate of flow. Some students may choose to create a downstream dam.

Students can choose to use one or more soil types to investigate the process of deposition downstream. You may want to use the following steps, or the Streambed Simulation Student Data Sheet (see page 39), as a procedural guideline for your students, but students should construct their own investigations of the impact of water flow on water systems.

- Study how water flows down the curbside gutter or other location.
- Devise a method for recording observations of direction and flow rates using a floating object (cork, Ping-Pong balls, or foam peanuts), a meter tape, and a timer.
- By using the rocks, bricks, or pieces of wood, the students will create "streambeds" that will meander and currents will vary.
- Students will hypothesize as to how various soils will be affected by changes in flow and direction of the water.
- Students should test their hypotheses and record their data, then critique their hypotheses based on the data results.
- Students should observe the "streambeds" created by other groups, then compare and contrast factors affecting flow rate and direction in each "streambed" and the location of downstream deposition of soil materials.

  [Note: Have students clean up the area after completing the investigation.]

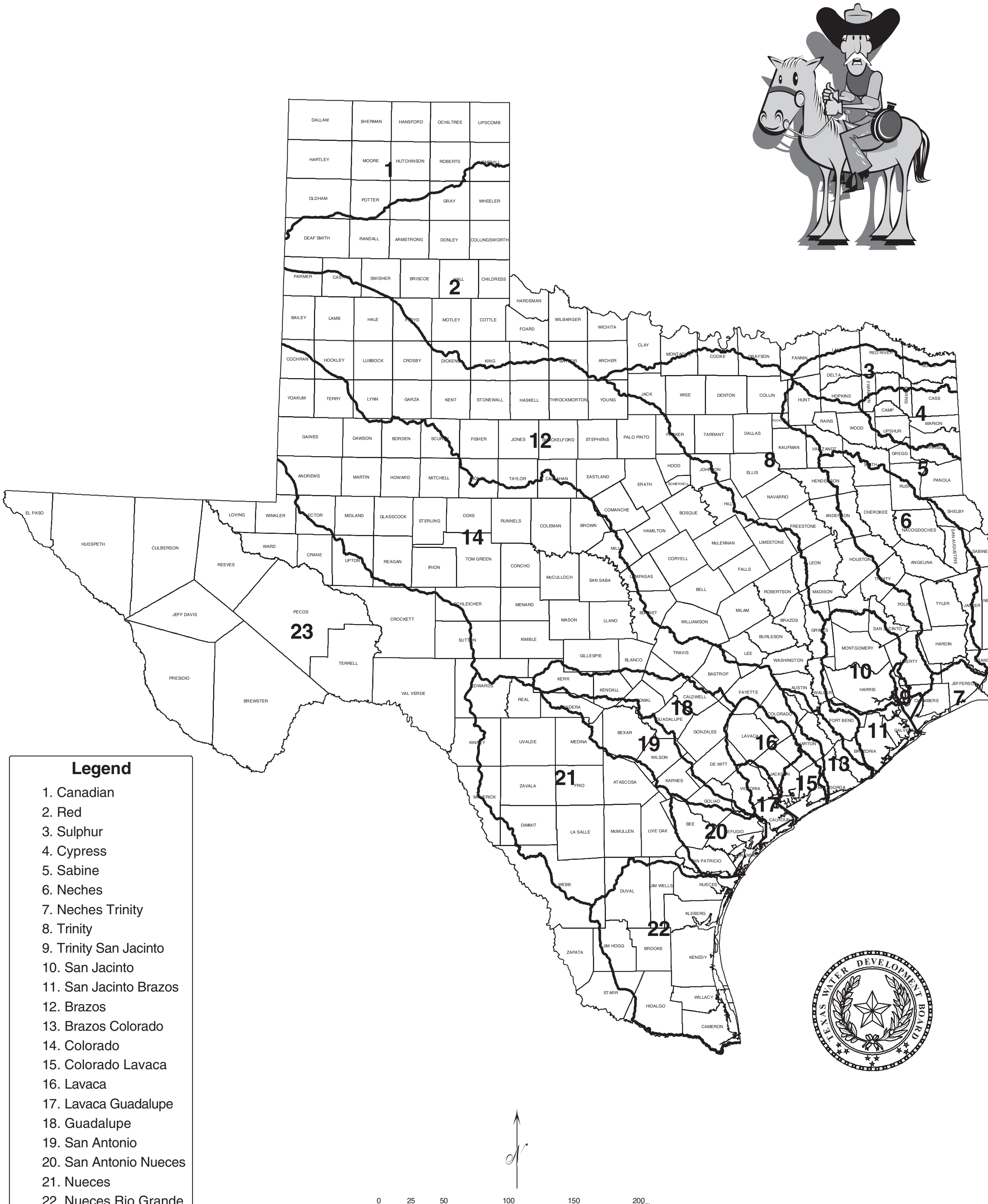
Optional Extension and Enrichment Activities:

- Have students research information about their watershed using the web pages provided with the resources at the end of this lesson. Students can create a salt or clay map of their local watershed.
- Teacher demonstration: Use the groundwater/surface water model from Lesson 3 and make some modifications to build a watershed model.

  Pour water on the model to simulate rainfall. Note how some water flows to the center of the model forming a river or surface water, how some may go underground, and the path the water takes on its way to the river. Discuss runoff and similar vocabulary that you have used in recent lessons.
- Take the students to a nearby stream or river. Have the students walk along the bank to make observations about the direction of water flow (they can use compasses), measure or estimate the width of stream or river, and measure changes in bank height above the water source. Using their observations, students should infer as to how and why the stream or river changes along the area in which they have walked.

Name____

Major River Basins in Texas



Legend

1. Canadian
2. Red
3. Sulphur
4. Cypress
5. Sabine
6. Neches
7. Neches Trinity
8. Trinity
9. Trinity San Jacinto
10. San Jacinto
11. San Jacinto Brazos
12. Brazos
13. Brazos Colorado
14. Colorado
15. Colorado Lavaca
16. Lavaca
17. Lavaca Guadalupe
18. Guadalupe
19. San Antonio
20. San Antonio Nueces
21. Nueces
22. Nueces Rio Grande
23. Rio Grande

For use with Lesson 4, Activity A.

Name____

Streambed Simulation
Student Data Sheet

1. Follow the directions below to create a river basin.
   - Use the materials provided (playground area, stream table, or aluminum roasting pan with diatomaceous earth, soil, rocks, bricks, or pieces of wood) to create a model streambed.
   - Model your streambed so it will meander (curve and twist) and so water and a floating object can travel the full length.
   - Use a floating object (cork, Ping-Pong balls, or foam peanuts) to measure the rate of water flow in your streambed. Do this by measuring the length of your streambed and timing how long it takes for the floating object to travel the length of the streambed.

2. Determine the rate of flow for your streambed. Rate = distance traveled ÷ travel time. Record the rate of flow. _____________meters/second

3. Sketch your streambed below.

4. Form a hypothesis as to how using different types of soil, rocks, bricks, pieces of wood, or more water force will affect the flow rate, direction of flow, and streambed. Record your hypothesis below.

____

____

5. Test your hypothesis, record data, then review your hypothesis based on the data collected and describe the outcome.

____

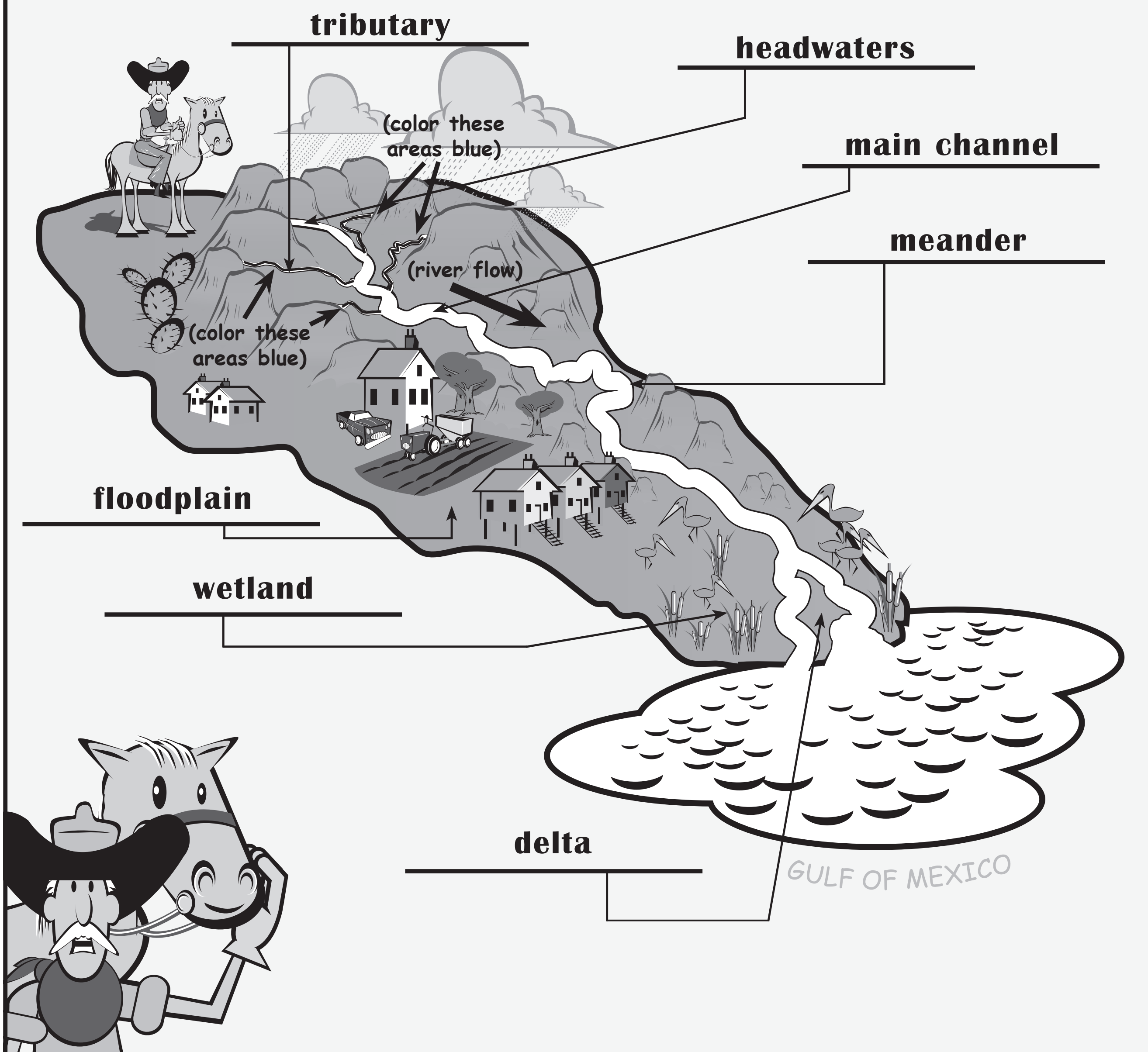
____

6. Observe the streambeds created by other groups. Describe any differences between the streambeds and explain how these differences affect the way water flows through the basin.

____

____

EXERCISE 4 ANSWER KEY



Directions:

1. Put the following words in the correct blank to label the watershed: tributary, floodplain, meander, headwaters, wetland, delta, and main channel.
2. Color the tributaries that flow into the main river blue.
3. Place an arrow showing the direction of the river's flow.

LESSON 4 VOCABULARY AND RESOURCES

Vocabulary:

Dam – A barrier constructed across a waterway to control the flow or raise the level of water.

Delta – A landform developed by sediments at the mouth of a river.

Drought – A period of dry weather or lack of rainfall.

Erosion – The gradual wearing away of the land surface materials by the action of water or wind.

Flood – An event where too much rainfall in a short period of time causes water to flow over the banks of streams, lakes, and rivers onto the surrounding land.

Floodplain – The land surrounding a river or stream that may flood during a heavy rain. Floodplains are made up of materials deposited by waterways during a flood.

Headwaters – Small streams or springs that are the water source for a river.

Main channel – The primary course of a river.

Meander – A bend or loop in a river channel. Most rivers have many meanders.

Reservoir – A manmade lake used for the storage and regulation of water.

River basin – The combination of many smaller watersheds that drain toward the same river.

Surface water – Water found on the earth's surface that does not soak into the ground. Streams, rivers, lakes, wetlands, and oceans contain surface water.

Tributary – A small stream or creek that joins a larger stream or river.

Watershed – An area of land that drains toward a common waterway (creek, stream, river) in a natural basin. The high points of land surrounding a waterway determine the boundary of a watershed.

Water source – A water supply such as an aquifer, river, or reservoir.

Wetlands – Low-lying areas that hold water long enough for plants and animals to adapt to wet conditions. Wetlands are an important part of a watershed, acting as a place to store extra water during floods or acting as a sponge to filter out sediments and pollutants.

Resources:

Environmental Protection Agency – Surf Your Watershed
http://cfpub.epa.gov/surf/locate/index.cfm

Exercise 4 (Page 41 of the Teacher's Guide and page 10 of the Student Workbook) adapted from: National Geographic Society, Geography Action! Rivers 2001 What is a River System? Worksheet found at National Geographic Society's webpage.
http://nationalgeographic.com/geography-action/rivers.html

Impact of water flow on water systems investigation (Page 35 of the Teacher's Guide) adapted from *Investigating Water – Water Education Program for School Enrichment and 4-H Leaders* by Ronald A. Howard, Jr. and Lisa Whittlesey. Texas Cooperative Extension. The State 4-H Office, 7607 Eastmark Drive, Suite 101, College Station, TX 77843-2473.
(409) 845-1214

Texas Water Development Board's Interactive Water Data Mapping website
http://www.twdb.texas.gov/mapping/index.asp

Message:
Water is used for a variety of purposes: in homes, businesses, industry, agriculture, recreation, and the generation of electricity. In fact, just about anything we do eventually involves some water use. Some of the ways we use water can have an adverse effect on our environment.

Objectives:
Students will identify various uses of water, including municipal, agricultural, industrial, recreational, and electrical generation.

Students will differentiate between point-source and nonpoint-source pollution.

Students will recognize that most water pollution is caused by human activity within the watershed.

Time Requirements:
Three class periods

Materials:
- Student Workbook
- Thermometers
- Optional:
  - Scheduled time in computer lab or classroom
  - Computer with Internet access and TV connection/LCD or computer projector

For Frankie the Fish activity:
- Frankie the Fish Data and Observation Sheet (enough copies for each student)
- Aquarium (optional)
- Three-liter soda bottles with top cut off
- Black permanent marker
- Graduated cylinder and measuring spoons
- Pitchers with water
- String • Water • White poker chips
- Yellow sponges • Washers • Hot-glue gun
- Ruler • Soil • Brown sugar
- Molasses • Detergent • Shredded paper
- Scissors • Red & yellow food coloring

Procedures:

A. Introduce water uses.
- Introduce vocabulary: agricultural, electricity, industrial, municipal, nonpoint-source pollution, point-source pollution, recreational, and turbidity. Definitions are included with the resources at the end of this lesson.
- Ask students to think about the many ways we use water. Provide the following categories on the board, and divide the students into groups to brainstorm and list how these various activities use water.
  1. Municipal activities
  2. Agricultural activities
  3. Recreational activities
  4. Industrial activities
  5. Generation of electricity

B. Students read from workbook: How Our Water Use Affects Our World, page 11. (See page 46 of Teacher's Guide.)
- Have students turn to page 11 in their workbooks. Call on individual students to take turns reading text aloud. Use the following questions to generate a discussion.

Municipal

1. What is municipal water?
   (Water that cities and towns treat and provide to their citizens.)
2. What are some of the ways we use municipal water?
   (For drinking water, water for homes, and for businesses.)
3. Where does this school get its water?
   (Teacher will have to research; answers will vary.)
4. What is the source of students' water at home?
   (Answers will vary.)
5. What home water use activities do you think use the largest amounts of water?
   (Bathing, watering the lawn, flushing the toilet, etc. — this is a preview to Lesson 7.)

Industrial

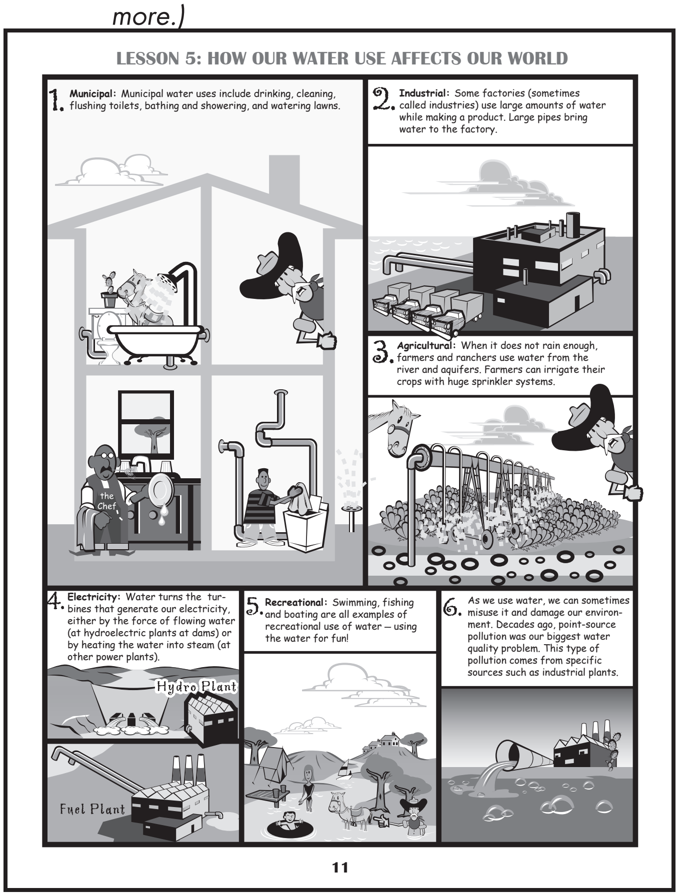
1. How do industries use water?
   (For the production of goods or for cooling equipment.)
2. Where is the most industrial use in Texas, east or west? Why do you think this is so?
   (Generally, in the east. Answers will vary as to why, but there are more industries where more

water is available for them to use.)

3. What are some of the industries in your community?
   (Answers will vary.)
4. Are industries important to your community? Do you have family or friends who work for industries?
   (Answers will vary.)
5. Do industries have to pay more for water? Do you think they use water wisely?
   (Answers will vary.)

Agricultural

1. What are a few examples of agricultural uses of water?
   (Farming and raising livestock.)
2. Where are the most farms in Texas?
   (The east and the north.)
3. Where are the most ranches in Texas?
   (The west and the south.)
4. What is irrigation?
   (The application of water to grow crops or maintain landscapes.)
5. What crops are grown in Texas?
   (*Cotton, corn, wheat, vegetables, and many more.)*



6. In what part of Texas are most of the vegetables and fruits grown?
   (South and Central Texas)
7. Where in Texas do you think most rice is grown?

   (Along the Gulf coastal plains and marshlands — near the coast.)
8. Where in Texas do you think cotton is grown?
   (Mostly in the Panhandle, but also near the coast.)
9. Why do ranchers need water?
   (Cattle and other livestock need water to survive.)

Electricity

1. How is water used to generate electricity?
   (The force of the water that is held behind the dams is used to turn giant turbines that generate electricity.)
2. Do you think this uses much water?
   (Electricity is generated through the motion of water. It does not actually consume water.)
3. Where are most hydroelectric plants in Texas, east or west?
   (The east)
4. Where does the school's electricity come from?
   (Most of our electricity comes from power plants that use coal or natural gas as fuel, although a small percentage comes from plants that use renewable energy such as water or wind.)
5. What is the difference between hydroelectricity and electricity generated by burning coal and natural gas?
   (Hydroelectricity is the production of electricity using water that is already moving downstream — in other words, it is a clean use of a resource that already exists in a particular location. When an electric power company burns coal or natural gas to generate electricity, it must transport the fuel from somewhere else.)
6. What does water have to do with the use of electricity?
   (When water is used, electricity is used. When we practice water conservation, we are also helping the environment through energy conservation — for example, your water heater.)

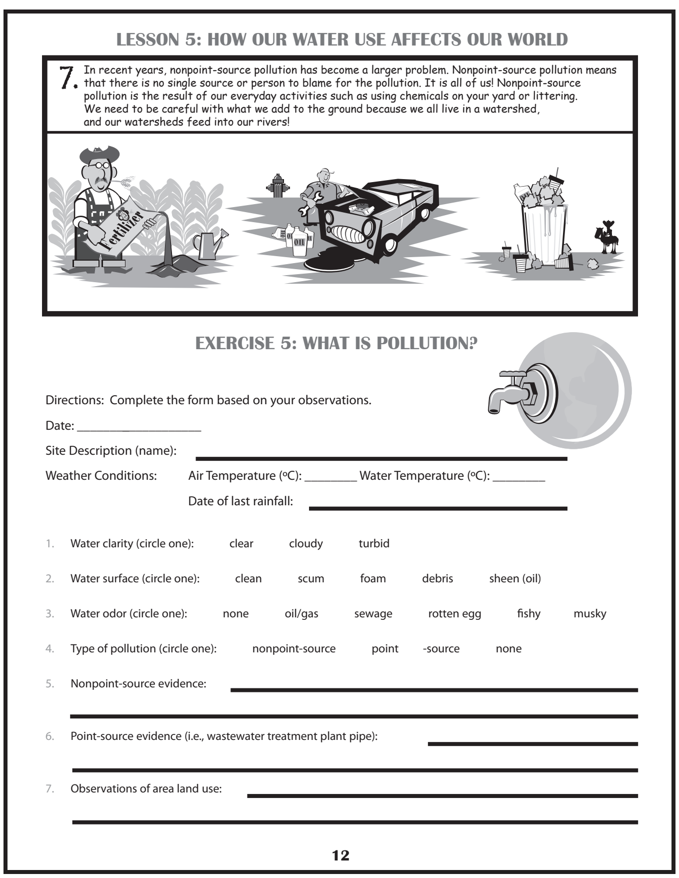
Recreational

1. What do we call it when we are using water for fun?
   (Recreation)
2. How does your family use water for fun?
   (Answers will vary — swimming, fishing, boating, etc.)
3. Where are most water recreation areas in Texas, east or west?
   (The east)
4. Is recreation an important use of water?
   (Answers will vary, an opinion question.)

- Following the discussion, instruct the groups to go back to their lists and see if there is anything they may have left off. Save these lists for students to use later in the lesson.

C. Read in Student Workbook: How Our Water Use Affects Our World, pages 11–12.

- Define and discuss point-source pollution and nonpoint-source pollution.



LESSON 5: HOW OUR WATER USE AFFECTS OUR WORLD

7. In recent years, nonpoint-source pollution has become a larger problem. Nonpoint-source pollution means that there is no single source or person to blame for the pollution. It is all of us! Nonpoint-source pollution is the result of our everyday activities such as using chemicals on your yard or littering. We need to be careful with what we add to the ground because we all live in a watershed, and our watersheds feed into our rivers!

EXERCISE 5: WHAT IS POLLUTION?

Directions: Complete the form based on your observations.

Date: ____________

Site Description (name): ____________

Weather Conditions: Air Temperature (ºC): ________ Water Temperature (ºC): ________

Date of last rainfall: ____________

1. Water clarity (circle one): clear cloudy turbid
2. Water surface (circle one): clean scum foam debris sheen (oil)
3. Water odor (circle one): none oil/gas sewage rotten egg fishy musky
4. Type of pollution (circle one): nonpoint-source point -source none
5. Nonpoint-source evidence: ____________
6. Point-source evidence (i.e., wastewater treatment plant pipe): ____________
7. Observations of area land use: ____________

12

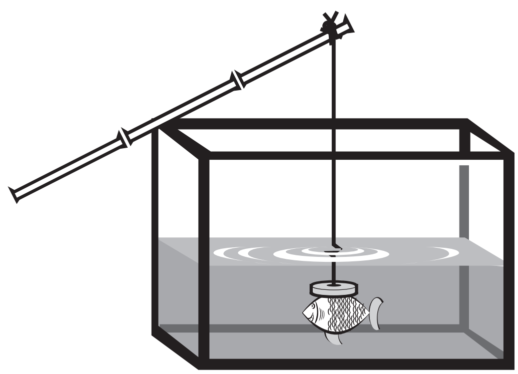
- Point-source pollution can be traced to a single point, such as a pipe. Example: an industrial plant pumping waste into a river, or an inefficient wastewater treatment plant discharging its waste into the river. Point-source pollution is less common these days because there are restrictions and severe fines for these incidents.
- Nonpoint-source pollution cannot be traced to a single point because it comes from many places or a widespread area. Examples include agricultural runoff and urban runoff from streets, yards, parking lots, etc. Nonpoint-source pollution is the direct result of our everyday land use activities.
- Discuss how our land use activities can result in nonpoint-source pollution.

1. How can our activities in our yards contribute to nonpoint-source pollution?
   (People put fertilizer on their lawns to help them grow faster and greener, and they put pesticides on their lawns to kill insects.)
2. How do our streets, driveways, and parking lots contribute to nonpoint-source pollution?
   (Oil and gas can drip from cars and accumulate on the ground surface; it will be caught up in the runoff and make its way into the watershed after a rain.)
3. What are some other ways that people contribute to nonpoint-source pollution?
   (By improperly disposing of household hazardous wastes, dumping oil and gas on the ground.)
4. Can new development add to our nonpoint-source pollution?
   (It could — sediment from the construction site could erode into the river.)
5. Do agricultural activities sometimes contribute to nonpoint-source pollution?
   (Perhaps — sediment after plowing, fertilizers, pesticides, and insecticides can get washed into our waterways as well as nutrients from animal waste.)

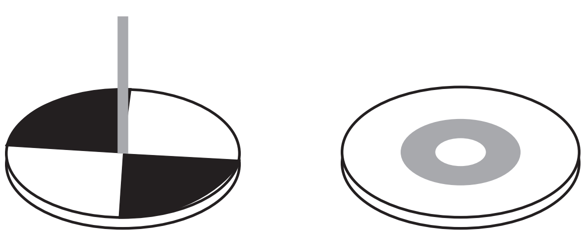
D. Student investigation: Differentiate between point-source and nonpoint-source pollution

- Give small groups of students copies of the Frankie the Fish story and observation sheet (see page 50). Students will read aloud the story about Frankie the Fish and complete each step of the activity by following the instructions in the brackets beneath each step of the story. Students should complete the appropriate steps on the observation sheet.

- Preparation for lab investigation:
  1. On a classroom table, have an aquarium or a 3-liter bottle (with the neck and top cut off) filled half way with water.
  2. Attach one end of a piece of 18-inch string to a ruler or stick.
  3. Cut a 2- to 3-inch fish out of a sponge and attach it along with a weight (washer) to the other end of the string as illustrated below. The fish also can be weighted down by cutting a slit in the bottom, inserting the string tied onto the weights, and pulling the string through the fish to the top.



  4. Create Secchi disks by hot-gluing a washer and one end of another 18-inch piece of string to a poker chip that has been divided into four equal pie wedges. Color alternate wedges black with a permanent black marker, as shown below.



[Note: To use the Secchi disk, lower it into the water until visibility of the colored wedges is reduced. After each scenario step, measure the distance from the top of the water to the submerged Secchi disk in centimeters and record the distance on the observation sheet. This distance measures turbidity (see vocabulary in Lesson 5 resources).]

  5. Have all other materials needed for the story ready to use (food coloring, detergent, brown sugar, molasses, paper, and additional water).

- Teacher will supervise as student groups read the story and complete the investigation.
- Post-investigation discussion questions should include the following:
  1. Which steps showed nonpoint-source pollution? *(3, 4, 5, 7, 8, 9, and 10)*
  2. Which allowed the water to become cleaner? *(6 and 11)* Why? *(Water was treated to remove pollutants before it was released into the river.)*
  3. Discuss how our land-use activities have a direct impact on water quality in a watershed.
  4. Discuss how each time it rains (clean water is added), the "pollutants" are diluted.
  5. Ask the students to determine the purpose of reading the story: 1) to gain knowledge/be informed, 2) to solve a problem, or 3) to enjoy and appreciate. *(1 and 2)*

E. Site Analysis Investigation: What is Pollution? (page 12 in Student Workbook) (See page 47 of Teacher's Guide.)

- In this activity, students will conduct a site analysis of a nearby water source and identify areas of point-source and nonpoint-source pollution.
- Procedure
  1. Locate a pond, stream, or river that is ideal for this activity.
  2. Divide students into groups of two or three.
  3. At the site, have students use thermometers to measure air and water temperatures. Record the temperatures on the Site Analysis Data Sheet, page 12 in the Student Workbook.
  4. Have each group complete the Site Analysis Data Sheet and identify the visible sources of pollution. This would include point and nonpoint-source pollution.
  5. Students should analyze their data and write an essay on how the conditions of the site could be improved.

[Note: Due to the nature of this exercise, no answer key is provided.]

Optional Extension and Enrichment Activities:

- Follow-up discussion: Divide students into their groups and ask them to refer to their lists about water uses. Instruct them to discuss what specific types of land-use activities would rainfall flow over on its way to the river? Could these places be creating or contributing pollution to the river?

- Students can research types and methods of erosion control and/or creekside management programs. Students can create and present a PowerPoint presentation or some other product to share their research.

Frankie the Fish Story

1. Frankie the Fish was born in a Texas state fish hatchery. He lived there in a controlled environment for months. The tank was very clean and he was well fed.

2. One day Frankie is loaded into a large truck with his friends. They are taken to a Texas river. Frankie is very happy — he has never felt so much freedom! There are also lots of new things to eat.

3. Frankie swims into a stretch of the river where there are a few cattle ranches. It begins to rain and soil and animal waste from the ranch washes into the river. Frankie has trouble breathing.

   [Pour 5 mL (one teaspoon) of soil into the water. Pour 60 mL (1/4 cup) clean water into the water (rain).]

4. Frankie enters an area of the river where there are homes all along the river. Many of these homes have septic systems. Unknowingly, a few of the septic systems leak. Frankie has to deal with the extra bacteria in the water.

   [Squirt two small drops of yellow food coloring into the water.]

5. Frankie swims farther downriver past a large housing development. Many of the homeowners had put lots of fertilizer on their lawns the day before. It begins to rain, and the runoff carries large amounts of nutrient pollution into the river. Frankie has trouble breathing — there is not enough oxygen!

   [Sprinkle 5 mL (1 teaspoon) brown sugar into the water. Pour 60 mL (1/4 cup) clean water into the water (rain).]

6. Frankie makes it past the subdivision and enters a stretch of the river where a city pumps water out of the river for its drinking water and for other uses in homes. After people use the water, it is cleaned by a wastewater treatment plant and returned to the river.

   [Pour 60 mL (1/4 cup) clean water into the water.]

7. Frankie realizes he is going on an adventure when he sees lots of motor boats. A few of them are leaking oil. He also sees fishermen with yummy bait trying to catch him, but he outsmarts them!

   [Pour 5 mL (1 teaspoon) molasses into the water.]

8. Frankie swims farther downstream and enters farming country. The farmers have problems with insects and have applied pesticides to their crops. As it begins to rain, Frankie deals with toxins in the water!

   [Squirt two small drops of red food coloring into the water. Pour 60 mL (1/4 cup) clean water into the water (rain).]

9. Frankie swims under a highway bridge. Some of the cars traveling on the highway are leaking oil. The rain is washing this oil into the river. More pollution! Frankie feels a little weak.

   [Pour 1 mL (1/4 teaspoon) molasses into the water.]

10. Frankie swims past a state park. Some holiday picnickers did not properly dispose of their trash, and the wind is blowing it into the river. Other campers are bathing and washing their clothes in the river. Frankie has trouble seeing through the bubbles, and he struggles to get free from some plastic netting. He feels a little better when it starts to rain.

    [Drop small pieces of shredded paper and 5 mL (1 teaspoon) detergent into the water. Pour 60 mL (1/4 cup) clean water into the water (rain).]

11. Frankie is almost all the way down the river. He passes by several factories. One of the factories has a pipe flowing into the river that is releasing toxic chemicals into the river. Frankie is feeling queasy and light-headed. Another factory further downstream is discharging clean water into the river, following state regulations designed to keep industrial sites from polluting the river. Frankie feels a little better. Even farther downstream, a power plant discharges warm water into a cooling pond before it is released into the river. Phew, Frankie and other aquatic life could have been hurt by that warm water. Even small changes in water temperature can affect aquatic life.

    [Pour 1 mL (1/4 teaspoon) molasses into the water. Pour 60 mL (1/4 cup) clean water into the water. Pour an additional 60 mL (1/4 cup) clean water into the water.]

12. Frankie swims down the pleasant river living a healthy life.

Name________________________________

Frankie the Fish Data and Observation Sheet

Step	Visibility Depth (cm)	Pollution Source	Check Pollution Type		Description and Effect on Frankie
			Point-Source	Nonpoint-Source	
1-2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Based upon your observations, do you agree or disagree with the statement in step 12? Explain your answer with supporting information. (Use the back of this sheet to write your answer.)

LESSON 5 VOCABULARY AND RESOURCES

Vocabulary:

Agricultural – Relates to the science and business of cultivating soil, producing crops, and raising livestock; also known as farming and ranching.

Electricity – A form of energy associated with moving electrons and protons. Energy for electricity can be generated by the wind, moving water, or burning fossil fuels, or it can occur in nature (lightning). Electric current is used as a source of power.

Industrial – Relates to businesses and companies that produce materials and goods. Examples: concrete manufacturing and distribution plant, computer manufacturer, and a food canning plant.

Livestock – Domesticated animals, such as cattle, goats, and sheep, raised to produce commodities such as food, fiber, and labor.

Municipal – Relates to a community, town, city, or any other local government.

Recreational – Relates to activities that are engaged for amusement, sport, or pastime.

Nonpoint-source pollution – Pollution that cannot be traced to a single point because it comes from many places or a widespread area. Examples include agricultural runoff or urban runoff from streets, yards, and parking lots. Nonpoint-source pollution is the direct result of our everyday land use activities.

Point-source pollution – Pollution that can be traced to a single point, such as an industrial plant pumping waste into a surface water source, or an inefficient wastewater treatment plant discharging its waste into a surface water source.

Turbidity – Having sediment or other dissolved particles suspended in water that affects visibility.

Resources:

The U.S. Environmental Protection Agency's Water Sense site
http://www.epa.gov/watersense/kids/

Texas Water Development Board's Kids website: Journey of a Raindrop (interactive game about nonpoint-source pollution)
http://www.twdb.texas.gov/conservation/resources/educational-resources.asp

Metric Equivalents for Standard Measurements:

Milliliters (mL)	Teaspoon (tsp.)	Tablespoon (Tbs.)	Fluid Ounce (oz.)	Cup (c.)
237	48	16	8	1
177	36	12	6	3/4
158	32	11	5	2/3
118	24	8	4	1/2
79	16	5	3	1/3
59	12	4	2	1/4
30	6	2	1	1/8
15	3	1	0.5	1/16
5	1			

Message:
Many organizations exist to provide water efficiently and safely to residents. Local communities and neighborhoods have their own utilities that provide water to homes and schools. Water must be treated before and after we use it to remove pollution. Water should be safe for us to use and not harm the environment once it leaves our homes.

Objective:
Students will identify the steps and processes of the water distribution system in Texas — wells and reservoirs, pipelines, water and wastewater treatment plants, septic systems, and recycled water.

Time Requirements:
Three class periods

Materials:
- Student Workbook
- Water Treatment and Distribution handout
- Optional:
  - Scheduled time in computer lab or classroom
  - Computer with Internet access and TV connection/LCD or computer projector

For Water Treatment Lab:
- Water Treatment Laboratory worksheet (enough copies for each student)

Below is enough for four groups. ***[Note: you will need at least 16 of the 20-ounce soda bottles and at least 12 small plastic cups.]***

Plan ahead a couple of weeks and ask students to bring these materials in from home:

- 4 small (4-ounce) plastic cups (such as an applesauce cup) containing 15 mL (1 tablespoon) alum (Buy it at any grocery store.)
- 4 two-liter soda bottles containing 750 mL (24 ounces or 3 cups) water mixed with 230 mL (8 ounces or 1 cup) of garden dirt (Label these: “Source Water” or “Surface Water.”) ***[Note: Mix water to soil in a 3:1 ratio.]***
- 4 clean two-liter soda bottles, cut in half without tops, labeled “Aeration”
- 4 clean two-liter clear soda bottles, cut in half without tops, labeled “Coagulation”
- 4 clean two-liter soda bottles, cut in half with tops labeled “Filtration” (see diagram on page 58)
- 4 rubber bands
- 4 stirring sticks
- 4 small pieces of old stockings or cheesecloth
- 4 eight-ounce plastic cups filled with gravel
- 4 eight-ounce plastic cups filled with sand
- 4 metric rulers
- 4 graduated cylinders or measuring spoons
- 4 stop watches or watches with a second hand

Procedures:

A. Introduce vocabulary and review words from previous lessons that will aid in the students’ understanding of water treatment and distribution.
- New words: aeration, coagulation, disinfection, filtration, irrigate, pipelines, recycled water, sedimentation, septic system, sewage, water treatment plant, wastewater, and water meter.
- Review words: groundwater, reservoir, surface water, and water well.

Definitions are included with the resources at the end of this lesson.

B. Students read and discuss Water Treatment and Distribution. (See page 56 of Teacher’s Guide.)
- Instruct students to open their workbooks to page 13, Water Treatment and Distribution. Call on individual students to take turns reading the text.
- Use the following questions to discuss the reading:
  1. How did people get water in early days? *(They used buckets to get water out of the rivers or they dug wells into the ground.)*
  2. How did the method of getting water then make life different than it is now? *(There were no pipelines or indoor plumbing to carry water to homes or move water within those homes. Water was also not treated or cleaned in any way before it was used, therefore diseases could be spread quickly by contaminated [dirty] water.)*
  3. River authorities and water districts were created to help get water to the people. What did they do? *(They built dams to store water in reservoirs, and they built pipelines and canals to carry water to the people.)*

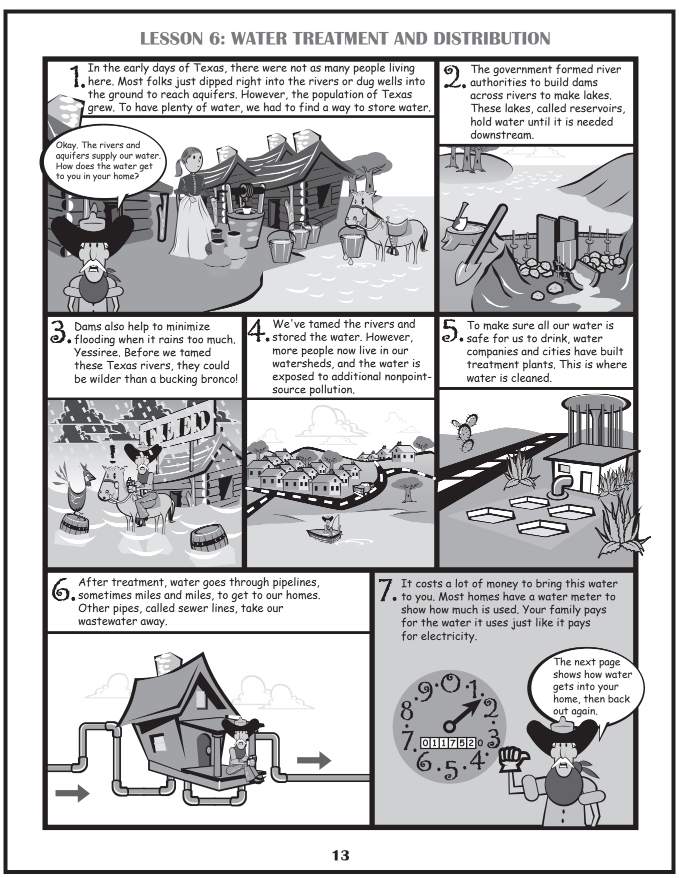
4. Dams also hold water back to help keep rivers from flooding. Why is it important to prevent rivers from flooding?
   (Floods can cause a lot of damage to homes and crops. They can kill people and animals.)

5. Why is water treated before it goes into our homes?
   (Water is treated to remove any pollutants — dirt, toxins, and bacteria — that might have gotten into the water.)

6. How does water get from its source to your home?
   (Water travels through pipelines from either a water treatment plant or a well.)

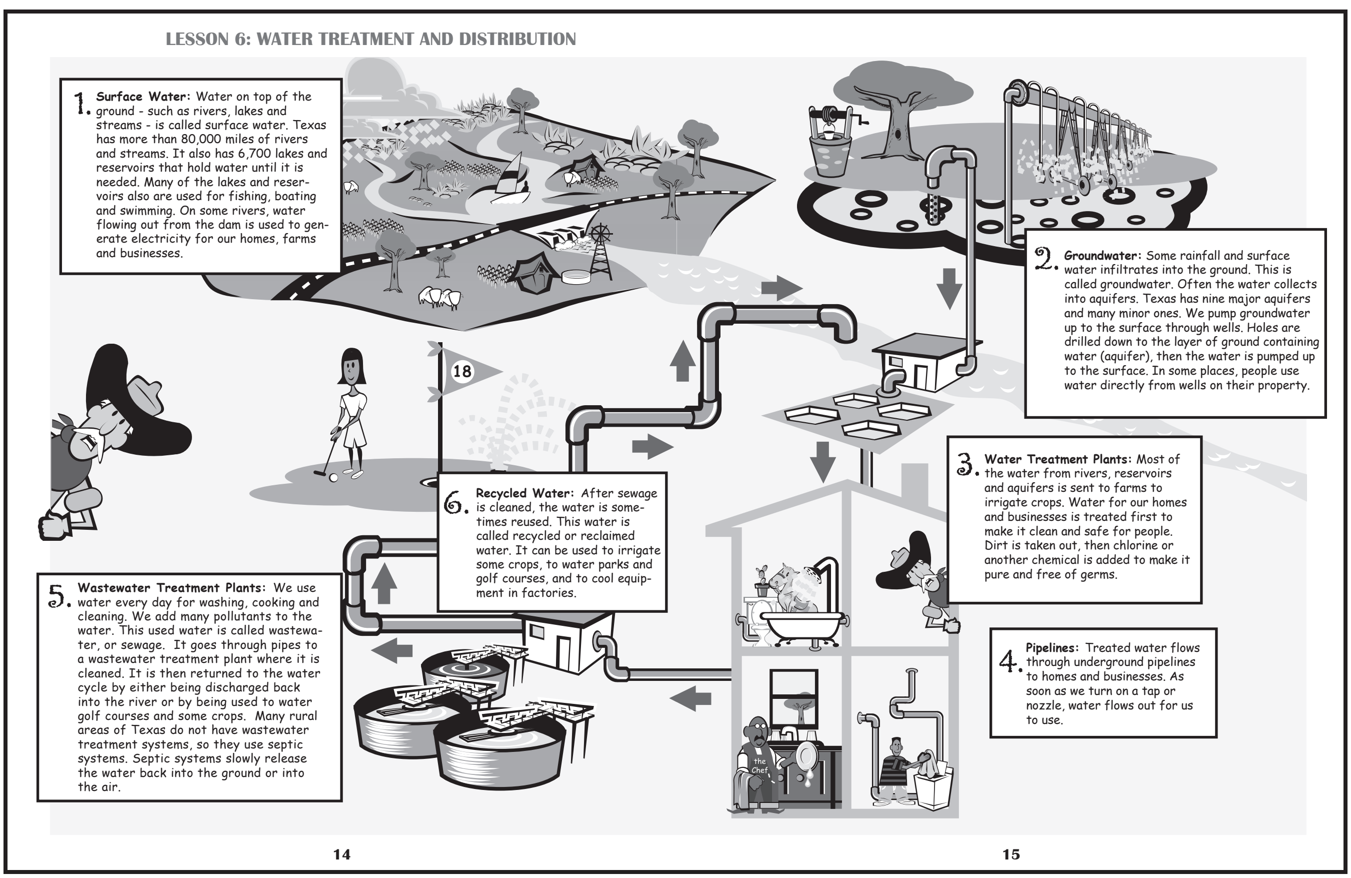
7. Is the water that comes out of our faucets free?
   (No. It costs money to clean the water and get the water to us, so we must pay for the water we use.)

8. How do we know what to pay for our water?
   (Most homes have a water meter to keep track of how much is used. Someone reads the meter, then the water agency or company sends a bill for the water used.)



C. Use diagram to discuss the process of water treatment and distribution.

- Instruct students to turn to pages 14 and 15 in their workbooks.
- Have students take turns reading aloud about each step in the distribution of water.
- Use the following questions to discuss the treatment and distribution of water.
  1. Where do we store water until we need it?
     (Water is stored in reservoirs or large water tanks.)
  2. What else are reservoirs used for?
     (Reservoirs are used for fishing, boating, and swimming.)
  3. How do we get water out of an aquifer?
     (Water from an aquifer is pumped from wells, which are like straws drilled into the ground.)
  4. Most of the water we get from water utilities goes to a water treatment plant. Why?
     (To remove dirt and pollutants from the water and make it safe for people to use.)
  5. What happens to water at a water treatment plant?
     (Dirt and pollution are taken out and chlorine or another chemical is added to make it pure and free of germs.)
  6. Does all water go to a water treatment plant?
     (No. Some water goes directly from the rivers and aquifers to farms to irrigate crops. Also, in some places, people get water directly from wells on their property.)
  7. How does water get to our homes from a water treatment plant?
     (Water flows through underground pipelines into our homes and businesses.)
  8. What happens to water after we're finished with it and it goes down the drain?
     (The wastewater either goes into a septic system on our property, where it is slowly released back into the ground or air; or it goes to a wastewater treatment plant. At a wastewater treatment plant, the water is cleaned and then pumped into the ground or into rivers and lakes.)
  9. What is another name for wastewater?
     (Sewage)



10. What is recycled water?
    (Recycled water is wastewater that has been cleaned enough to be used again. It is used to water parks and golf courses, to cool equipment in factories, and to water some crops and landscapes. In some cases, recycled water is not suitable for human consumption.)

D. Water Treatment and Distribution handout

- Use this handout to show students how water is supplied and distributed in Texas.
- Point out and discuss each step water must take as it makes its way through the path to get to our homes.
- Review vocabulary if needed.
- Review the rivers and aquifers on the map of Texas.
- Allow students to put their city on the map if it is not already labeled.

How to build a filter from a two-liter bottle

For use in creating materials for Activity E.

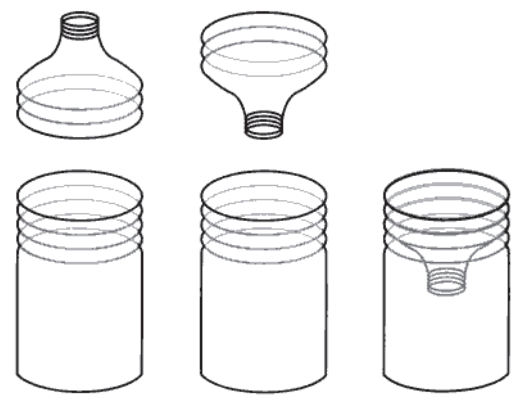


diagram courtesy of the City of Austin

E. Student activity: Water Treatment Laboratory

- In groups, students will investigate the water treatment process using dirt mixed in with water as their source (surface) water. Have the listed materials ready for each group of students. You also may want to write the following steps on the board for groups to copy and use to record their observations:

  1. Describe the "source water" or "surface water" your group has been provided for the lab.
  2. **Aeration**: Describe any changes you observe after you have aerated the water.
  3. **Coagulation**: Describe any changes after you added the alum.
  4. **Sedimentation**: Record in centimeters the depth of sedimentation and describe observations of the water at intervals of 0, 3, 6, 9, and 12 minutes.
  5. **Filtration**: After you have completed the treatment process by filtering the water, compare the treated water to the untreated water ("source water" or "surface water" — the water you started with). Record your observations.

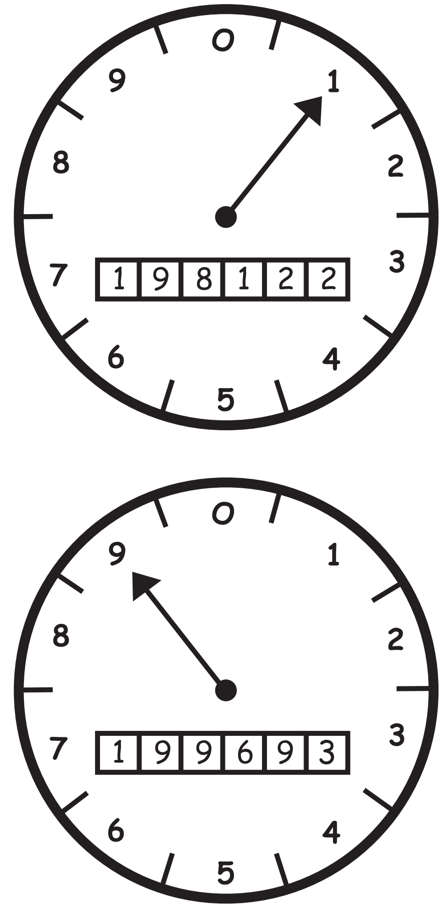
- Explain to the students they will be participating in a lab that will demonstrate the treatment process used by most water utility plants: aeration, coagulation, sedimentation and filtration. Give groups the following instructions, or use the Water Treatment Laboratory Worksheet (see pages 61 and 62).

  1. **Aeration** — Observe the bottle labeled "Source Water" or "Surface Water." Shake water vigorously for two minutes. Uncap and pour water into 2-liter bottle cut in half marked "Aeration." Slowly pour back and forth from "Aeration" bottle into "Coagulation" bottle for two minutes. Leave water in bottle marked "Coagulation." Observe, record, and discuss changes.
  2. **Coagulation** — Add 15 mL (1 tablespoon) of alum to water in "Coagulation" bottle. Stir for one minute. Observe, record, and discuss changes.
  3. **Sedimentation** — Allow the water to stand undisturbed in the bottle. Instruct students to measure the amount of sediment in centimeters at four intervals and record their observations of the water. These intervals will begin immediately after stopping the stirring process in the coagulation step (0 minutes) and at intervals of 3, 6, 9, and 12-minutes. Have them describe any changes they observe on their observation sheet. While waiting, students should go on to step four and make their filter.

     [Note: Students can graph the rate of sedimentation (time on x-axis and centimeters of sedimentation on y-axis.]
  4. **Filtration** — Make a filter by taking the cut-off top of a 2-liter bottle, turning it upside down and putting the piece of stocking over the mouth. Use rubber band to secure stocking. Put the upside down top into the bottom of the bottle marked "Filtration." Slowly pour gravel into the filter. Slowly pour sand on top of the gravel. After the sedimentation step is finished, instruct students to slowly pour water into the filter. Observe and record changes in the water.
  5. **Disinfection** — Students will not do this step, as it would involve using a hazardous chemical, like chlorine. Discuss how the water treatment plants add a small bit of chlorine or a like chemical to the water as it leaves the plant. The reason for this is to kill any bacteria that may still be in the water.

F. Water Distribution — Students practice reading water meters.

- Explain to students that meters measure water in gallons. Refer to the meter pictured on page 13 in the Student Workbook. Tell students that this is a straight-reading meter, like a mileage indicator in a car. The total gallons of water used since the meter was installed is shown in the slot with a fixed zero at the end, so the actual meter reading is rounded to the nearest 10 gallons. Write the number 177,520 on the chalkboard. Tell students that, as an example, the next month the meter has a reading of 189,520. Write this number above the first one on the chalkboard. Ask students if they can figure out how much water was used that month. Explain that the water company subtracts the first month's reading from the second month's to determine how much water was used and to compute the bill. (189,520 - 177,520 = 12,000 gallons.)



- Draw the meters (on previous page) on the chalkboard (or duplicate them) and have students practice reading them.
- Tell students these figures represent a typical family of four. Lead students in computing approximately how many gallons were used by these meters and how many gallons each person in the family used each day.
  1. Subtract the first month's reading from the second month's reading. This will indicate how many gallons were used that month.
     1,996,939 - 1,981,221 = 15,718 gallons
  2. Divide the number by 4 (number of people in family).
     15,718/4 = 3,929.5 gallons
  3. Round that number to the next whole number and divide this number by 30 (number of days in the month) to see how much water was used by each person each day.
     3,930/30 = 131 gallons per person
- Discuss possible reasons why some families use more than others. Swimming pools, lawns, gardens, wasteful, etc.

G. Evaluation: Students complete and correct Exercise 6: Water Treatment and Distribution, page 16. (See page 63 of Teacher's Guide.)

- Read the directions to Part A and Part B aloud to the class and then allow students to work on the exercise on their own.
- Correct the exercise as in previous lessons, using the answer key on page 63.

Optional Extension and Enrichment Activities:

- Fill a bucket with a gallon of water. Allow students to take turns carrying the bucket around the classroom to demonstrate the weight and difficulty of carrying water. Tell students that in the U.S., each person uses about 80 to 100 gallons of water each day in the home. Ask students how many of these buckets of water their families would need every day. Would they make any changes to their lifestyles if all their water had to be carried into their houses?
  [Note: this activity should be performed outside.]
- Challenge students to investigate how people obtained and used water in their community before the days of modern plumbing. Where did they build their houses? How did they get water to their houses? Did they use groundwater or surface water? How did they irrigate their crops? Students can write stories about how a pioneer would get and use water during a typical day.
- Have students write a story about a drop of water as it goes from a cloud to a river, to a reservoir, to a water treatment plant, through a pipeline to a user, into a wastewater treatment plant, and then back into the river and back into the air.
- Plan a field trip to a water treatment plant, to a reservoir, or to a wastewater treatment plant.
- Invite someone from your water utility, water district or river authority to come to your class and explain the process of water supply and distribution.
- Have students create a mural showing how water is treated and distributed in your area.
- Instruct students to find out where the water at their home and school originates. What is the name of the water company? Is it a city-owned water company? A municipal utility district? A rural water supply company? A well?
- Have students research diseases carried or transmitted by water.
- Have students research their city's water supply rating (superior, good, etc.).
- Have students research the Texas regulations for water treatment.

Name_______________________________________

Water Treatment Laboratory Worksheet

Directions

1. Aeration — Observe the bottle labeled "Source Water" or "Surface Water." Stir water vigorously for two minutes. Pour water into 2-liter bottle cut in half marked "Aeration." Slowly pour back and forth from "Aeration" bottle into "Coagulation" bottle for two minutes. Leave water in bottle marked "Coagulation." Record changes on the lab worksheet.

2. Coagulation — Add 15 mL (1 tablespoon) of alum to water in "Coagulation" bottle. Stir for one minute. Observe, record changes on the lab worksheet and discuss changes.

3. Sedimentation — Allow the water to stand undisturbed in the bottle (Do not move or shake the bottle). Measure the amount of sediment in centimeters at four intervals and record your observations of the water. Begin timing and measuring as soon as you stop the stirring process in Coagulation (step 2) (0 minutes on the worksheet). Continue timing and measure again at intervals of 3, 6, 9, and 12-minutes. Describe any changes on your lab worksheet. While you are waiting, make the filter.

   To make a filter: take the cut-off top of a 2-liter bottle, turn it upside down and put a piece of stocking over the mouth. Use rubber band to secure stocking. Put the upside down top into the bottom of the bottle marked "Filtration." Slowly pour gravel into the filter. Slowly pour sand on top of the gravel.

4. Filtration — After the sedimentation step is finished, slowly pour water into the filter. Observe and record changes in the water on your worksheet.

5. Disinfection — We will not perform this step, as it would involve using a hazardous chemical, like chlorine. Discuss how the water treatment plants add a small bit of chlorine or another chemical to the water as it leaves the plant. The reason for this is to kill any bacteria that may still be in the water.

Directions

1. Describe the source water or surface water your group has been provided for the lab.

2. Aeration: Describe any changes you observe after you have aerated the water.

3. Coagulation: Describe any changes after you added the alum.

4. Sedimentation: Record the depth of sedimentation in centimeters and describe observations of the water at intervals of 0, 3, 6, 9 and 12 minutes.

Time	Depth (cm)	Observations
0 minutes		
3 minutes		
6 minutes		
9 minutes		
12 minutes		

5. Filtration: After you have completed the treatment process by filtering the water, compare the treated water to the untreated water ("source water" or "surface water" — the water you started with). Record your observations.

EXERCISE 6 ANSWER KEY

Part A

Directions: Read each item. Fill in the blank spaces with the words listed below.

- surface water
- water treatment plants
- pipelines
- reservoirs
- wastewater treatment plants
- groundwater
- recycled water

1. **Dirt and germs are removed from water at** __water treatment plants__
2. **Water is delivered to homes through** __pipelines__
3. **Large amounts of surface water are stored in** __reservoirs__
4. **Sewage is cleaned at** __wastewater treatment plants__
5. **Cleaned wastewater that is used to water grass and some crops is called** __recycled water__
6. **Water we pump out of aquifers is called** __groundwater__
7. **Water from rivers, reservoirs, and lakes is called** __surface water__

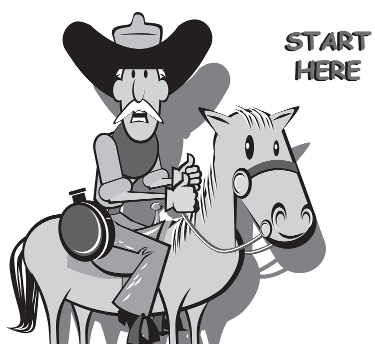
Part B

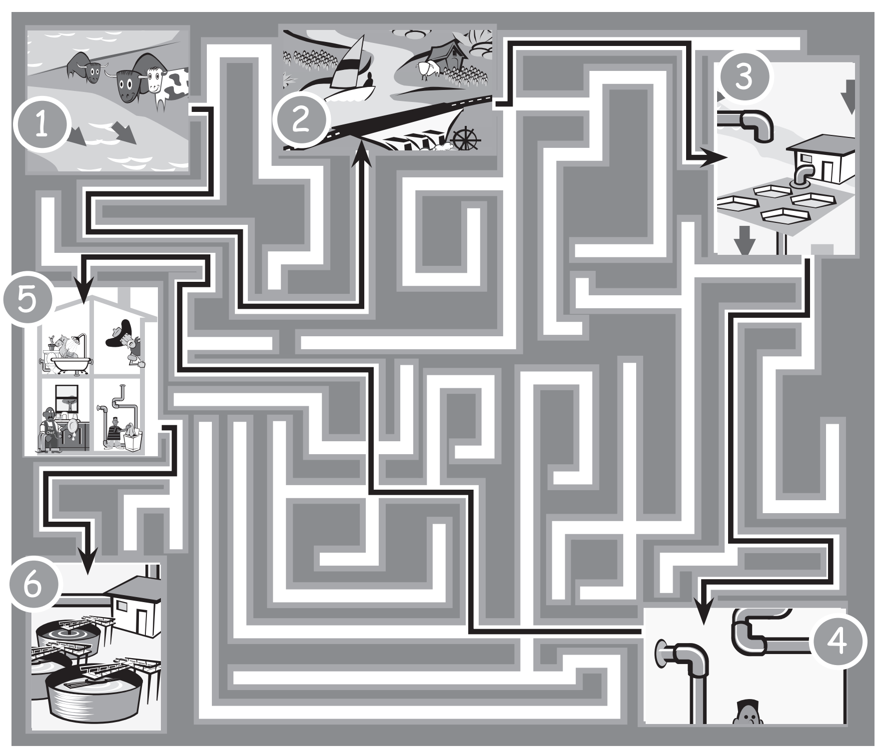
Directions: Trace Major Rivers and Aquifer through the maze. Stop at each water distribution point and unscramble the words to show where Major Rivers is.

ecafrus wraet
1. __surface water__

rrreesiov
2. __reservoir__

tawre ttrnaetme tnalp
3. __water treatment plant__





mohe
5. __home__

etsawretaw rtntaetme pntla
6. __wastewater treatment plant__

epipsenil
4. __pipelines__

LESSON 6 VOCABULARY AND RESOURCES

New Vocabulary:

Aeration – The use of air in the form of fast moving bubbles to mix water and eject some contaminants into the air.

Coagulation – The use of chemicals like alum to causes the solids in water to stick together into small groups called flocs. The combined weight of the solids and the alum causes the flocs to become heavy enough to sink to the bottom during sedimentation.

Disinfection – The use of a chemical like chlorine to kill any bacteria or microorganisms in water before it is distributed.

Filtration – The use of porous materials (sand, gravel, coal, etc.) to remove very small particles from water.

Irrigation – The application of water to land or soil to grow agricultural crops or to maintain landscapes.

Pipelines – A system of cylinders or tubes through which water is supplied.

Sedimentation – The action of solid particles of the water (flocs) falling to the bottom of the treatment tank. The flocs settle to the bottom and the clear water moves on to be filtered.

Septic system – A household-sized water treatment system consisting of a large tank buried under the ground where wastewater is collected and a drainfield that slowly releases water into the ground or into the air.

Sewage – Water containing human wastes; wastewater.

Wastewater – Water that has been used and not cleaned; sewage.

Water meter – A measuring device that shows how much water has been used.

Water treatment plant – Place where water is cleaned and treated.

Review Vocabulary:

Groundwater – Water contained underground in rock layers and soil that supplies wells and springs.

Recycled water – Wastewater that has been treated so that it can be used again. This is also known as reclaimed or reused water.

Reservoir – A manmade lake used for the storage and regulation of water.

Surface water – Water found on the earth's surface that does not soak into the ground. Streams, rivers, lakes, wetlands, and oceans contain surface water.

Water well – A deep hole or pipe sunk or drilled into an aquifer to obtain water.

Resources:

Visit a Water Treatment Plant (USGS)
http://water.usgs.gov/edu/wwvisit.html

What is Wastewater and Why Do We Treat It? (USGS)
http://water.usgs.gov/edu/wuww.html

Uses of Recycled (Reclaimed) Water (USGS)
http://water.usgs.gov/edu/wwreclaimed.html

Metric Equivalents for Standard Measurements:

Milliliters (mL)	Teaspoon (tsp.)	Tablespoon (Tbs.)	Fluid Ounce (oz.)	Cup (c.)
237	48	16	8	1
177	36	12	6	3/4
158	32	11	5	2/3
118	24	8	4	1/2
79	16	5	3	1/3
59	12	4	2	1/4
30	6	2	1	1/8
15	3	1	0.5	1/16
5	1			

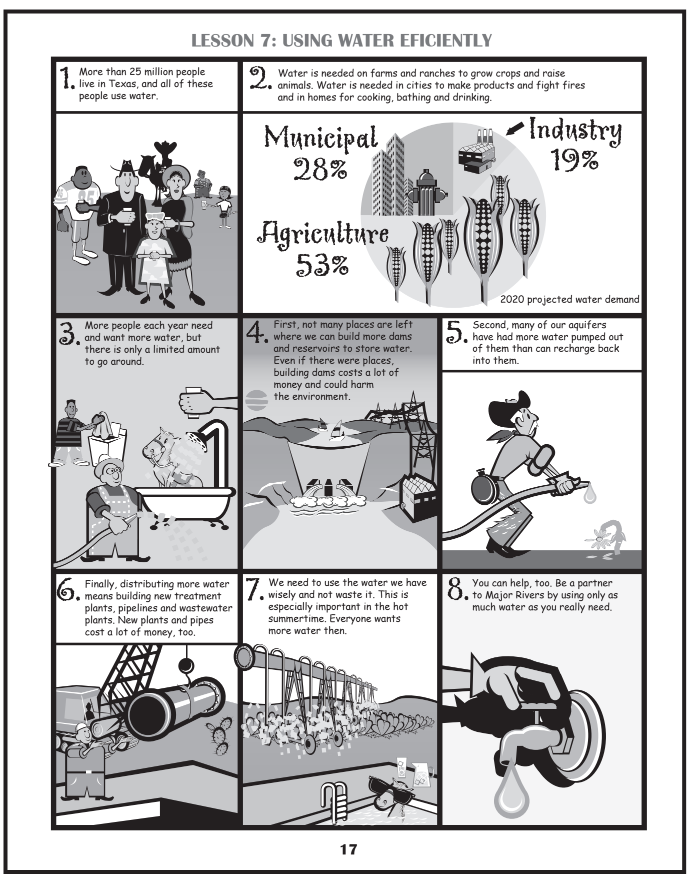
Message:
A growing population has produced a growing demand for water, yet we have a limited amount of water. Therefore, we need to use it as wisely and efficiently as possible.

Objective:
Students will review which home water activities use the most water, identify water conservation practices, and assess their individual water conservation practices.

Time Requirements:
Three class periods

Materials:
- Student Workbook
- 3 x 3 inch pieces of blue, yellow, and red paper for each student
- Major Rivers Home Information Leaflet

For Lawn Watering Laboratory:
- Stopwatches (enough for every group of three students to have one)
- Lawn sprinkler and hose



[Note: Use a spray-type sprinkler with a high precipitation rate (volume per minute) that covers at least a 10 x 10 foot square area. Rotating and oscillating sprinklers tend to have lower precipitation rates.]
- Large graduated cylinders
- Small, medium and large-sized flat-bottomed straight-sided containers (small 4 x 4 inch plastic container, 8 x 8 inch foil baking pan, and 9 x 13 inch baking pan)
- Ruler to measure inches and centimeters
- Student worksheets
- Blank sheet of paper
- Pencils, pens
- Masking tape
- Clipboard (one per group)

For Don't Be Clueless Investigation:
- Student worksheet for Don't Be Clueless investigation (pages 75 and 76 of this Teacher's Guide)
- Compasses
- Metric rulers/measuring tapes
- Red markers

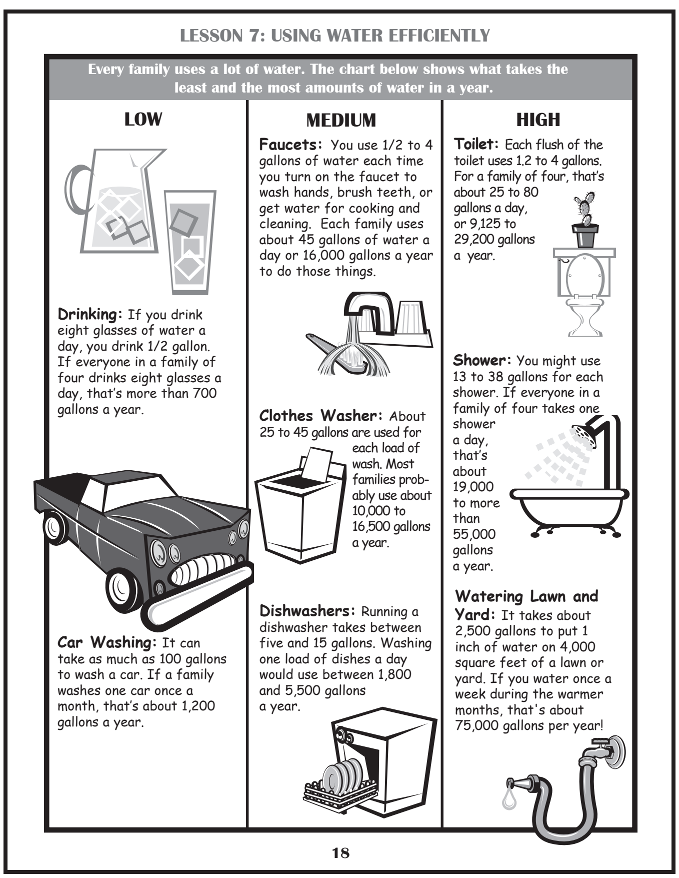
Procedures:

A. Introduce vocabulary that will aid in the students' understanding of using water efficiently: conserve, conservation, efficient, native plant, and naturalized or adapted plant. Definitions are included with the resources at the end of this lesson.

B. Students will read and discuss Using Water Efficiently.
- Have students turn to page 17 in Student Workbook. Call on individual students to take turns reading the text aloud.
- Use the following questions to generate a discussion of water use. Possible student answers are shown in parentheses.
  1. The pie graph shows that water is used in agriculture, municipalities. and industry. What are some examples of how water is used in each of these areas?
     *(**Agriculture** — Water is used to irrigate crops and for animals to drink. **Municipal** — Water is used for drinking, washing clothes, cooking, bathing, watering lawns, washing*

cars, washing dishes, and brushing teeth. Water is used at schools, in restaurants, in hospitals, for street cleaning, in swimming pools and golf courses, and in car washes. ***Industry*** *— Water is used in industries and manufacturing to cool machinery, produce food, manufacture products and refine oil and gas.)*

2. Why do we need to conserve water?
   (There is only a limited amount of water, and more and more people every year want and need water.)
3. Why can't we just build more dams and reservoirs to get more water?
   (Not many places are left where we can build more dams and reservoirs. Building dams also costs money and could harm the environment. Reservoirs just store water; they will not create more water.)
4. Why can't we just use more groundwater?
   (We often use more water from aquifers than infiltrates back into the aquifers, so we could eventually run out of groundwater.)


LESSON 7: USING WATER EFFICIENTLY

Every family uses a lot of water. The chart below shows what takes the least and the most amounts of water in a year.

LOW	MEDIUM	HIGH
Drinking: If you drink eight glasses of water a day, you drink 1/2 gallon. If everyone in a family of four drinks eight glasses a day, that's more than 700 gallons a year.	**Faucets:** You use 1/2 to 4 gallons of water each time you turn on the faucet to wash hands, brush teeth, or get water for cooking and cleaning. Each family uses about 45 gallons of water a day or 16,000 gallons a year to do those things.	**Toilet:** Each flush of the toilet uses 1.2 to 4 gallons. For a family of four, that's about 25 to 80 gallons a day, or 9,125 to 29,200 gallons a year.
Car Washing: It can take as much as 100 gallons to wash a car. If a family washes one car once a month, that's about 1,200 gallons a year.	**Clothes Washer:** About 25 to 45 gallons are used for each load of wash. Most families probably use about 10,000 to 16,500 gallons a year.	**Shower:** You might use 13 to 38 gallons for each shower. If everyone in a family of four takes one shower a day, that's about 19,000 to more than 55,000 gallons a year.
	Dishwashers: Running a dishwasher takes between five and 15 gallons. Washing one load of dishes a day would use between 1,800 and 5,500 gallons a year.	**Watering Lawn and Yard:** It takes about 2,500 gallons to put 1 inch of water on 4,000 square feet of a lawn or yard. If you water once a week during the warmer months, that's about 75,000 gallons per year!

18

5. Why must we be especially careful using water in the summertime?
   (In the summer when it is hot, people use more water. It takes more water to fill pools and to water lawns and yards. We even drink more water.)

C. Have students make lists of typical household water uses.

- Make a list on the chalkboard of all the uses students can think of.
- Divide students into groups. Ask groups to categorize the water uses as to what are high uses of water in a year's time, medium uses, and low uses.
- Have students turn to page 18 in their workbook, Using Water Efficiently.
- Explain to students that this page shows what uses the least and the greatest quantity of water in a year for typical families. Have individuals read each of the categories under low, medium, and high water uses. Tell them that the figures are based on a family of four.
- Point out to students that all the water uses listed in the medium category involve some kind of washing — dishwashing, clothes washing, and car washing.
- Have the students compare their list on the chalkboard with the one in the workbook. Ask if they are surprised about how much water is used for certain activities.

D. Divide students into groups for practice on water use.

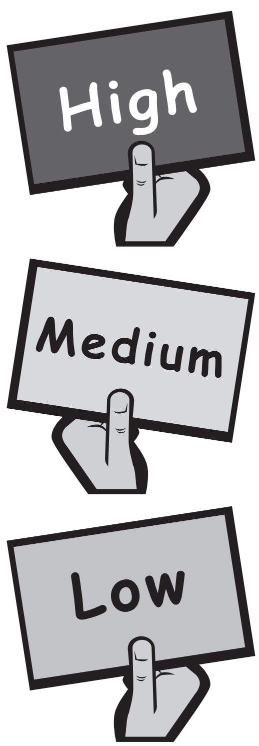
- Tell students that you are going to read several uses of water. As each one is read, they are to hold up the appropriately colored piece of paper to show whether this use of water is high, medium, or low. ***[If you like, you can turn this into a contest by dividing the class into teams and keep score.]***
- Give each student one 3 x 3 inch piece of each color. Have them label the pieces as follows:
  High — red, Medium — yellow, Low — blue

- Continue doing the practice, repeating difficult items until students are doing well.

    1. Watering the lawn *(high — red)*
    2. Washing the car *(low — blue)*
    3. Drinking *(low — blue)*
    4. Running faucets *(medium — yellow)*
    5. Taking a shower *(high — red)*
    6. Washing clothes *(medium — yellow)*
    7. Flushing the toilet *(high — red)*
    8. Washing dishes *(medium — yellow)*

- List the following pairs of water uses on the board, one pair at a time. Call on students to identify which use of water in the pair uses the most water in a year. Larger user is in ALL CAPS.

    1. drinking — WASHING THE CAR
    2. washing dishes — WASHING CLOTHES
    3. FLUSHING THE TOILET — washing clothes
    4. washing the car — TAKING A SHOWER
    5. RUNNING THE FAUCET — drinking
    6. WATERING THE LAWN — taking a shower



E. Discussion: Water conservation for all uses

- Refer to page 18 in Student Workbook. Discuss different ways that people can try to cut down on water uses.

Low:

Car washing — Do not let the water run while you wash the car. Purchase a spray nozzle with an automatic shutoff device and use a bucket. The spray nozzle will pay for itself in no time — remember the water you let run down the street costs you money!

Drinking — Keep a container of cold water in the refrigerator. Running water from the tap until it is cool is wasteful.

Running the faucet — Turn the water off while you brush your teeth. Turn it on only to rinse. Don't let the water run while you are rinsing vegetables or utensils. Don't leave the water running when you are not using it.

Medium:

Clothes washing — Make sure you have a full load before you turn on the washer. If you have a small load, adjust the setting. When you need a new washer, consider purchasing a water-efficient washer.

Dishwashing — Again, make sure you have a full load before washing. If you have just a few, wash by hand and make sure you don't let the water run the whole time. Rinse all of the dishes at once.

High:

Toilet — Do not use the toilet as a trash can. Consider replacing a high water use toilet with a new water-efficient toilet.

Watering the lawn and yard — Water only early in the morning or late at night, and know what your watering restrictions are. Consider using native plants and grasses. Use a sprinkler or a hose with a timer to avoid overwatering and wasting water.

Shower — Use the shower for what it is intended — to get clean! You can get just as clean with a short shower. Or turn the water off while you lather, then turn it back on to rinse.

F. Don't Be Clueless Investigation

- Explain to students that they are going to become detectives in search of wise and unwise use of water around their school. As Detective Water Wise, they will walk around the school building and grounds collecting clues and gathering information.
- Discuss the following concepts and vocabulary with students: drawing things to scale, native plants, naturalized or adapted plants, evaporation, and efficiency. You might consider having a master gardener, landscape architect, or your county cooperative extension agent give a presentation to your students about designing a Water-wise landscape.
- Make copies of the Don't Be Clueless Worksheet, pages 75 and 76 in Teacher's Guide, for your students.
- Make sure to have enough metric rulers for measuring mulch and soil depth. Consider testing for soil depth in an area that has been watered recently to make pushing the shovel into the ground easier.
- Take a walk around the school grounds to collect information in order to complete the lab sheet. Consider having students work in teams to complete the worksheet, as this will encourage discussion. In a post-lab discussion, have students share what they have learned by doing this field investigation. What are their ideas on how they can help their school improve in conserving water? Can they develop an action plan to implement one or more of their ideas as a service learning activity?

G. Have students complete and correct Exercise 7: Using Water Efficiently on page 19 of the Student Workbook. (See page 80 of Teacher's Guide.)

[Note: For Part A, inform students that they should compare the amount that each activity uses per year, not for a single use.]

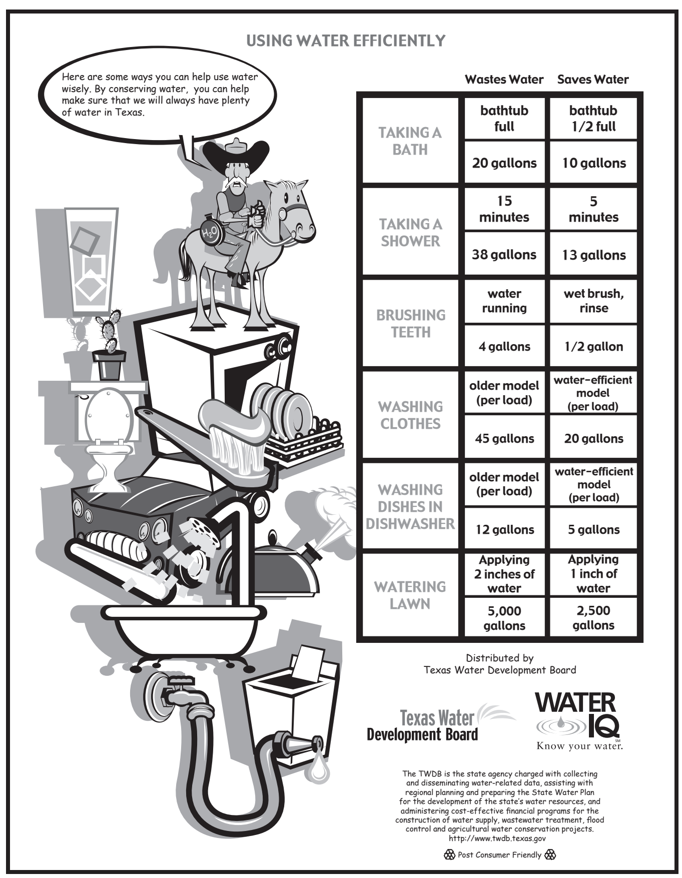
- Correct the exercise as in previous lessons, using the answer key on page 80.

H. Read and discuss Using Water Efficiently on the back cover of the Student Workbook.

- Direct students to the back cover of the workbooks.
- Ask students what it means to conserve water. *(To use water wisely and not waste it.)*
- Explain that this page shows how much water is used for various activities we do. Point out that the chart shows how water can be wasted or saved doing each activity.
- Have students read through the chart. For each activity, have students figure out how much water can be saved by using water wisely.
- Divide students into groups to calculate the water savings for various situations.

[Note: Suggestions are given below, but any situation involving the wasteful activities on the back page of the Student Workbook can be used.]

- If everyone in his or her family took one bath a day and filled the bathtub only half full instead of full, how much water would be saved every day?
- If everyone in the class turned the water off instead of letting the water run when they brushed their teeth, how much water would be saved in a day? A week? A month? A year?


USING WATER EFFICIENTLY

	Wastes Water	Saves Water
TAKING A BATH	bathtub full	bathtub 1/2 full
	20 gallons	10 gallons
TAKING A SHOWER	15 minutes	5 minutes
	38 gallons	13 gallons
BRUSHING TEETH	water running	wet brush, rinse
	4 gallons	1/2 gallon
WASHING CLOTHES	older model (per load)	water-efficient model (per load)
	45 gallons	20 gallons
WASHING DISHES IN DISHWASHER	older model (per load)	water-efficient model (per load)
	12 gallons	5 gallons
WATERING LAWN	Applying 2 inches of water	Applying 1 inch of water
	5,000 gallons	2,500 gallons

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http://www.twdb.texas.gov

Post Consumer Friendly

- If a student took a 5-minute shower every day instead of a 10-minute, 15-minute or 20-minute shower, how much water would the student save every week? How much water would the entire class save?

I. Evaluation: Role Playing

- Tell students that they are now going to get a chance to show how well they understand how to use water efficiently.
- Divide students into four groups. Provide each group with a card titled Wa-Ter (What Are) Your Choices? ***[Copy the cards on page 79.]***
- Explain that they have been given a water-wasting situation, and they are to act out what they would do to conserve or save water. They will be provided a couple of sample endings to the story, but encourage students to use their imaginations — they are not restricted to these options. Students could also be encouraged to role-play two different endings — one that shows wise use of water and one that doesn't.

J. Lawn Watering Laboratory

- In this activity you will explore how much water is used in watering the lawn and what you can do to conserve water outdoors when watering your lawn. Key skills practiced in this activity are measurement of length and volume and the calculation of area. This activity may result in students getting damp and is best done on a warm day. You will want to find a grassy area close to a water faucet to run the sprinkler.

  [Note: This activity can be performed using standard or metric measurements. English measurement standards are emphasized in this exercise because lawn watering recommendations provided by Texas communities are always listed in inches.]
- Give each student a copy of the Lawn Watering Lab Worksheet.
- Ask one of the students to read the introductory paragraph aloud to the class.
- Ask the student to look at the graph of average yearly water use for drinking water and lawn watering and explain in their own words what the graph represents.
- Introduce and explain the vocabulary words: area and volume.
- Explain to the students that they will be going outdoors to perform an experiment to measure the volume of water captured from a lawn sprinkler by small, medium, and large containers.
- Divide students into groups of three. One student will be the timer, one will be the observer, and one will be the recorder. Assign each group a letter.
- Give each group a small, medium, and large container, masking tape, a pen, and a ruler. Ask them to use the tape to mark each container with their group's letter.
- Have the students complete the indoor exercise portion of the worksheet to determine the area of their containers.
- Prior to going outdoors for the activity, determine the current local weather conditions (temperature, humidity, and wind speed) by either using the local newspaper or an internet source such as www.weather.com. Take this information with you to use for discussion of the outdoor exercise.
- Take the class outdoors and have each group bring pencils, worksheets, an extra sheet of paper, rulers, graduated cylinders, and a stopwatch.
- Find a relatively flat section of the school lawn for the activity and set up the hose and sprinkler.
- Turn the sprinkler on for a few minutes and allow the students to observe the water coming out of the sprinkler. Ask them to describe the pattern they observe. (How far does the water spray, how high, what pattern, etc.)
- Turn off the sprinkler and ask the students to think about where to place their containers around the sprinkler that will increase the likelihood that each container will have an equal chance of capturing water.
- Tell the students that you will be turning the sprinkler on for 15 minutes.
- Before you turn on the sprinkler, ask the students to predict which container (small, medium, or large) will collect the largest volume of water in the same amount of time under the sprinkler. Have them write down their predictions on the worksheet.
- Start the sprinkler and the stopwatches to measure 15 minutes of time.

- While the sprinkler is running, ask the students to draw the sprinkler and the location of their three containers. (5 minutes)
- Tell the students the current temperature, humidity, and wind speed and have them write it on their worksheet. Ask the students if they notice anything that may be creating water waste (water falling on the sidewalk, water running off the lawn instead of soaking in, water blowing away in the wind, etc.) (5 minutes)
- Ask the students to observe and write down any other factors that might have an effect on how much water is collected in their containers (slope of the container, evenness of the water falling on the grass, etc.), and have the students write down their description of the type of sprinkler used in the activity. (5 minutes)
- The timers should tell the class when the 15 minutes has passed. Turn off the sprinkler.
- Tell the students to carefully take their containers to a level area such as a sidewalk and work as a group to measure the depth and volume of water collected in each container and write the results down in the data table of their worksheet.
- Take the class back inside.

  [Note: The remaining steps in the exercise may be completed back in the classroom or as a homework assignment to be reviewed the next day.]
- Have the students use the data table to construct the graph in step #7 of their worksheet.
- Ask them to explain what their graph means and compare their results to the prediction they made before the water was turned on outside.
- Ask the students to read silently and answer questions #9 and #10 individually.
- Review the answers to questions #9 and #10 as a class and let the students share their ideas of what they can do to conserve water use outdoors.
- Lead the students in discussing the following questions related to the lawn watering laboratory:

1. Do you notice a relationship between the area of the bottom of the container and the amount of water it holds when filled to 1 inch? What is that relationship? Would it take more water to cover an area the size of your classroom with one inch of water, or an area the size of your playground?

   (The larger the area, the larger the volume; the playground would take more water than the classroom.)
2. Did it take the same amount of time to fill up all of the containers to one inch?

   (Usually the time to fill differs. This is called distribution uniformity and has implications for landscape irrigation because many people over-water to compensate for dry spots.)
3. What might cause some containers to fill up faster than others?

   (Uneven sprinkler coverage or distance from the sprinkler may cause this. Many sprinklers do not put the same amount of water on every square foot of the area. Uneven watering causes some sections to be over-watered and other sections to be under-watered. Water is wasted if the whole area is watered enough to keep the under-watered sections healthy. This can be caused by poor irrigation design or misdirected sprinklers.)
4. Many communities in Texas recommend watering lawns with no more than 1 inch of water per week during the summer months. How could you repeat this activity at home to figure out how long to run your sprinklers every week?

   (Set containers in the yard and run the sprinklers to see how long it takes to fill the containers to 1 inch.)
5. From what you have learned in this activity, what are three things you could change to use less water outdoors every year?

   (Water a smaller area, put out less than 1 inch of water, or water less frequently.)
6. If it rains, do you think the sprinklers need to put out 1 inch of water to keep your lawn healthy?

   (No, the sprinklers need to put out 1 inch minus the amount of rain collected.)

Optional Extension and Enrichment Activities

Water Use Activities:

- Have students make bar graphs depicting the nine different uses of water listed in their workbooks.
- Lead students in various math exercises with the figures for water uses. Some examples are:
  1. Keep track of how many times the toilet is flushed in your home in one day. If the toilet uses 5 gallons for each flush, how many gallons were used in a day? How many in a week? Compare that to a water-efficient toilet that uses only 1.2 gallons per flush (the current standard for new toilets).
  2. If a shower or bath takes 45 gallons of water, how many gallons does your family use in a week?
  3. If every member of your family drank eight glasses of water a day (one glass = 8 ounces), how much water would the entire family drink in a day? (128 ounces = 1 gallon)
- Create a classroom water supply. Explain to students that as recently as 100 years ago in the United States, people had to get their water by carrying it from wells, springs, or rivers. People in many parts of the world still do this. To demonstrate this process of water supply and distribution and to help students develop an appreciation of how much water we use, create a classroom water supply. Tell students that just for drinking purposes, every person needs about two quarts (1/2 gallon) of water a day. Have students figure out how much water that would be for the entire class. Using one or more buckets that hold 2 to 3 gallons, have students get water from a faucet a short distance from the classroom, carry the water into the classroom, and use a funnel to pour the water into clean, plastic water bottles. Have students carry the amount of water the class will need to drink for one day. Tell students that this will be their water supply for the day. Discuss the difficulty of the task. Discuss how much more water they think they'd need for other uses — bathing, washing clothes, cleaning dishes, etc. Ask students if they think they would use less water if they had to carry all the water they used.
- Have students study water bills for their household for the past six months or year. Have them chart or graph their household's water use and study the chart/graph for patterns. If they are able to identify any water use patterns, have them suggest some possible reasons for the patterns (such as seasonal changes or outdoor watering).

Water Conservation Activities

- Conduct a shower versus a bath experiment. Tell students that the next time they take a bath they are to use a yardstick to measure the depth of the water before they get in the tub. Keep a chart in the classroom. Then, tell them to take a shower in a bathtub, but before they turn on the water, they should close the drain so the shower water collects in the tub. Have them use a yardstick again to measure the depth of the water. Record the shower depths on your classroom chart and compare.
- Have students make water conservation posters to hang around the school.
- Have students keep track of how much water the school uses by reading the school meter with the custodian's help. This can be done daily for a week. They can multiply the number to get a probable total for a month, then for a year.
- Have students conduct a toilet leak detection experiment at school or at home. With the help of a supervising adult, remove the lid from the toilet tank. Place several drops (5 to 10) of red, blue, or green food coloring in the tank of the toilet. DO NOT FLUSH THE TOILET. Let the water remain in the tank for 10 minutes without disturbing. If colored water appears in the bowl, then the toilet has a fast leak. If the water in the bowl is colorless, wait at least 10 more minutes and look again. If colored water has appeared after 20 minutes, the toilet has a slow leak. In either case, the supervising adult should either attempt to repair the leak or contact the appropriate person to do so. (A leaking toilet can waste up to 200 gallons of water per day.)
- Have students track their household's water use for one day and write a suggestion list of ways their family can use water more efficiently.

- Conduct a school water conservation campaign. Have students tour the school or community looking for water waste. Ask them to look for leaking pipes or sprinkler heads, dripping faucets, leaking toilets, sprinklers running in the middle of the day, poorly adjusted sprinklers that water the cement, and drinking fountains that will not shut off. Have students report back to the class what they found, then have them plan and conduct a water conservation campaign. For example:
  1. Make posters and slogans to display around the school.
  2. Give talks on water conservation in other classrooms.
  3. Organize a group of water-smart volunteers to do a survey of how water is used in their school and how they could use water more efficiently (identify leaks, make suggestions for ways to use water wisely).

Name______________________________________

Don't Be Clueless Worksheet

Today you get to be Detective WaterWise. Detective WaterWise is a keen observer and excellent problem solver. As Detective WaterWise, you will investigate the school grounds to identify possible sources of water wastefulness and create solutions for a more water-efficient landscape.

Below is a list of things that can save water in a landscape:

- Covering soil with 5 to 10 centimeters (2 to 4 inches) of mulch in flower beds keeps soil moist longer so plants can be watered less often.
- Having at least 15 to 20 centimeters (6 to 8 inches) of soil under grass and plants holds more water so plants can be watered less often.
- Shade trees help keep soil cooler and moist so plants can be watered less often.
- Planting native plants can use 25 to 40 percent less water than other plants.
- Watering between dusk and dawn when the sun and wind are less likely to cause evaporation.
- Fixing any leaking pipes, faucets, or irrigation equipment (like sprinkler heads).

Use your investigative skills and this form to evaluate your school for water-saving practices in the landscape:

Is there mulch on the ground around the plants? If so, what type (such as bark, chips, or recycled phone books)? ____

If mulch is present, determine if it is deep enough. The optimal depth of mulch is 5 to 10 centimeters (2 to 4 inches). To determine the depth, push a metric ruler down through the mulch to the bottom of the layer. Record the depth in centimeters. Repeat this step in four other locations, then average the five depths.

First site _____ Second site _____ Third site _____ Fourth site _____ Fifth site _____

Average depth of mulch _____ Do you recommend adding more mulch? __________

With help from your teacher, find a place to push a shovel in the ground. Mark the back of the shovel at the soil line and remove it to measure how deep the shovel went.

How deep were you able to push the shovel into the soil? __________

Is this deep enough for healthy plants? __________

In addition to saving water, water-wise gardening and landscaping can save energy. Properly placed trees provide shade that can significantly reduce cooling bills in the summer.

How many shade trees do you count on your school grounds? _____

Are there places that you think might benefit from planting a shade tree? __________

If so, where?____

Work with your teacher to find out when the grounds keepers water the landscape at your school. Is this the best time to water? ____

Are there any leaking pipes, faucets, or sprinklers at your school? ______________________

Now design a native plant garden for your school. Use plant information from http://www.wildflower.org and http://urbanlandscapeguide.tamu.edu/ to find plants that are native or adapted to your area.

List 10 native or adapted plants that you would like to use in your design:

Plant Common Name	Plant Botanical Name	Type (Tree, Shrub, Flower)	Size (Height and Width)	Flower Color and Bloom Season

Use graph paper to draw your garden design. Each square equals 1 square foot on the ground. (A plant that grows to be 3 feet wide would take up nine squares on the graph paper.)

You have done a great job investigating your school landscape. List at least three main recommendations to help your school improve in conserving water.

1. ____

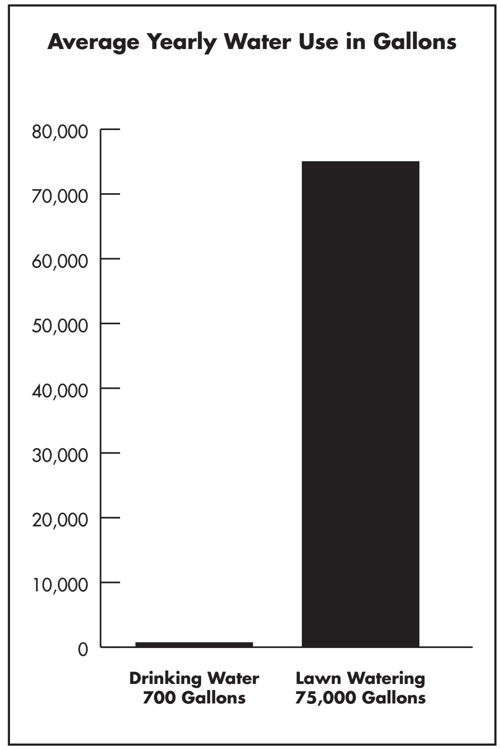
2. ____

3. ____

Group __________ Timer ________________ Observer ________________ Recorder ________________

Lawn Watering Lab Worksheet

The population of Texas is growing, with more people using water every year. There is a limited amount of water for us to use for our daily needs. When each of us uses a little less water, there is more water available for everyone. Outdoor water use can add an additional 50 to 80 percent to home water use during the summer months. It doesn't take a very deep layer of water on your yard to add up to a lot of gallons. One inch of water spread over a typical 4,000-square-foot yard is about 2,500 gallons of water. That means, if you water 1 inch per week during the warmer months, you use about 75,000 gallons a year just on your yard. That is about 1,300 bathtubs full! Your whole family only drinks about 700 gallons of water per year. This is why watering the yard is considered a high water use.



Indoor Exercise

1. The average lawn is 4,000 square feet or about 1/10 of an acre. To help us understand this number, let's calculate the area of a 10-foot-by-10-foot section of lawn. In a straight-sided object, the area is equal to the length multiplied by width. For a 10-foot-by-10-foot section of lawn, the area is:

Area = length times width
= 10 ft. x 10 ft.
= 100 sq. ft.

If a 10-foot-by-10-foot section of lawn is 100 square feet, how many 10-foot-by-10-foot areas would you need to fill in a whole 4,000-square-foot lawn?

Number of 10-foot-by-10-foot sections needed to fill a 4,000-square-foot lawn = $\frac{4{,}000 \text{ sq. ft.}}{100 \text{ sq. ft.}} = 40$

It would take ______ 10-foot-by-10-foot sections of lawn to equal the same area as a 4,000-square-foot lawn.

2. Calculate the area of the bottom of each container for this activity. First, measure the length and width of the container in inches. Then multiply the length times the width to calculate the area of the container.

Area of large container = __________ (in) length x _________ (in) width = _____________ sq. in.

Area of medium container = __________ (in) length x _________ (in) width = _____________ sq. in.

Area of small container = __________ (in) length x _________ (in) width = _____________ sq. in.

3. If you use a 9-inch-by-13-inch baking pan as your container, what is the area? _________ sq. in.

Note: It would take about 5,000 9-inch-by-13-inch baking pans to cover an area of 4,000 square feet.

Outdoor Laboratory

4. Predict which container (small, medium, or large) will collect the largest volume (amount) of water in 15 minutes of watering. ______________________________

5. Try your best to place each container around the sprinkler where you think they each have an equal chance of capturing water. On a separate piece of paper, draw a diagram that shows the placement of your sprinkler and the large, medium, and small containers. While the sprinkler is running, record your observations about the type of sprinkler, the environmental conditions (temperature, wind speed, humidity, cloud cover, etc.), and any other observations that you think may affect the results of this experiment below:

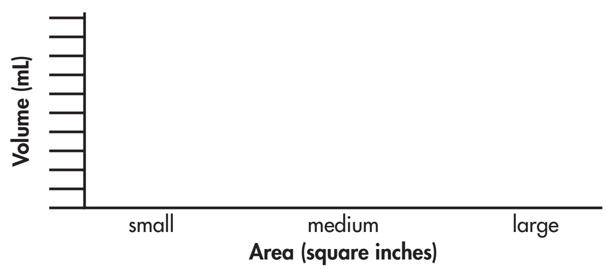
__________ Temperature (F) __________Humidity (%) __________ Wind speed (mph)

Type of sprinkler: ________________ Other observations: ______________________________

6. Measure the water depth in both inches and centimeters. Measure the water volume in mL with a large graduated cylinder. Write your results in the data table below.

Container Size	Water depth (inches)	Water depth (cm)	Water volume (mL)
large			
medium			
small			

7. In the space below, construct a graph showing the relationship between the size of the bottom of the container (area) and the amount or volume of water that you collected by running the sprinkler 15 minutes.



8. Explain what the graph above tells you about the relationship between the size of the bottom of the container (area) and the volume (amount) of water collected. ______________________________

9. Many communities in Texas recommend watering lawns with no more than 1 inch of water per week during the summer months. Major Rivers and Aquifer have been trying to calculate how many minutes they should run their sprinkler in order to apply 1 inch of water a week. They measured the amount of water that their sprinkler put out on their lawn. Their sprinkler spread ½ inch of water over their 4,000-square-foot lawn in 15 minutes using 1,250 gallons of water.

   A) How many minutes should Major Rivers run his sprinkler in order to put 1 inch of water on his lawn? ________ minutes.

   B) How many gallons of water will Major Rivers use if he puts 1 inch of water over his entire 4,000-square-foot lawn? ________ gallons.

10. From what you have learned in this activity, what are three things you could change to use less water outdoors every year?

1. ______________________________

2. ______________________________

3. ______________________________

Wa-Ter Your Choices?
Sidewalk Sudsing
Characters: Ann and Keith

Ann and Keith have just come back from a day at the lake. As they start to carry their bag of toys into the house, their dad tells them, "Clean those before bringing them inside." Ann looks at Keith and says, "Okay, Keith, lay everything out on the sidewalk and we'll hose them off." What does Keith say or do?

Possible choices:
Keith tells Ann that washing everything on the sidewalk with the hose running wastes water. They could wash things off in a bucket of water, or they could put everything on the lawn to wash them off so the water doesn't run down the gutter but waters the grass.

Wa-Ter Your Choices?
Clean Carrots
Characters: Margarita and Antonio

It's Margarita's turn to set the table and Antonio's turn to peel the carrots. As Margarita is getting the dishes for the table, she notices that Antonio has the water running all the time in the sink as he washes and peels each carrot. What does Margarita say or do?

Possible choices:
Margarita tells Antonio that he is wasting water by just letting it run down the drain. He should peel the carrots, then wash them in a sink partly filled with water; or he can peel them, then rinse them all at once, capturing the rinse water to water some house plants.

Wa-Ter Your Choices?
Twice as Clean
Characters: Christopher and Marcia

Christopher is taking a bath. Marcia is waiting for him to finish so she can take a shower. She hears the water draining out of the bathtub, so she gets her towel and bathrobe. As she stands outside the bathroom door, she hears the bathtub filling with water again. "Christopher!" she yells, "What are you doing?" "The water got cold," says Christopher, "so I'm filling up the bathtub again." What does Marcia say or do?

Possible choices:
Marcia explains to Christopher that filling the bathtub again is wasting water and money. Not only is there a limited supply of water, but it also costs money to get the water and to heat it. She tells him that he can get quite clean with just one shallow bath. Or she can tell him that he can take a five-minute shower that will use less water than a bath. He will still get quite clean.

Wa-Ter Your Choices?
Flushed Away
Characters: Rosie and Raul

Rosie and Raul are sitting on the floor cutting out paper dolls and snowflakes. Scraps of paper are scattered all over the rug. When they are finished, Raul says, "We'd better pick up all these little scraps of paper." Rosie picks up a few scraps of paper, runs into the bathroom, and flushes them down the toilet. She comes back, picks up a few more scraps, and heads toward the bathroom with them again. What does Raul say or do?

Possible choices:
Raul tells Rosie that every flush of the toilet uses between 1 and 5 gallons of water, so she is wasting water by flushing the scraps of paper down the toilet. She should put the scraps of paper in the trash. He could point out that the toilet could get clogged up with all that paper, then overflow, which would waste even more water.

EXERCISE 7 ANSWER KEY

Part A

Directions: Look at each group of activities that uses water. Place a check on the line of the one that uses the most water in each group.

1. ✔ taking a shower
   ___ drinking
   ___ running dishwasher

2. ___ washing the car
   ✔ watering lawn
   ___ washing clothes

3. ___ drinking
   ✔ flushing a toilet
   ___ washing the car

4. ___ running dishwasher
   ___ drinking
   ✔ using the faucet

5. ___ washing clothes
   ✔ watering lawn
   ___ flushing a toilet

6. ✔ using the faucet
   ___ drinking
   ___ washing the car

Part B

Directions: For each use of water listed, think of a way you could use less water. Write your answers in complete sentences.

1. Washing dishes **Run the dishwasher with a full load or fill a tub with water for hand washing.**
2. Taking a bath **Fill the tub only half full, then take a shallow bath.**
3. Using the faucet **Turn off the water while brushing.**
4. Washing clothes **Run the clothes washer with a full load or adjust the water level.**
5. Taking a shower **Take a quick (five-minute) shower. Turn off water to lather.**
6. Washing the car **Use a spray nozzle with an automatic shut off and a bucket.**
7. Watering the lawn or yard **Water only when needed, and not when windy or raining. Don't water sidewalks and driveways. Water in early morning or late evening.**

LESSON 7 VOCABULARY AND RESOURCES

Vocabulary:

Area – For an object with four straight sides, the area is a two-dimensional space that is found by multiplying the length times the width.

Conserve – To use something carefully or sparingly, avoiding waste.

Conservation – The act of conserving. The protection, preservation, management, or restoration of natural resources such as water. Conservation includes practices that reduce water consumption and improve water use efficiency so that a water supply is made available for future or alternative uses.

Efficient – Complete an action in such a way that creates a minimum amount of waste.

Native plant – A plant that lives or grows naturally in a particular region without direct or indirect human intervention.

Naturalized or Adapted plant – A plant that was introduced by humans and has adapted or acclimated to an environment.

Volume – The amount of space that a three-dimensional object occupies.

Resources:

Lady Bird Johnson Wildflower Center Native Plant Information Network
http://www.wildflower.org/explore/

Texas Urban Landscape Guide
http://urbanlandscapeguide.tamu.edu/

Texas Water Development Board's Kids website: Who Uses Water in Texas and The Power of Many Interactive Modules
http://www.twdb.texas.gov/conservation/education/kids/InteractiveModules/index.asp

WaterWise Drip Calculator
http://www.awwa.org/resources-tools/public-affairs/public-information/dripcalculator.aspx

Metric Equivalents for Standard Measurements:

Milliliters (mL)	Teaspoon (tsp.)	Tablespoon (Tbs.)	Fluid Ounce (oz.)	Cup (c.)
237	48	16	8	1
177	36	12	6	3/4
158	32	11	5	2/3
118	24	8	4	1/2
79	16	5	3	1/3
59	12	4	2	1/4
30	6	2	1	1/8
15	3	1	0.5	1/16
5	1			

Message:
Each of us can help conserve and protect our limited water resources through wise water use.

Objective:
Through a review of home water use and key concepts, students will exhibit an understanding of the importance of water to Texas.

Time Requirements:
Home Water Use Survey — a couple of days at home
Posttest — one class period

Materials:
- Major Rivers Home Information Leaflet
- Posttest
- Program Evaluation Sheet

Procedures:

A. Hand out and discuss Major Rivers Home Information Leaflets.
[Note: You may want to hand out the leaflets and ask them to be returned by the time you plan to teach Lesson 8.]

MAJOR RIVERS' HOME WATER USE SURVEY

Work through the survey with your child. If you put these water-saving ideas to work in your home, your family can save thousands of gallons of water a year.

OUTDOORS

☐ **1. The lawn and garden are watered only when they need it.**
Before you water, check the soil to make sure it is dry. If the grass springs back when you walk across it, it doesn't need to be watered! Plants use the most water during summer. We usually receive enough rainfall in the spring, fall and winter so that watering is not necessary.

☐ **2. The lawn and garden are watered only during the cool parts of the day.**
Water during the evening or very early in the morning. Never water when the sun is high overhead because water is wasted by evaporation and the hot temperatures burn the leaves.

☐ **3. The lawn and garden are not watered when it's windy or raining.**
If you water when it's windy, you waste water because it evaporates or is blown away from the area you are trying to water.

☐ **4. The water does not run off the lawn and garden onto the sidewalk or gutter.**
If you water too long or the soil is already moist, water will run off the lawn and be wasted. If you have a sprinkler system, you could have a controller installed that will shut off the sprinklers when the ground has received enough water.

☐ **5. The yard has plants and trees that do not use much water.**
There are many flowers, grasses, shrubs and trees that are native to Texas or are adapted to our weather. These plants are beautiful and are drought tolerant.

☐ **6. Mulch is used around trees and shrubs.**
Mulch can be tree bark, cottonseed hulls, pine straw or hay. Mulch helps to keep the soil cool and slows down the evaporation of water.

☐ **7. A bucket of water and a hose nozzle that shuts off when you release the handle are used to wash the car.**
Use a sponge and a pail of soapy water to wash the car. Use water from the hose to rinse the car.

☐ **8. A broom is used to sweep the driveway and sidewalks.**
It is wasteful to wash driveways and sidewalks with the hose.

KITCHEN

☐ **9. Dishwasher is run only for full loads.**

☐ **10. Clothes washer is run only for a full load or set for the right amount of water for the amount of clothes.**

☐ **11. Vegetables are cleaned in a sink of water.**
Rinse vegetables in a sink partially filled with water rather than under a running faucet.

☐ **12. Hand-washed dishes are rinsed in a sink of water or by pouring water over them.**
If you have two sinks, fill one with rinse water. If you have only one sink, put your washed dishes in a dish rack and rinse them by spraying them quickly or by pouring a pan of water over them.

☐ **13. Drinking water is kept in the refrigerator.**
Running tap water to cool it for drinking is wasteful.

☐ **14. Kitchen faucets and pipes are free of leaks.**

BATHROOM

☐ **15. We take shallow baths.**
A partially filled tub uses less water than most showers.

☐ **16. We take quick showers.**
Limit your showers to the time it takes you to soap up, wash down, and rinse off – less than five minutes.

☐ **17. We have water-efficient shower heads.**
Hardware stores and plumbing supply stores carry inexpensive, easy-to-install water-efficient showerheads and flow restrictors.

☐ **18. We turn off the water while brushing our teeth and shaving.**
Before brushing, wet your brush and fill a cup with water for rinsing. For shaving, rinse your razor in a sink partially filled with water.

☐ **19. We have water-efficient toilets.**
If your house was built after 1992, this is probably true. If not, check the markings on the toilet to see what the tank volume is. The most efficient toilets use 1.2 gallons per flush or less. If you have older, high-water-use toilets, consider replacing them or installing a water displacement device.

☐ **20. Toilets are not used as wastebaskets.**
Put trash in the wastebasket. Flushing it is wasteful!

☐ **21. Bathroom faucets, pipes and toilets are free of leaks.**
To check for leaky toilets, put a few drops of food coloring in the toilet tank. If the color appears in the bowl without flushing, you have a water-wasting leak.

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Texas Water Development Board

WATER IQ
Know your water.℠

Texas Water Development Board

The TWDB is the state agency charged with collecting and disseminating water-related data, assisting with regional planning and preparing the State Water Plan for the development of the state's water resources, and administering cost-effective financial programs for the construction of water supply, wastewater treatment, flood control and agricultural water conservation projects.
http://www.twdb.texas.gov

Post Consumer Friendly

- Tell students that they are to take these leaflets home and give them to their parents.
- Have students turn to the back page of the leaflet to the Major Rivers' Home Water Use Survey. Explain to students that this survey shows many ways that their families can conserve water. Read aloud the 21 items. Discuss if students practice these conservation methods. Which practices are easy to do? Which are more difficult?
- Encourage students to conduct the water use survey with their parents. Tell students to be prepared to share with the class what they discovered about water use in their homes.

B. Have students make conservation checklists.
- Tell students that beginning tomorrow they are going to keep track of how well they are conserving water.
- Sketch the following chart on the chalkboard and ask students to copy it onto a piece of paper.
- Instruct students that they are to check each day whether they turn the water off while brushing their teeth and take shallow baths or short showers.
- Students also will list any other water conservation practices that they follow on those days.
- Check periodically during the next few days to be sure that students are filling in their conservation checklists.

	DAY 1	DAY 2	DAY 3
Turned off water while brushing teeth.			
Took a shallow bath or a short shower.			

Other things I did to help conserve water:

1.____________________

2.____________________

3.____________________

4.____________________

5.____________________

C. Follow-up discussion

- Ask students to tell what happened when they took the leaflets home. How many completed the water-use survey with their families? How many plan to complete the survey in the next few days?
- Ask those students who completed the survey to comment on what they found out. Did they find that their families conserve water in many ways? Did they find that there are several things they can do to improve water conservation?

D. Conduct a review quiz.

- Tell students that you are going to read some statements about water, and they must decide whether each statement is true or false.
- The quiz may be conducted in several ways: 1) Read the statements aloud one at a time to the class, allowing everyone to formulate an answer before calling on various students to respond "true" or "false." 2) Divide the class into two teams and alternate asking questions, or let the first one to raise a hand answer the question. Give one point to a team each time it answers correctly. 3) Have students take a sheet of paper and number from 1 to 15. Students will write "true" or "false" as you read each question. Discuss answers briefly.

1. Evaporation means that water changes from water vapor back to a liquid.
   (False. Evaporation means that water gets heated, turns into a vapor, and rises up to form clouds. Water vapor changing back into liquid is called condensation.)
2. Water soaking into the ground is called infiltration.
   (True)
3. Rain and snow are called precipitation.
   (True)
4. The east side of Texas is drier than the west.
   (False. The west side of Texas is drier, getting only between 8 and 30 inches of rain a year. The east side gets between 30 and 60 inches of rain a year.)
5. Aquifers supply more than half of the water for Texas.
   (True)
6. We get very little water from surface water.
   (False. Almost half the water supply in Texas comes from surface water.)
7. The Rio Grande separates Texas from Oklahoma.
   (False. The Rio Grande separates Texas from Mexico. The Red River separates Texas from Oklahoma.)
8. The Sabine River runs between Texas and Louisiana.
   (True)
9. An aquifer is another name for surface water.
   (False. An aquifer is water stored underground. Surface water is rivers and lakes.)
10. Water is cleaned and made safe to drink at a water treatment plant.
    (True)
11. Water is stored in reservoirs.
    (True)
12. Sewage is another name for wastewater.
    (True)
13. Recycled water can never be used again.
    (False. Recycled water can be used to water parks and golf courses, to irrigate some crops, and to cool machinery in factories.)
14. Washing your car uses more water than watering your lawn.
    (False. It takes more water to water your lawn.)
15. You use more water taking a shower than you do cooking every day.
    (True)

E. Have students complete review worksheets.

- If you'd like students to have more practice, reproduce the worksheets in Appendix 1.
- Give each student a copy of each worksheet. Read the directions for each part of the worksheets. Be certain that the students understand the directions; then allow them to work independently.
- Correct the worksheets as a group.

F. Administer Exercise 8: Posttest.

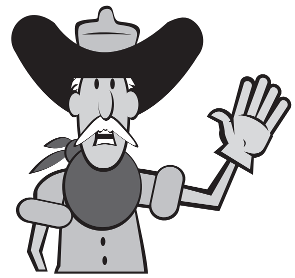
- Give each student a copy of the posttest. Tell students they now will have a chance to show how much they have learned about water.
- Administer the posttest, using the same procedures followed for the pretest in Lesson 1.

- Score the posttest using the answer key provided. Record the scores on the program evaluation sheet in the same way you did for the pretests, then return the tests and go over them with the class. Congratulate students on their scores and their improvement from the pretest.

G. Program evaluation

- Have students write about what they have learned in the Major Rivers program and submit their writings to the campus newsletter, school district newsletter, or local paper.
- Have students keep a journal for one week listing every use of water. Have students figure out the amount of water they used.
- Thank you for participating in Major Rivers. Your feedback is essential to the continued success of this program. Please complete the included program evaluation and mail to: Texas Water Development Board, Attn: Conservation, P.O. Box 13231, Austin, TX. 78711-3231. A copy is included on the CD-rom if you need to reprint one. If you prefer, you can fill out the online evaluation at http://www.twdb.texas.gov/conservation/education/kids/MajorRivers/doc/MR_Evaluation_Sheet.pdf.

Name ____



POSTTEST

MAJOR RIVERS
TEXAS WATER EDUCATION PROGRAM

PART A: The Water Cycle
Directions: Circle the letter of the word that best completes each sentence.

1. Water falls to earth as either rain or snow. This is called ________________________.
   a) surface runoff b) infiltration c) precipitation

2. Some water on the ground flows into rivers, lakes, and oceans. This is called ________________________.
   a) condensation b) evaporation c) surface runoff

3. Some water soaks into the ground. This is called ________________________.
   a) infiltration b) precipitation c) condensation

4. The sun heats water on the ground and changes it into vapor. The vapor rises into the sky. This is called ________________________.
   a) evaporation b) precipitation c) infiltration

5. Vapor cools, forms clouds, and changes back into water. This is called ________________________.
   a) infiltration b) condensation c) precipitation

PART B: Texas Water Supply
Directions: Circle the letter of the word that best completes each sentence.

6. Most large cities in Texas are in the ________________________ half of the state where there is more water.
   a) eastern b) northern c) western

7. The river that supplies Austin, our capital city, is the ________________________.
   a) Sabine b) Colorado c) Trinity

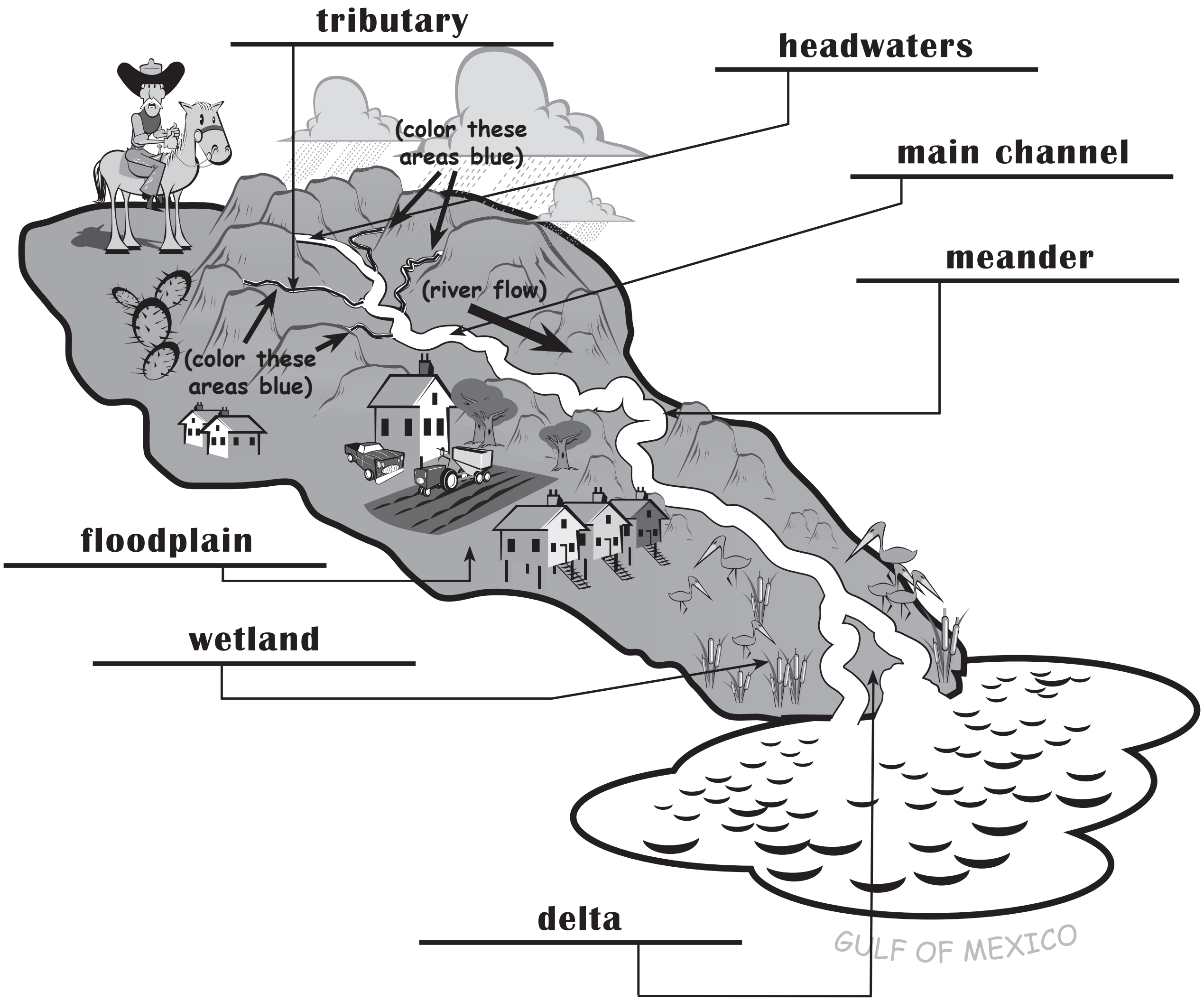
8. An underground layer of gravel, sand, or rocks that is filled with water is called ________________________.
   a) a reservoir b) an aquifer c) a lake

9. The river between Texas and Mexico is the ________________________.
   a) Red b) Brazos c) Rio Grande

10. More than half of the water used in Texas comes from ________________________.
    a) the ocean b) rivers c) aquifers

PART C: What is a Watershed?

Directions: Put the following words in the correct blank to label the watershed: tributary, floodplain, meander, headwaters, wetland, delta, and main channel. Color the tributaries that flow into the main river blue. Place an arrow showing the direction of the river's flow.



PART D: Water Treatment and Distribution

Directions: Match the words on the left with their definitions on the right. Write the correct letter in the blank space.

__d__ water treatment plant	a) place where surface water is stored
__b__ wastewater treatment plant	b) place where sewage is cleaned
__e__ recycled water	c) carries water to homes and businesses
__c__ pipeline	d) place where water is cleaned and made safe to drink
__a__ reservoir	e) wastewater that is cleaned and reused

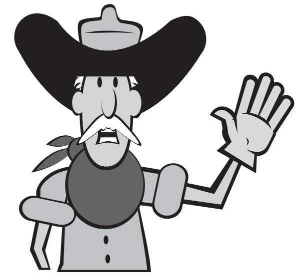
PART E: Using Water Efficiently

Directions: Look at each group of activities that use water. Place an X next to the activity in each group that uses the most water in a year.

__X__ flushing the toilet	_____ using the faucet	_____ washing clothes	_____ using the faucet
_____ washing dishes	__X__ watering the lawn	__X__ watering the lawn	__X__ flushing the toilet
_____ drinking water	_____ taking a shower	_____ drinking water	_____ washing the car

APPENDIX 1

Name ____



PRETEST

MAJOR RIVERS
TEXAS WATER EDUCATION PROGRAM

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   a) surface runoff   b) infiltration   c) precipitation

2. Some water on the ground flows into rivers, lakes, and oceans. This is called ________________________.
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   a) infiltration   b) precipitation   c) condensation

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   a) evaporation   b) precipitation   c) infiltration

5. Vapor cools, forms clouds, and changes back into water. This is called ________________________.
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Directions: Circle the letter of the word that best completes each sentence.

6. Most large cities in Texas are in the ________________________ half of the state where there is more water.
   a) eastern   b) northern   c) western

7. The river that supplies Austin, our capital city, is the ________________________.
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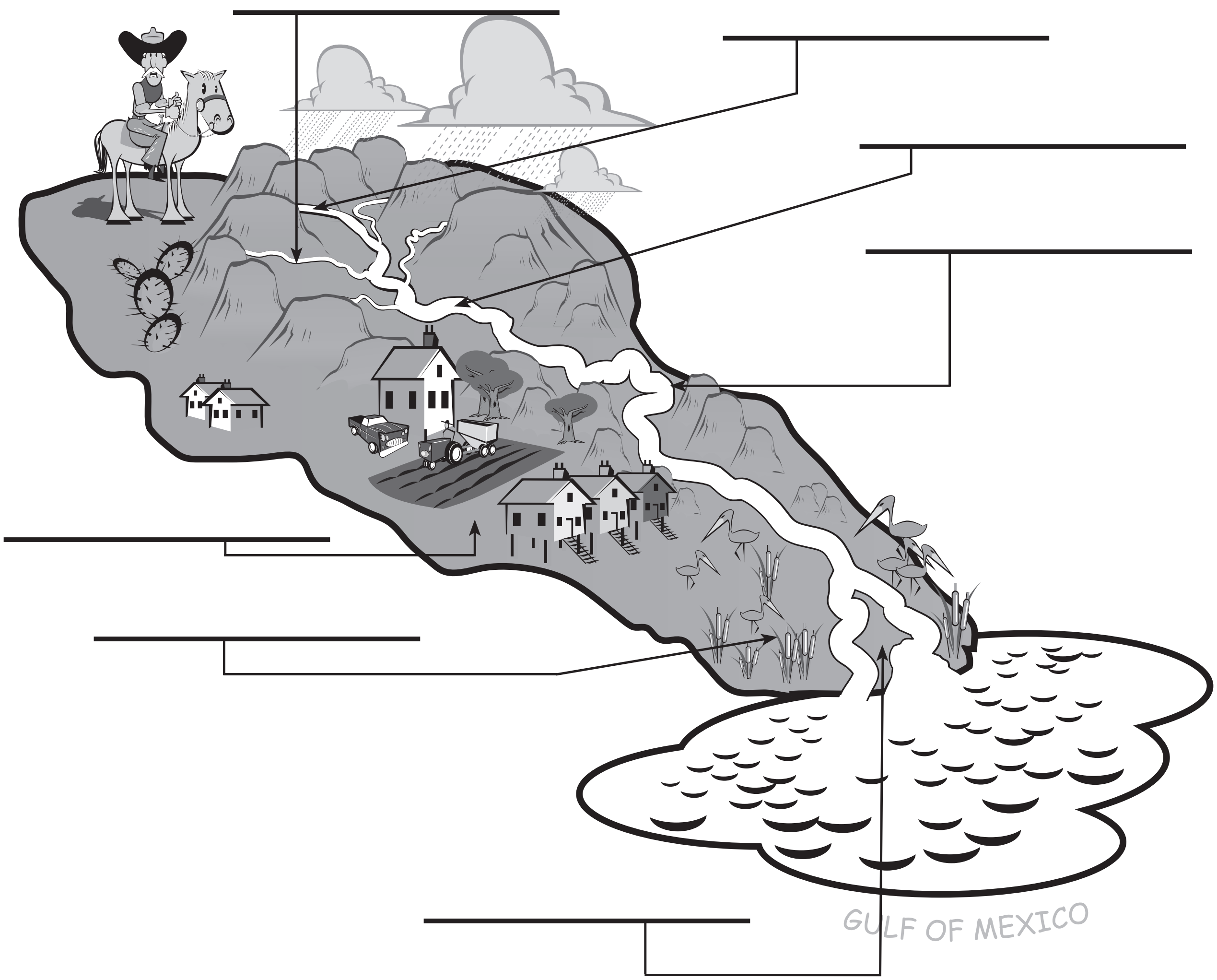

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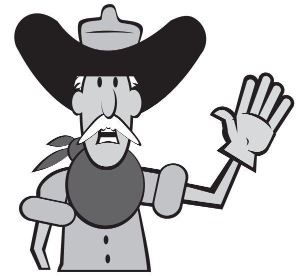
_____ reservoir	e) wastewater that is cleaned and reused

PART E: Using Water Efficiently

Directions: Look at each group of activities that use water. Place an X next to the activity in each group that uses the most water in a year.

_____ flushing the toilet	_____ using the faucet	_____ washing clothes	_____ using the faucet
_____ washing dishes	_____ watering the lawn	_____ watering the lawn	_____ flushing the toilet
_____ drinking water	_____ taking a shower	_____ drinking water	_____ washing the car

Name ____



POSTTEST

MAJOR RIVERS
TEXAS WATER EDUCATION PROGRAM

PART A: The Water Cycle

Directions: Circle the letter of the word that best completes each sentence.

1. Water falls to earth as either rain or snow. This is called ________________________.
   a) surface runoff b) infiltration c) precipitation

2. Some water on the ground flows into rivers, lakes, and oceans. This is called ________________________.
   a) condensation b) evaporation c) surface runoff

3. Some water soaks into the ground. This is called ________________________.
   a) infiltration b) precipitation c) condensation

4. The sun heats water on the ground and changes it into vapor. The vapor rises into the sky. This is called ________________________.
   a) evaporation b) precipitation c) infiltration

5. Vapor cools, forms clouds, and changes back into water. This is called ________________________.
   a) infiltration b) condensation c) precipitation

PART B: Texas Water Supply

Directions: Circle the letter of the word that best completes each sentence.

6. Most large cities in Texas are in the ________________________ half of the state where there is more water.
   a) eastern b) northern c) western

7. The river that supplies Austin, our capital city, is the ________________________.
   a) Sabine b) Colorado c) Trinity

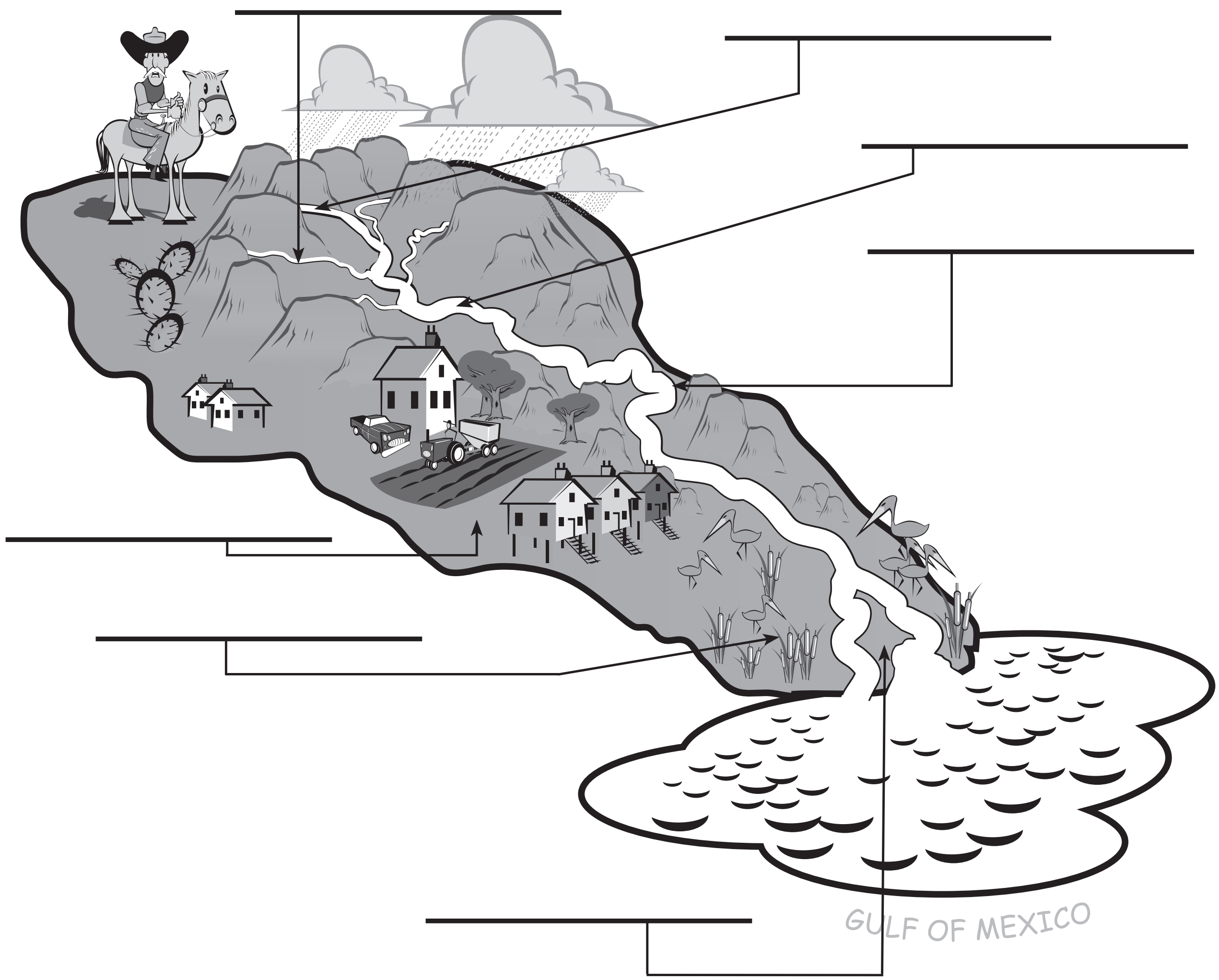
8. An underground layer of gravel, sand, or rocks that is filled with water is called ________________________.
   a) a reservoir b) an aquifer c) a lake

9. The river between Texas and Mexico is the ________________________.
   a) Red b) Brazos c) Rio Grande

10. More than half of the water used in Texas comes from ________________________.
    a) the ocean b) rivers c) aquifers

PART C: What is a Watershed?

Directions: Put the following words in the correct blank to label the watershed: tributary, floodplain, meander, headwaters, wetland, delta, and main channel. Color the tributaries that flow into the main river blue. Place an arrow showing the direction of the river's flow.



PART D: Water Treatment and Distribution

Directions: Match the words on the left with their definitions on the right. Write the correct letter in the blank space.

_____ water treatment plant	a) place where surface water is stored
_____ wastewater treatment plant	b) place where sewage is cleaned
_____ recycled water	c) carries water to homes and businesses
_____ pipeline	d) place where water is cleaned and made safe to drink
_____ reservoir	e) wastewater that is cleaned and reused

PART E: Using Water Efficiently

Directions: Look at each group of activities that use water. Place an X next to the activity in each group that uses the most water in a year.

_____ flushing the toilet	_____ using the faucet	_____ washing clothes	_____ using the faucet
_____ washing dishes	_____ watering the lawn	_____ watering the lawn	_____ flushing the toilet
_____ drinking water	_____ taking a shower	_____ drinking water	_____ washing the car

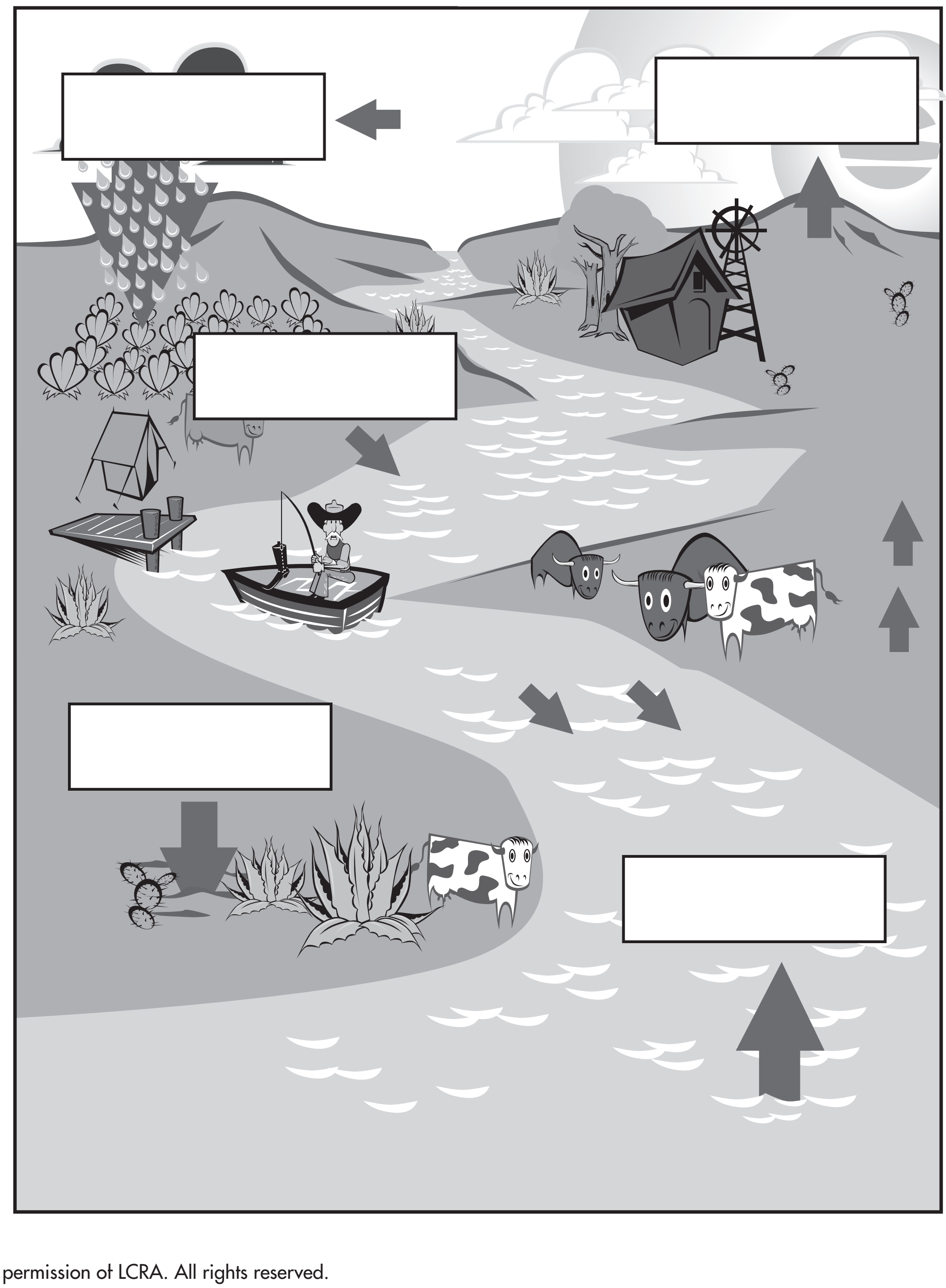
Name______________________________________

REVIEW WORKSHEET

Part A. The Water Cycle

Directions: *The picture below shows the cycle of water. Fill in the blank spaces on the diagram with the words below.*

condensation *infiltration* *surface runoff*
evaporation *precipitation*



Name______________________________________

REVIEW WORKSHEET

PART B. Water Supply
Directions: *Fill in the crossword puzzle by completing each sentence.*

Across:

2.______________ supply almost half of the water for Texas.

4. The ____________River supplies water to our capital city.

7.___________ supply more than half the water for Texas.

9. The west side of Texas gets very little ____.

Down:

1. The ________ River forms the border between Texas and Mexico.

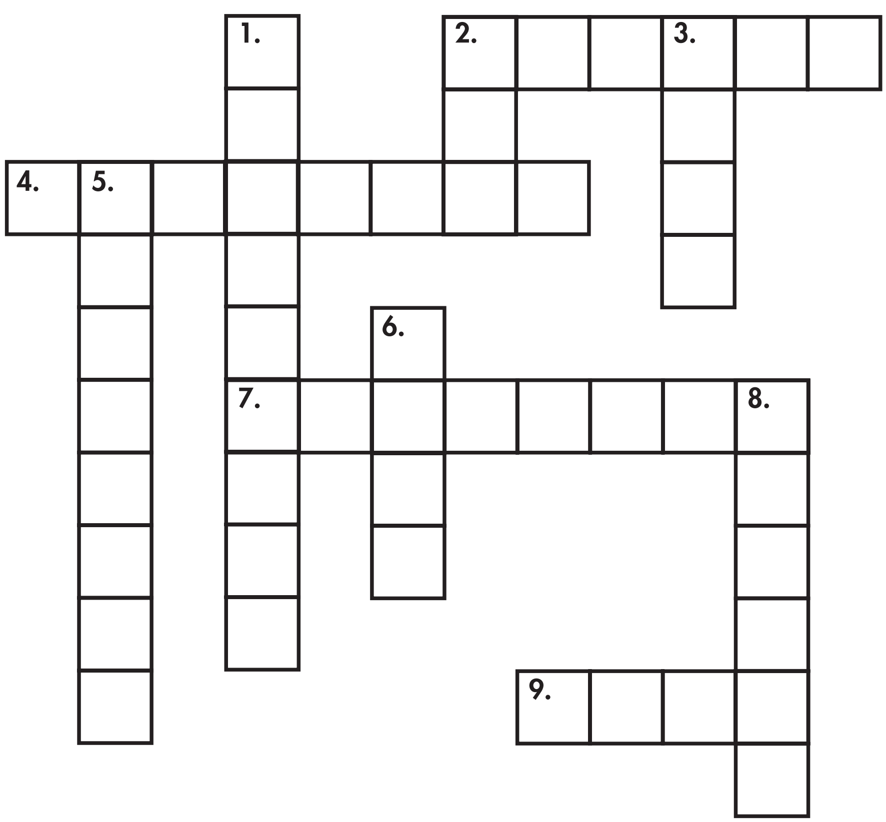
2. The _____________ River runs between Texas and Oklahoma.

3. The_______________ side of Texas gets the most rain.

5. The __________________Aquifer supplies water to the Panhandle.

6. Most rivers in Texas empty into the_______ of Mexico.

8. The ___________ River separates Texas and Louisiana.

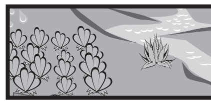
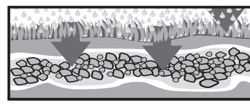
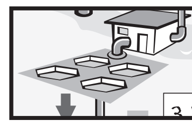
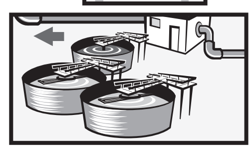
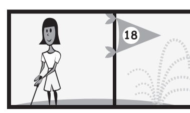


Name_______________________________________

REVIEW WORKSHEET

Part C. Water Distribution

Directions: *Fill in the blank spaces to complete each sentence.*

Texas has 80,000 miles of rivers and streams and 221 large lakes and reservoirs. The water we can see on top of the ground is called  _____________________ *. Texas also uses water from under the ground. This water is called*  _____________________ *.*
Most of the water from rivers, reservoirs, and aquifers is sent to a  _____________ _____________________ *to be cleaned. Then the water travels through*  _____________ *to our homes and businesses. After we use the water, it goes to a*  __________________________________ *. Sometimes, wastewater can be used to irrigate some crops and to water parks. This water is called* 

____________________ *.*

PART D. Water Use

Directions: *Fill in the chart showing which uses of water are high, medium, and low.*

bathing	drinking	washing clothes
brushing teeth	flushing toilet	washing dishes
using the faucet	washing car	watering lawn

HIGH	MEDIUM	LOW
______________________	______________________	______________________
______________________	______________________	______________________
______________________	______________________	______________________

Name____

WATER MATH

Directions: *Solve the problems and then use the key to make a sentence about water in Texas.*

130 = many	*484 = Texas*	*864 = water*
165 = flows	*494 = of*	*855 = into*
216 = The	*544 = rivers*	*901 = Gulf*
315 = in	*700 = Mexico*	*976 = the*

18	36	15	10	22	17
x 12	x 24	x 21	x 13	x 22	x 32
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

11	45	61	17	19	14
x 15	x 19	x 16	x 53	x 26	x 50
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Name____

A WATER CYCLE PUZZLE

Directions: *Complete each statement by filling in the blanks. When you have finished, there will be a word spelled in the arrow. Choose the correct words from the list.*

snow	*surface*	*water*	*cycle*	*taste*
Texas	*ice*	*fog*	*rain*	
infiltrates	*rivers*	*vapor*	*evaporates*	

1. *Water goes into the air when it* ___ ___ ___ ___ ___ ___ ___ ___ ___ ___.
2. *Water* ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ *into the soil.*
3. *Water conservation is important in* ___ ___ ___ ___ ___.
4. *The water* ___ ___ ___ ___ ___ *never stops.*
5. *Frozen water is called* ___ ___ ___.
6. *Water in the air is called* ___ ___ ___ ___ ___.
7. ___ ___ ___ ___ *falls from the clouds.*
8. *All living things need* ___ ___ ___ ___ ___.
9. *Water on the ground is* ___ ___ ___ ___ ___ ___ ___ *water.*
10. *Water has no odor, color, or* ___ ___ ___ ___ ___.
11. *Water flows in* ___ ___ ___ ___ ___ ___.
12. ___ ___ ___ *is a cloud close to the ground.*
13. *In cold places,* ___ ___ ___ ___ *falls from the clouds.*

____

Name____________________________________

WATERY WORD SEARCH

Directions: Find and circle the water words in this puzzle. The words go down and across.

Word List:

AQUIFER	GROUNDWATER	IRRIGATION	RESERVOIR
CONDENSATION	GULF	LAKE	RIVER
DAM	ICE	PRECIPITATION	SNOW
EVAPORATE	INFILTRATE	RAIN	WELL

C	O	N	D	E	N	S	A	T	I	O	N	Q	S	T	I	L	O	I	P	X
S	W	D	R	S	T	U	T	L	O	P	S	A	Q	U	I	F	E	R	L	O
T	U	T	Z	I	L	R	U	P	L	L	T	Z	X	Y	U	V	W	R	S	T
Q	R	S	U	N	U	R	T	M	B	O	L	S	T	U	V	W	X	I	Y	Z
D	E	F	G	F	I	J	K	L	E	M	O	P	Q	R	S	T	U	G	V	W
A	B	C	H	I	E	F	G	H	L	I	J	K	L	M	N	O	P	A	Q	R
V	W	X	T	L	E	V	A	P	O	R	A	T	E	A	B	C	E	T	F	G
K	E	M	N	T	P	Q	R	I	C	S	T	U	V	W	X	Y	Z	I	H	I
N	L	P	Q	R	I	V	E	R	S	T	U	V	R	T	W	X	A	O	P	L
L	L	N	O	A	P	R	E	C	I	P	I	T	A	T	I	O	N	N	L	I
Q	R	S	T	T	E	Z	X	E	T	W	I	Z	T	S	Q	R	L	M	N	O
B	C	D	E	E	R	S	T	D	S	L	A	K	E	Q	R	S	J	K	L	M
W	T	S	T	R	C	T	M	A	Q	W	M	Z	R	A	I	N	K	H	L	N
D	A	M	S	C	Z	W	N	K	R	S	T	U	V	W	X	O	W	Y	Z	T
F	G	U	L	F	D	I	C	E	T	G	R	O	U	N	D	W	A	T	E	R
Q	R	S	T	T	Y	D	R	B	E	L	C	I	T	R	I	A	Z	A	B	E
Z	R	E	S	E	R	V	O	I	R	T	Y	X	Z	Q	R	D	W	A	B	R

APPENDIX 2

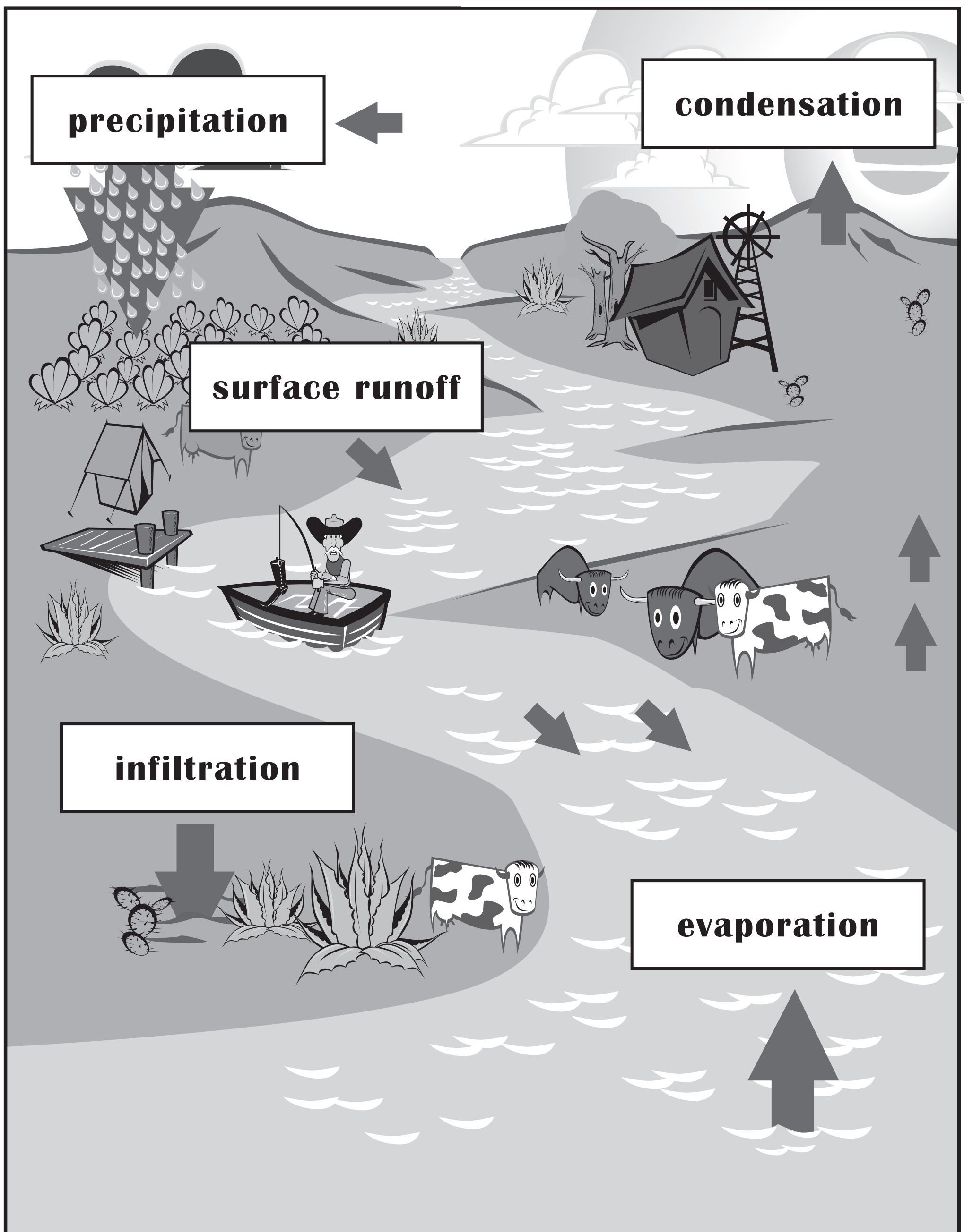
ANSWER KEY

REVIEW WORKSHEET

Part A. The Water Cycle

Directions: *The picture below shows the cycle of water. Fill in the blank spaces on the diagram with the words below.*

condensation	*infiltration*	*surface runoff*
evaporation	*precipitation*	



ANSWER KEY

REVIEW WORKSHEET

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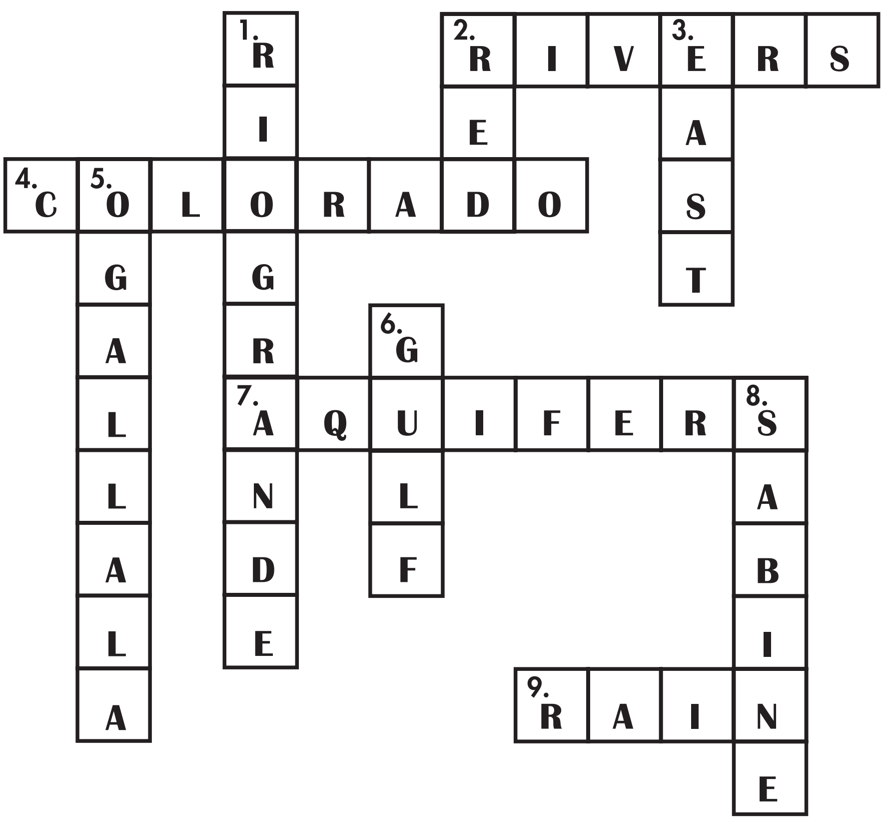

ANSWER KEY

REVIEW WORKSHEET

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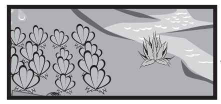
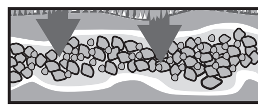
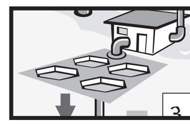
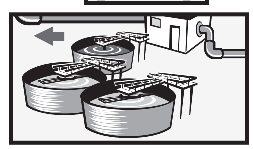
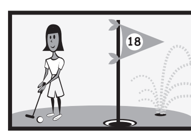
Texas has 80,000 miles of rivers and streams and 221 large lakes and reservoirs. The water we can see on top of the ground is called  **surface water**. *Texas also uses water from under the ground. This water is called*  **groundwater**. *Most of the water from rivers, reservoirs, and aquifers is sent to a*  **water treatment plant** *to be cleaned. Then the water travels through*  **pipelines** *to our homes and businesses. After we use the water, it goes to a*  **wastewater treatment plant**. *Sometimes, wastewater can be used to irrigate some crops and to water parks. This water is called* 

recycled water.

PART D. Water Use

Directions: *Fill in the chart showing which uses of water are high, medium, and low.*

bathing	drinking	washing clothes
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using the faucet	washing car	watering lawn

HIGH	MEDIUM	LOW
bathing	**using the faucet**	**brushing teeth**
flushing toilet	**washing clothes**	**drinking**
watering lawn	**washing dishes**	**washing car**

ANSWER KEY

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The	water	in	many	Texas	rivers

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ANSWER KEY

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1. *Water goes into the air when it* **e v a p o r a t e s**.
2. *Water* **i n f i l t r a t e s** *into the soil.*
3. *Water conservation is important in* **T e x a s**.
4. *The water* **c y c l e** *never stops.*
5. *Frozen water is called* **i c e**.
6. *Water in the air is called* **v a p o r**.
7. **r a i n** *falls from the clouds.*
8. *All living things need* **w a t e r**.
9. *Water on the ground is* **s u r f a c e** *water.*
10. *Water has no odor, color, or* **t a s t e**.
11. *Water flows in* **r i v e r s**.
12. **f o g** *is a cloud close to the ground.*
13. *In cold places,* **s n o w** *falls from the clouds.*

p r e c i p i t a t i o n

ANSWER KEY

WATERY WORD SEARCH

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EVAPORATE	INFILTRATE	RAIN	WELL

C	O	N	D	E	N	S	A	T	I	O	N	Q	S	T	I	L	O	I	P	X
S	W	D	R	S	T	U	T	L	O	P	S	A	Q	U	I	F	E	R	L	O
T	U	T	Z	I	L	R	U	P	L	L	T	Z	X	Y	U	V	W	R	S	T
Q	R	S	U	N	U	R	T	M	B	O	L	S	T	U	V	W	X	I	Y	Z
D	E	F	G	F	I	J	K	L	E	M	O	P	Q	R	S	T	U	G	V	W
A	B	C	H	I	E	F	G	H	L	I	J	K	L	M	N	O	P	A	Q	R
V	W	X	T	L	E	V	A	P	O	R	A	T	E	A	B	C	E	T	F	G
K	E	M	N	T	P	Q	R	I	C	S	T	U	V	W	X	Y	Z	I	H	I
N	L	P	Q	R	I	V	E	R	S	T	U	V	R	T	W	X	A	O	P	L
L	L	N	O	A	P	R	E	C	I	P	I	T	A	T	I	O	N	N	L	I
Q	R	S	T	T	E	Z	X	E	T	W	I	Z	T	S	Q	R	L	M	N	O
B	C	D	E	E	R	S	T	D	S	L	A	K	E	Q	R	S	J	K	L	M
W	T	S	T	R	C	T	M	A	Q	W	M	Z	R	A	I	N	K	H	L	N
D	A	M	S	C	Z	W	N	K	R	S	T	U	V	W	X	O	W	Y	Z	T
F	G	U	L	F	D	I	C	E	T	G	R	O	U	N	D	W	A	T	E	R
Q	R	S	T	T	Y	D	R	B	E	L	C	I	T	R	I	A	Z	A	B	E
Z	R	E	S	E	R	V	O	I	R	T	Y	X	Z	Q	R	D	W	A	B	R