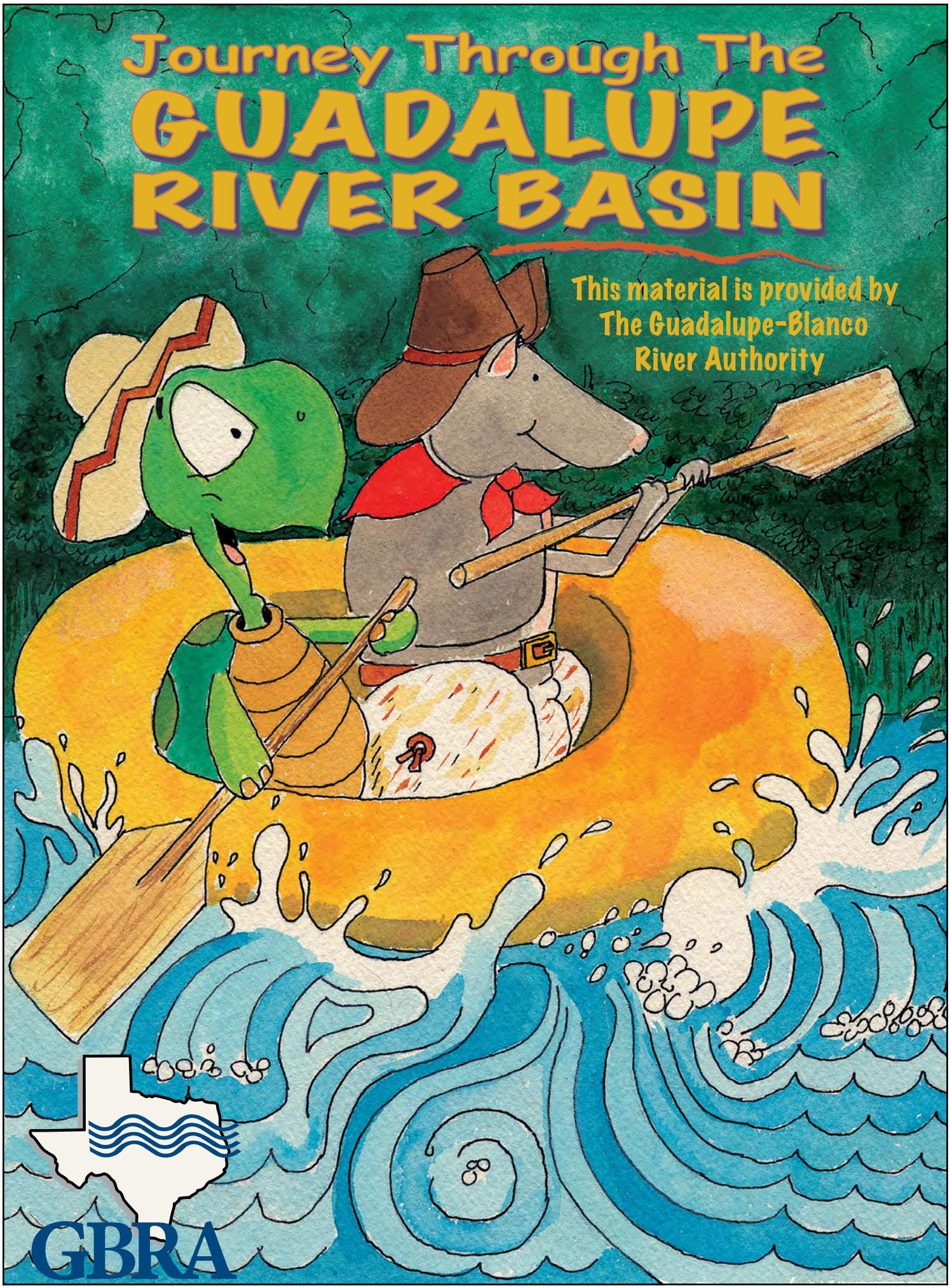
Journey Through The GUADALUPE RIVER BASIN

This material is provided by
The Guadalupe-Blanco
River Authority



GBRA

Journey Through the Guadalupe River Basin

2019-2020 Teacher's Guide

Guadalupe-Blanco River Authority
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Journey Through the Guadalupe River Basin
4th Grade Curriculum Supplement
Teacher's Guide

Journey Through the Guadalupe River Basin has been especially designed for fourth grade students in the Guadalupe River Basin. The information and activities in this unit are intended to promote students' knowledge and awareness of local water uses and issues.

The Guadalupe-Blanco River Authority (GBRA) originally developed the unit in 1989 with the assistance of two fourth-grade teachers, Leslie M. W. Pentecost of Canyon Lake and Cynthia Hall of New Braunfels. Revisions since 1998 have been written and coordinated by Cinde Thomas-Jimenez, GBRA Environmental Education Administrator.

TEKS
This version of the *Journey Through the Guadalupe-River Basin* has been correlated to the current TEKS. Most of the concepts covered in the unit complement the science and social studies TEKS, with opportunities for reinforcement in math and reading.

Instructional Planning
Instructions for this unit are organized into 7 lessons (including a Pre-test) and a Post-test. Procedures for each of the lessons are found in this teacher's guide. Each lesson can usually be completed in approximately one class period (one hour). Many of the lessons include extension activities and suggestions are provided for enrichment activities. These may be introduced in learning centers, in science labs, or assigned as individual enrichment. It is suggested that teachers keep a comprehensive vocabulary list for daily review.

Materials Included in Package
25 student workbooks
25 GBRA pencils
Guadalupe River Basin poster map
USB Drive includes:
- *Endangered Species* Power Point
- *Teacher's Guide* PDF
- *Map of the Guadalupe River Basin* PDF
- *Journey Through the Guadalupe River Basin* Student Workbook PDF

Lesson Sequence
Lesson 1: Introduction to the Guadalupe River Basin (includes Pre-test)
Lesson 2: The Water Cycle and Watersheds
Lesson 3: Four Uses of Water
Lesson 4: The Importance of Springflow
Lesson 5: Water Quality
Lesson 6: Water Regulation
Lesson 7: Water Use and Conservation
Conclusion and Post-test
Appendix: Pre and Post-test Master, Program Record Sheet

Call or email GBRA for information about
in-class presentations and field trips!
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Table of Contents

Texas Essential Knowledge and Skills (TEKS)

4th Grade Social Studies - Texas Essential Knowledge and Skills Objectives (TEKS)	Lesson 1	2	3	4	5	6	7
(2) History (A) summarize reasons for European exploration and settlement in Texas	✓						
(5) History (A) identify the impact of various issues and events on life in Texas, like urbanization			✓	✓	✓	✓	✓
(6) Geography (A) apply geographic tools, including legends, etc. to construct and interpret maps	✓	✓	✓				
(B) translate geographic data into a variety of formats such as raw data to graphs and maps	✓	✓	✓	✓			
(7) Geography (A) describe a region in Texas... that result from patterns of human activity...	✓	✓	✓		✓		
(B) describe a variety of regions in Texas... that result from physical characteristics...	✓	✓	✓	✓			
(8) Geography (A) identify clusters of settlements in Texas and explain their distribution...	✓		✓	✓	✓		
(B) describe the location of cities in Texas and explain their distribution...	✓		✓				
(C) explain the geographic factors that influence patterns of settlement...	✓	✓	✓	✓			
(9) Geography (A) describe ways people have adapted to and modified their environment in Texas	✓	✓	✓	✓	✓		
(B) identify reasons why people have adapted to and modified their environment in Texas	✓	✓	✓	✓	✓		
(C) analyze the consequences of human modifications of the environment, past and present			✓	✓	✓		
(12) Economics (A) explain how people in different regions of Texas earn their living			✓				
(B) explain how geographic factors have influenced the location of economic activities		✓	✓				
(C) analyze the effects of limited resources on economic development and growth...		✓	✓			✓	
(21) Social Studies Skills (B) analyze information by sequencing, categorizing... cause/effects			✓	✓	✓	✓	
(C) organize and interpret information in outlines, reports, databases, and visuals, including graphs, charts timetables and maps...	✓	✓	✓	✓	✓	✓	✓
(E) use appropriate mathematical skills to interpret social studies into such as maps and graphs	✓	✓	✓	✓	✓	✓	✓
(22) Social Studies Skills (A) use a problem-solving process to identify a problem, gather information, list and consider options...				✓	✓	✓	✓

4th Grade Science - Texas Essential Knowledge and Skills Objectives (TEKS)	Lesson 1	2	3	4	5	6	7
(1) Scientific Investigation and Reasoning (B) make informed choices in the use and conservation of natural resources	✓						✓
(2) Scientific Investigation and Reasoning (C) construct simple tables, charts, bar graphs, and maps using tools and current technology...	✓	✓	✓	✓	✓	✓	✓
(F) communicate valid, oral, and written results supported by data					✓		✓
(3) Scientific Investigation and Reasonings (B) represent the real world using models such as rivers, stream tables... identify their limitations		✓		✓	✓		
(7) Earth and Space (A) examine properties of soils, including color and texture, capacity to retain water...		✓					
(B) observe and identify slow changes to Earth's surface caused by weathering, erosion, and deposition from water		✓					
(C) identify and classify Earth's renewable resources, including air, plants, water and animals... and the importance of conservation	✓	✓	✓	✓	✓	✓	✓
(8) Earth and Space (B) describe and illustrate the continuous movement of water above and on the surface of Earth through the water cycle...		✓					
(10) Organisims and environments (A) explore how adaptations enable organisims to survive in their environment...						✓	

4th Grade English Language Arts and Reading - Texas Essential Knowledge and Skills Objectives (TEKS)	Lesson 1	2	3	4	5	6	7
(1) Reading/Fluency. Students read grade-level text with fluency and comprehension. Students are expected to read aloud grade-level stories with fluency (rate, accuracy, expression, appropriate phrasing) and comprehension	✓	✓	✓	✓	✓	✓	✓
(2) Reading/Vocabulary Development (B) use the context of the sentence (e.g., in-sentence example or definition) to determine the meaning of unfamiliar words or multiple meaning words	✓	✓	✓	✓	✓	✓	✓
(13) Reading/Comprehension of Informational Text/Procedural Text (A) determine the sequence of activities needed to carry out a procedure (e.g., following a recipe)					✓		
(B) explain factual information presented graphically (e.g., charts, diagrams, graphs, illustrations)				✓			✓
(16) Writing/Literacy Texts (A) write imaginative stories that build the plot to a climax and contain details about the characters and setting				✓	✓		
(17) Writing. Students write about their own experiences. Students are expected to write about important personal experiences							✓
(19) Writing/Persuasive Texts. Students write persuasive texts to influence the attitudes or actions of a specific audience on specific issues. Students are expected to write persuasive essays for appropriate audiences that establish a position and use supporting details				✓		✓	✓
(27) Listening and Speaking/Listening (B) follow, restate, and give oral instructions that involve a series of related sequences of action				✓			
(29) Listening and Speaking/Teamwork. Students are expected to participate in teacher-and student-led discussions by posing and answering questions with appropriate detail and by providing suggestions that build upon the ideas of others	✓	✓	✓	✓	✓	✓	✓

Time Requirements:
1 1/2 hours

Social Studies TEKS:
2(A), 6(A), 6(B), 7(A), 7(B), 8(A), 8(B), 8(C), 9(A), 9(B), 9(C), 21(C), 21(E)

Science TEKS:
1(B), 2(C)

Language Arts TEKS:
1, 2(B), 29

Materials:
- Student Workbooks
- Student copies of Pretest (master can be found in the appendix; answer key is in teacher's guide, pp. 5-6)

Objectives:
1. Pre-assess mastery of unit objectives.
2. Students will identify the three major rivers and the aquifer that supply water to the Guadalupe River Basin.
3. Students will identify the counties and cities in the Guadalupe River Basin.

Vocabulary:
Basin - the land area where rainfall run-off drains to a river.
Native - something that is found naturally in a specific area.
Reservoir - a body of water such as a lake, that stores water.
Dam - dirt, rock, or other material placed across a river or stream to control the flow or raise the level of the water.
Hydroelectricity - the process of making electricity using the force of water.

Procedures:

A. Administer Pretest

1. Print student copies of pretest. (Master is found in the Appendix at end of the teacher's guide.)
2. Inform the students that they will be starting a one-and-a-half week unit about the importance of water in the Guadalupe River Basin. They will also learn the importance of the Comal and San Marcos Springs.
3. Tell the students they are going to take a test to show how much they already know about the Guadalupe River Basin. Explain to students that they are not expected to know everything on the pretest, but will learn the correct answers during the unit.
4. Administer the pretest.
5. Score the pre-tests using key in the teacher's guide pp. 5-6. Record student scores on program record sheet, found in the appendix of the teacher's guide.

B. Read aloud "Introduction to the Guadalupe River Basin," p. 2 in student book.

Discussion questions:
- Who will be your guides in this unit? *(Edward A. Armadillo and Lupe)*
- What is a basin? *(the land area where rainfall run-off drains to a river)*
- What rivers will we be learning about? *(Guadalupe, San Marcos, Comal & Blanco Rivers)*
- Who were the first people to live along these rivers? *(Native Americans)*
- What river do you live closest to? *(answers vary- Guadalupe, San Marcos, Comal, Blanco)*
- Where do the Guadalupe and San Marcos Rivers meet? *(near the city of Gonzales)*
- What body of water does the Guadalupe River flow into? *(San Antonio Bay at the Gulf of Mexico)*
- What is an aquifer? *(an underground area of sand, gravel or rock where voids are filled with water)*
- What is a reservoir? *(a place, such as a lake, where water is stored-could be natural or man-made)*
- What are built across rivers to make reservoirs and keep rivers from flooding? *(dams)*
- What springs supply water to the Guadalupe River Basin? *(Comal & San Marcos Springs)*
- What county do you live in? *(answers will vary)*
- Name some animals that are native to the rivers. *(Red Shiner Minnow, Spot-tail Shiner Minnow, Stone Roller Minnow, Gray Red Horse Sucker, Large Mouth Bass, Guadalupe Bass, Crayfish, Round Nose Bass, Red Ear Turtle, Mud Turtle, Freshwater Mussels, Freshwater Prawn [Shrimp], Water Moccasin, Mayflies, Stone Flies, Caddis Flies, Dobson Flies, Beavers, Alligators.* ***Endangered Species –*** *Texas Blind Salamander, Fountain Darter, San Marcos Gambusia, Comal Springs Riffle Beetle, Comal Springs Dyropid Beetle, Peck's Cave Amphipod, Texas Wild Rice; Candidate for listing - Cagle's Map Turtle; Threatened specie - San Marcos Salamander)*

Materials:
- Student Workbook
- Copies of *Guadalupe River Basin Map Activity* for each student; blackline master p. 7 in teacher's guide
- Electronic copy of *Guadalupe River Basin* map can be found on USB Drive as a PDF
- Computer and projector
- Poster of *Guadalupe River Basin Map*

- What agencies are involved in planning ways to make sure we all have enough clean water? *(Basin-wide: Guadalupe-Blanco River Authority; State-wide: Texas Commission on Environmental Quality, and Texas Water Development Board; Locally: cities, and other districts such as Municipal Utility Districts and Water Control & Improvement Districts.)*
- What is surface water? *(water found on the surface of the ground such as water in a river, lake, or stream)*
- What is water on the ground that flows into rivers and lakes called? *(surface runoff)*
- What is water called that percolates into the ground, beneath the surface? *(groundwater)*
- Why do you think the Guadalupe, Comal, San Marcos and Blanco Rivers are important to us? *(answers will vary)*

C. Map Exploration - student workbook, page 3. Use the map/poster or electronic version of the Guadalupe River Basin as a guide.

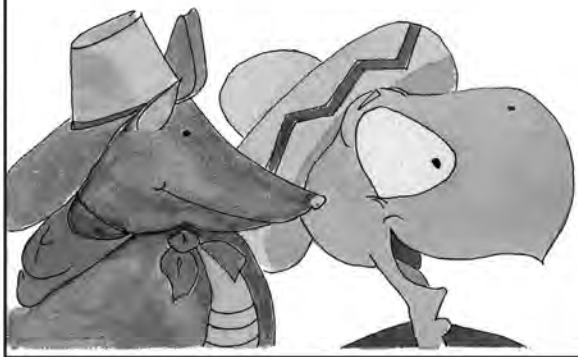
1. While reviewing the map on p. 3 in the student workbook, take advantage of the opportunity to review the concept of a system. A system is a collection of cycles, structures, and processes that interact. The Guadalupe River Basin (and all other river basins!) is a system of streams, creeks, tributaries and rivers that all feed into one main river – the Guadalupe. The map clearly shows there are numerous tributaries that feed into the main river, all the way from the northern part of the basin to the southern part of the basin. Introduce the idea that a drought could severely impact the river system – some of the creeks could dry up, which means less inflow to the river. This change could upset the balance of the ecosystem of the river system, as well as impact human users of the river.
2. Instruct students to trace the rivers with their fingers, beginning at the headwaters of the Blanco and Guadalupe Rivers in Kerr County. As they trace the rivers, instruct students to locate the following features: Guadalupe River Basin, Canyon Reservoir, Guadalupe River, Blanco River, Edwards Aquifer, San Marcos River, San Antonio Bay.
3. Have students name the eleven counties in the Guadalupe River Basin: (Kerr, Kendall, Comal, Hays, Caldwell, Guadalupe, Gonzales, De Witt, Victoria, Refugio, Calhoun).
4. Make certain students locate the county in which they live.

D. Geography in Action: Application of Map Skills.

1. Students complete *Guadalupe River Basin Map Exercise.* (blackline in teacher's guide p. 7, answer key p. 8). Students will use student book page 3 and/or the Guadalupe River Basin map poster for reference. (*Map included on USB Drive.)
2. Lesson 3 includes a PowerPoint presentation (and movie version) on the USB Drive titled: *A Journey Through the Guadalupe River Basin.* The presentation/movie leads students through the basin county by county, with the shape of each county highlighted. Some teachers have indicated that this is a very good tool to use while students are working on their map activity.

LESSON 1 — INTRODUCTION TO THE GUADALUPE RIVER BASIN

1 Hi kids! You are invited to join us for an exciting tour of the Guadalupe River Basin. We would like to introduce ourselves -- Edward A. Armadillo and Lupe the Turtle. We will be your guides for this watery adventure.

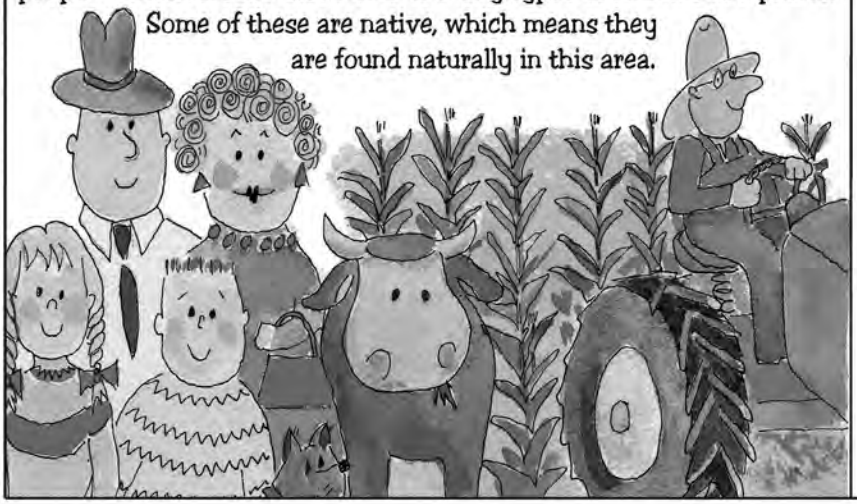


2 On this trip you will learn about the importance of the river to all of us who live in the Guadalupe River Basin. A river basin (sometimes called a watershed) is the land area where rainfall run-off drains to a river.

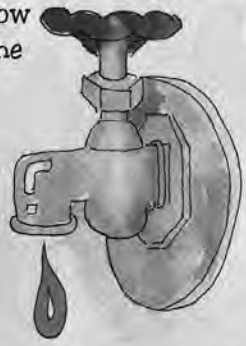
3 The Guadalupe River begins in the central Texas Hill Country. It is joined by the Comal River at New Braunfels, and the Blanco and San Marcos Rivers near the city of Gonzales. The Guadalupe continues its flow southeast to the San Antonio Bay and the Gulf of Mexico.

4 Long ago, Native Americans lived on the banks of these rivers. In 1689, Spanish explorer Alonzo DeLeon named the Guadalupe River after the saint, "Our Lady of Guadalupe." Later, pioneers settled near the rivers and started communities. The rivers provided water for people, their crops and animals.

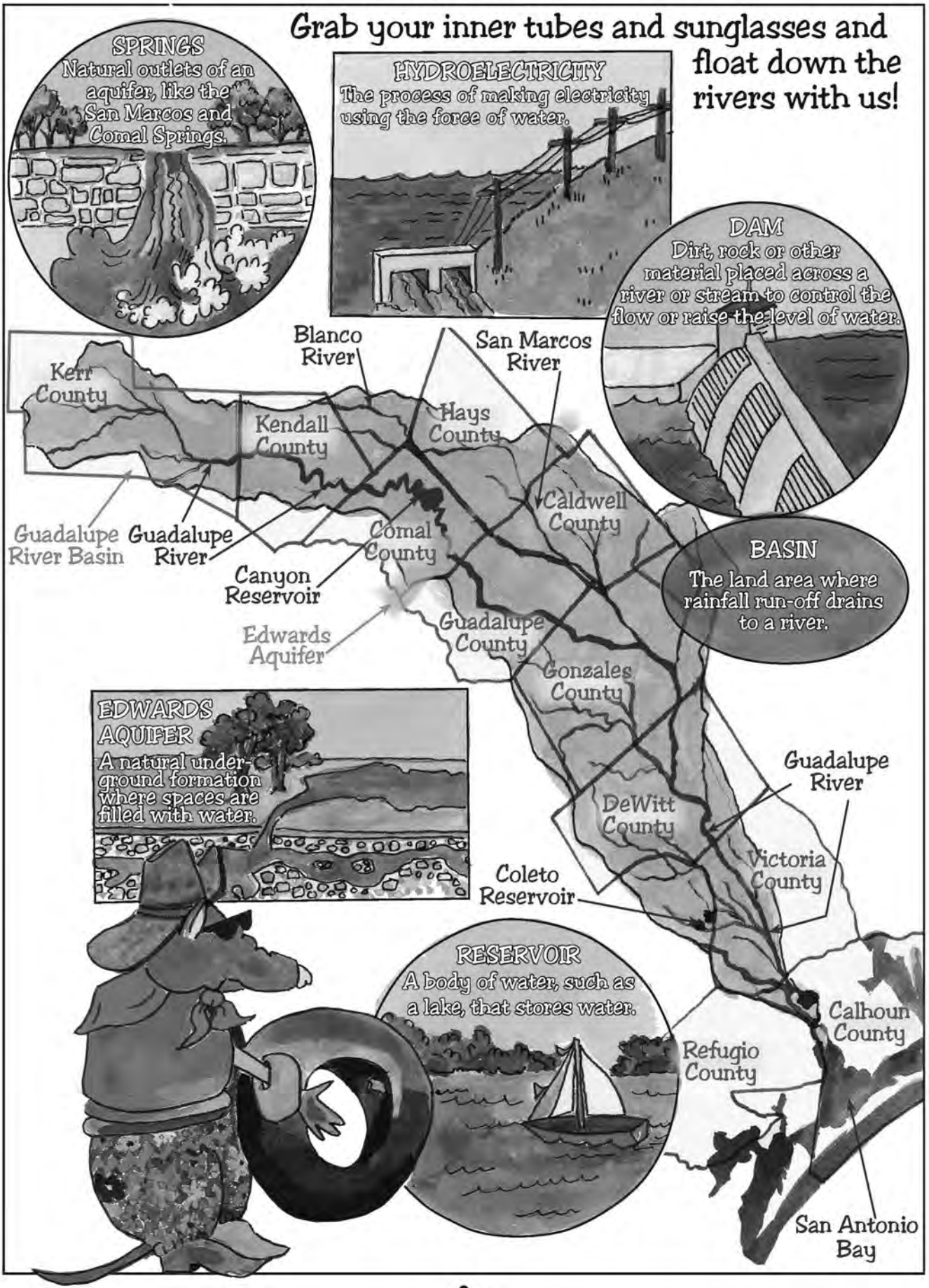
5 Today, about 500,000 people live in the Guadalupe River Basin. The rivers provide water to meet the needs of many of these people. The rivers are also home to many types of animals and plants. Some of these are native, which means they are found naturally in this area.



6 As you can see, the rivers are important to all living things in the basin. The Guadalupe-Blanco River Authority plans ways to make sure we all have enough clean water now and in the future.



GUADALUPE RIVER BASIN



TEACHER'S KEY

Pretest

A. Matching: Place the letter of the word(s) in the blank that matches the correct definition.

A. native	B. Guadalupe	C. basin	D. dam
E. hydroelectricity	F. water cycle	G. Edwards	H. Edwards Plateau
I. reservoir	J. Guadalupe River Basin	K. spring	L. bacterial

1. ___C___ The land area where rainfall run-off drains to a river.

2. ___I___ A body of water, such as a lake, that stores water.

3. ___E___ The process of making electricity using the force of water.

4. ___D___ Dirt, rock, or other material placed across a river or stream to control the flow or raise the level of water.

5. ___A___ An animal or plant found naturally in an area.

6. ___B___ The river that joins with the San Marcos River near the city of Gonzales.

7. ___J___ The area which provides rainfall runoff and springflow to the Guadalupe River.

8. ___K___ A place where water naturally flows out of an aquifer.

9. ___G___ The aquifer that feeds the Comal, Guadalupe and San Marcos Rivers.

10. ___H___ The Eco-Region (natural area of Texas) where the Guadalupe River begins.

11. ___L___ This type of pollution comes from human and animal waste.

12. ___F___ The continuous movement of water on this planet.

B. Fill in the Blank:
Write the letter of the word that best completes the sentence in the blank.

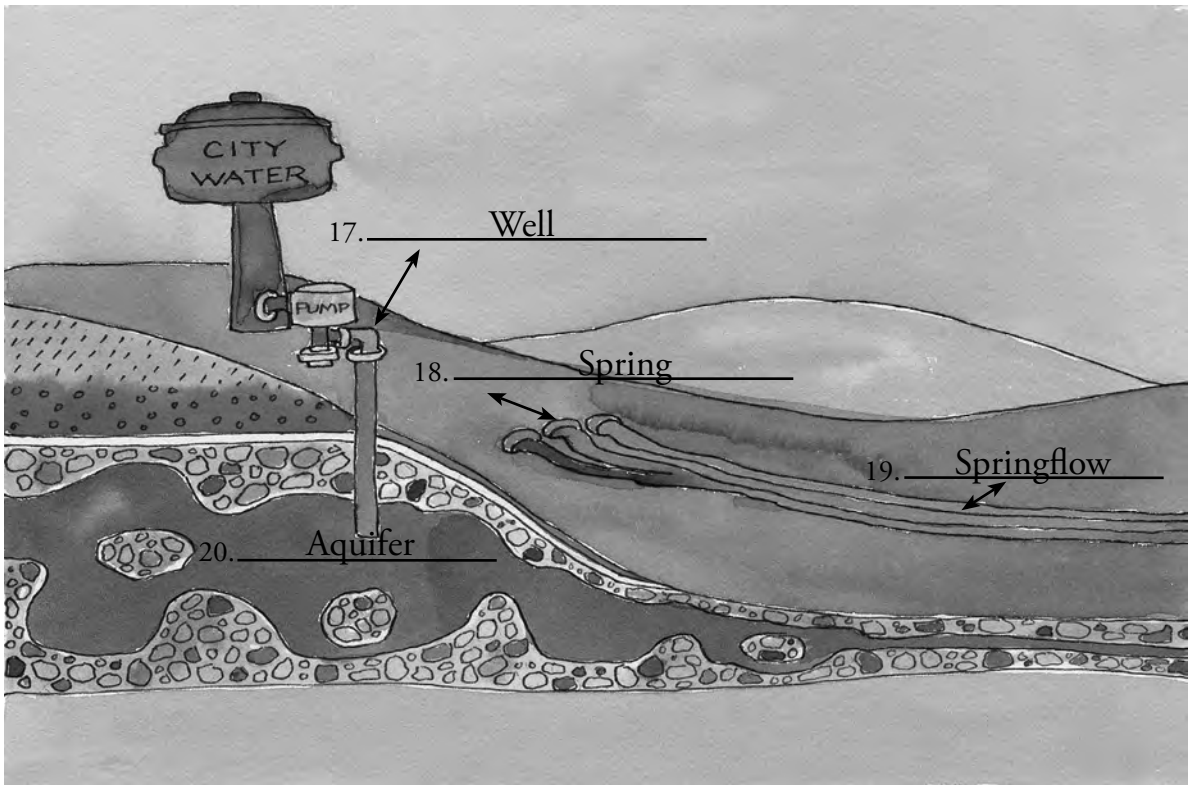
13. Water used to create or make a product is _____C_____ water.
A. Recreational B. Municipal C. Industrial

14. Water used to produce food or raise animals is _____C_____.
A. Industrial B. Recreational C. Agricultural

15. _____A_____ water is used by cities or for household use.
A. Municipal B. Industrial C. Agricultural

16. _____B_____ water is used just for fun.
A. Agricultural B. Recreational C. Industrial

C. Label the picture using these words: spring, springflow, aquifer, well



D. Identify whether these two examples are point source or nonpoint source pollution. Circle the answer.

21. Factory with discharge pipe into the river. (Point Source) Nonpoint Source

22. Parking lot at mall within one mile of the river. Point Source (Nonpoint Source)

E. Fill in the Blank: Write the letter of the word that best completes the sentence in the blank.

23. Over half of the water that you use during the day is used in _____C_____ .
A. the kitchen B. the bedroom C. the bathroom

24. During the _____A_____ season, your outdoor water use is much greater.
A. summer B. fall C. spring

F. List at least two ways you can conserve water:

25. _____Answers will vary_____

26. _____Answers will vary_____

G. Fill in the blank using these words: regulation, surface water, groundwater, permit

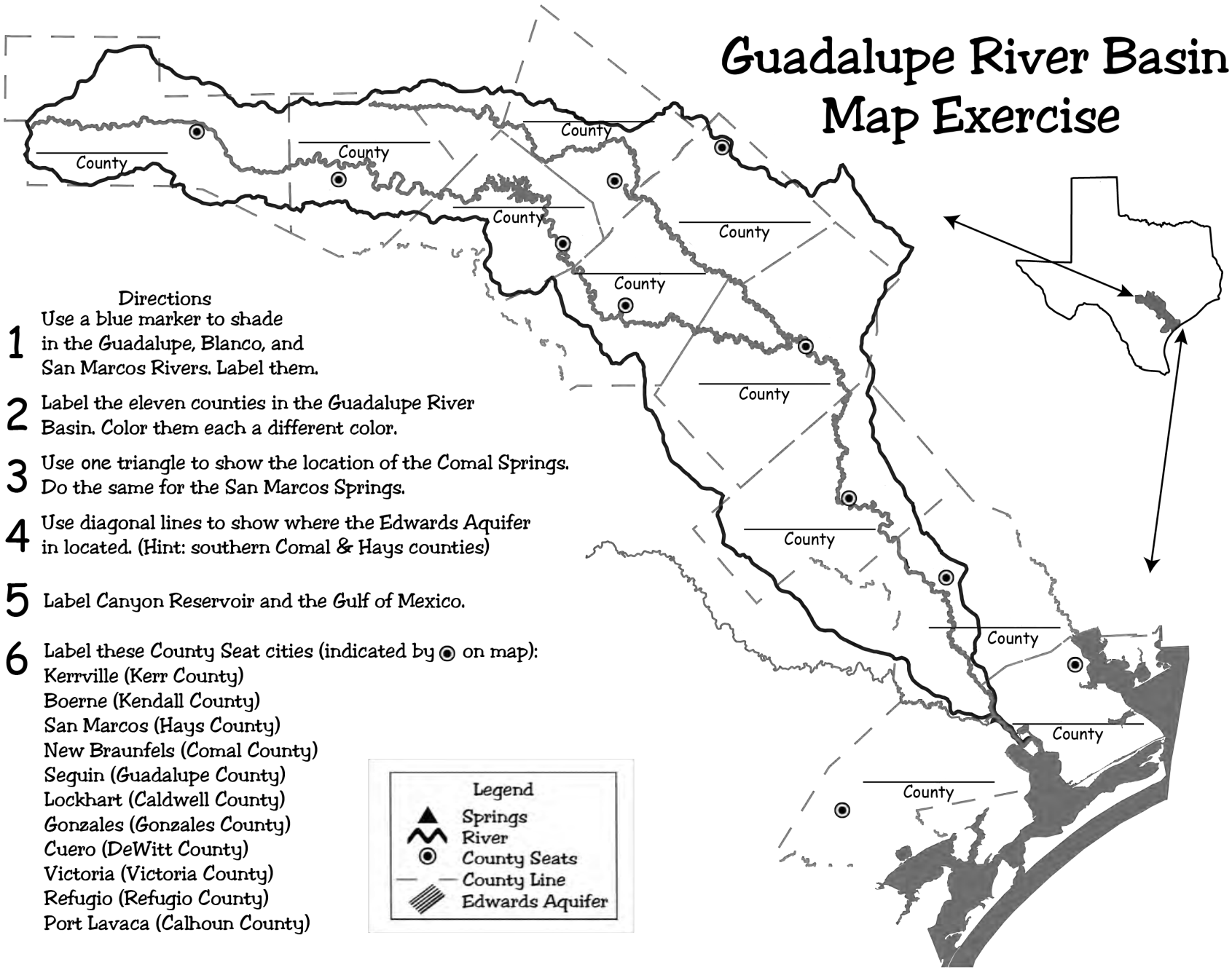
27. Water that percolates underground is _____groundwater_____.

28. Another name for a rule is a _____regulation_____.

29. Water in rivers, lakes and streams is known as _____surface_____ _____water_____.

30. A _____permit_____ is written permission.

Guadalupe River Basin Map Exercise



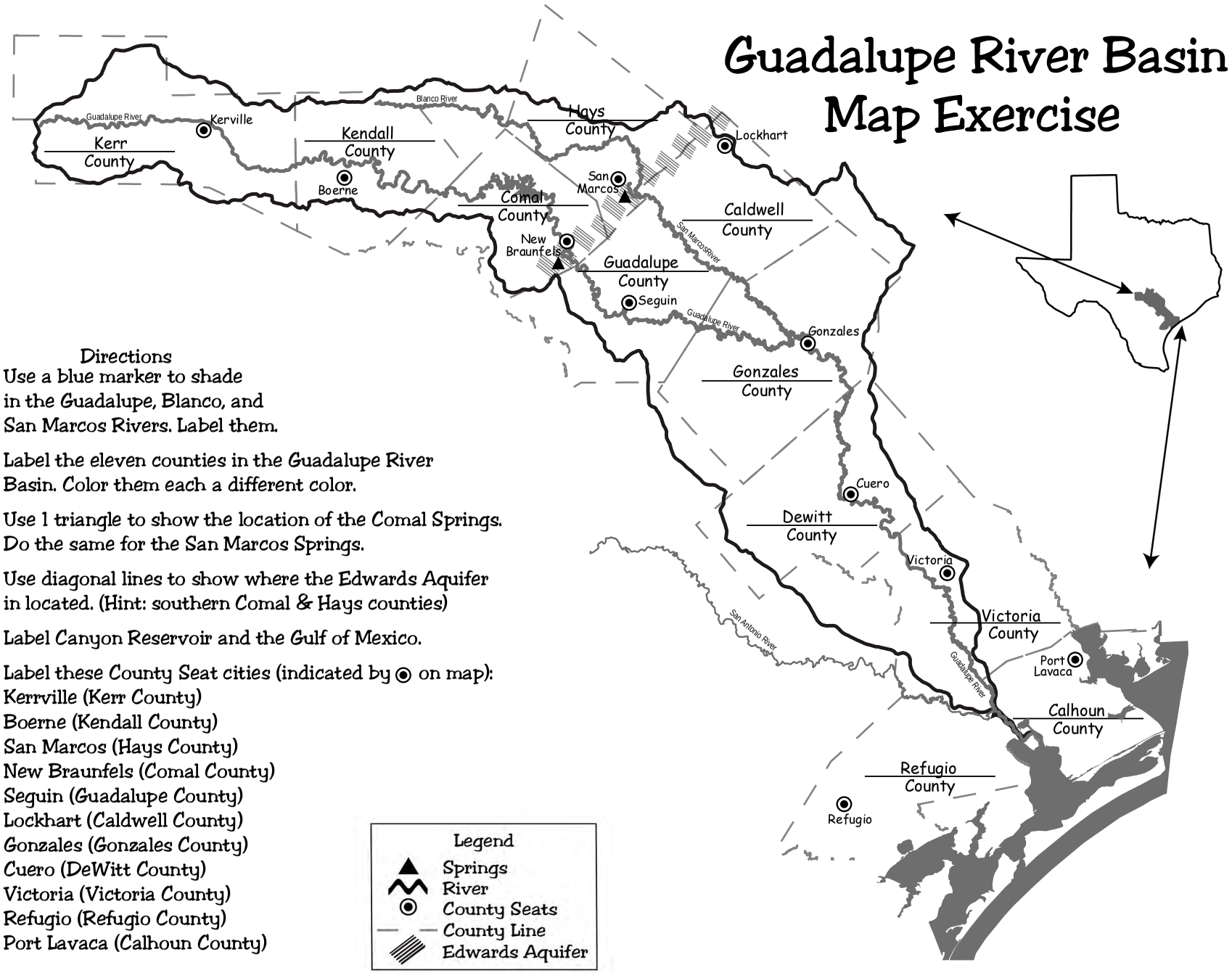
Directions

1. Use a blue marker to shade in the Guadalupe, Blanco, and San Marcos Rivers. Label them.
2. Label the eleven counties in the Guadalupe River Basin. Color them each a different color.
3. Use one triangle to show the location of the Comal Springs. Do the same for the San Marcos Springs.
4. Use diagonal lines to show where the Edwards Aquifer in located. (Hint: southern Comal & Hays counties)
5. Label Canyon Reservoir and the Gulf of Mexico.
6. Label these County Seat cities (indicated by ◉ on map):
   - Kerrville (Kerr County)
   - Boerne (Kendall County)
   - San Marcos (Hays County)
   - New Braunfels (Comal County)
   - Seguin (Guadalupe County)
   - Lockhart (Caldwell County)
   - Gonzales (Gonzales County)
   - Cuero (DeWitt County)
   - Victoria (Victoria County)
   - Refugio (Refugio County)
   - Port Lavaca (Calhoun County)

Legend
- Springs
- River
- County Seats
- County Line
- Edwards Aquifer

Name _____

Guadalupe River Basin Map Exercise



Directions

Use a blue marker to shade in the Guadalupe, Blanco, and San Marcos Rivers. Label them.

Label the eleven counties in the Guadalupe River Basin. Color them each a different color.

Use 1 triangle to show the location of the Comal Springs. Do the same for the San Marcos Springs.

Use diagonal lines to show where the Edwards Aquifer in located. (Hint: southern Comal & Hays counties)

Label Canyon Reservoir and the Gulf of Mexico.

Label these County Seat cities (indicated by ◉ on map):
Kerrville (Kerr County)
Boerne (Kendall County)
San Marcos (Hays County)
New Braunfels (Comal County)
Seguin (Guadalupe County)
Lockhart (Caldwell County)
Gonzales (Gonzales County)
Cuero (DeWitt County)
Victoria (Victoria County)
Refugio (Refugio County)
Port Lavaca (Calhoun County)

Legend
- Springs
- River
- County Seats
- County Line
- Edwards Aquifer

Time Requirements:
2 hours

Social Studies TEKS:
2(A), 6(A), 6(B), 7(A), 7(B), 8(C), 9(A), 9(B), 12(B), 12(C), 22(C), 22 (E)

Science TEKS:
2(C), 3(B), 7(A), 7(B), 7(C), 8(B)

Language Arts TEKS:
1, 2(B), 13(A), 13(B), 27, 29

Materials:
- Student Workbooks

For water cycle demo:
- Clear plastic 4 oz. cups for every 2 students
- Water
- Plastic wrap
- Tape
- Windowsill or area outside to place the cups in the sun.

Objectives:
1. Students will identify the steps of the water cycle.
2. Students will understand the working dynamics of a watershed.
3. Students will identify the Eco-Regions (natural areas) that the Guadalupe River Basin crosses through.

Vocabulary:
Evaporation - Liquid water changing into water vapor and rising into the air.
Condensation - Water vapor changing back into a liquid, typically forming clouds.
Precipitation - Water falling to the earth from clouds as rain, sleet or snow.
Accumulation - Water that has runoff into ponds, lakes, creeks or rivers.
Watershed - The area of land that water crosses over as flows in to creeks and rivers.

Procedures:

A. Read aloud Part 1 of Lesson 2: The Water Cycle and Watersheds, p. 4 in student workbook

Discussion questions:
- After it rains, what happens to the water? *(Water flows into creeks or streams, or seeps underground.)*
- What do we call the process where liquids (rain) or solids (snow, sleet, hail) fall from the clouds to the surface? *(precipitation)*
- What do we call the process where water gathers in lakes and rivers? *(accumulation)*
- What happens to water that evaporates – does it just disappear? *(The water doesn't disappear, it simply changes states from a liquid to a water vapor)*
- What is the process called where water vapor (gas) in the sky forms clouds and begins to change back to a liquid? *(condensation)*
- Why does rain fall out of the clouds and return to the surface of the Earth? *(Clouds are made of water vapor, or gas. When the water vapor gets heavy enough and cold enough, it changes back to liquid water and falls back to the earth.)*
- What is the source of energy for the Earth? *(The sun is the source of energy for the planet. Without it, there would be no life.)*
- What role does the sun play in the water cycle? *(The sun heats the water on the surface, causing it to change form from a liquid to a gas.)*

B. Learn and sing *The Water Cycle* song. Sing to the tune of *Oh My Darling Clementine.*

Evaporation
Condensation
Precipitation's on my mind
Accumulation
The Water Cycle,
Yes it happens all the time…..

C. Instruct students to complete Exercise 2-A, found in student workbook p. 4.
The answer key is found in the teacher's guide p. 12.

D. Extension - Student demonstration of the Water Cycle:
1. Fill a four-oz. cup halfway with water.
2. Cover with plastic wrap.
3. Place in the sun in a windowsill or outdoors on a sidewalk or table.
4. Observe every 15-20 minutes for one hour.
5. Discuss how the model represents the steps of the water cycle.

Materials:
- Student Workbooks

Materials for model (per group):
- Cake pan (12-14 inches in length)
- Newspaper
- Waxed paper or aluminum foil
- Spray bottle w/ water

Materials for lab (per group)
- Three 1 or 2 liter bottles
- Nylon stocking or cheesecloth
- Rubber bands
- Gravel
- Dirt
- Sand
- Water
- Graduated cylinders
- Stopwatch

E. Read aloud Part 2 of Lesson 2: The Water Cycle and Watersheds, p. 4-5 in student workbook. Discuss, using questions below. Complete Exercise 2-B. The answer key is found in the teacher's guide p. 13.

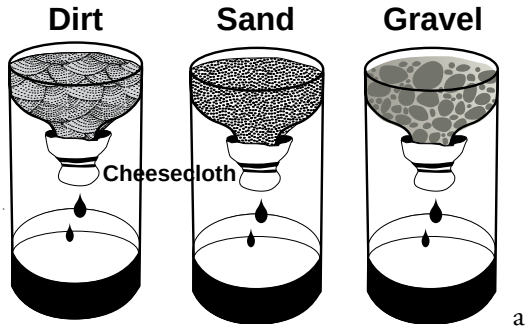
Discussion questions:
- What is a watershed? *(The area of land that water crosses as it flows into creeks and rivers.)*
- Are watersheds large or small? *(Some watersheds are very small, such as when the land drains into a small creek. Some are very large, such as a river basin.)*
- What is a river basin? *(A river basin is a very large watershed, typically a combination of several small watersheds that all feed into the same river.)*
- What river basin watershed do you live in? *(the Guadalupe River Basin Watershed)*
- How many river basins are there in the state of Texas? *(There are 23 major river basins in Texas.)*
- How many Eco-Regions are included in the Guadalupe River Basin watershed? *(Five)*
- Name the Eco-Regions that the Guadalupe River Watershed overlies. *(Edwards Plateau, Blackland Prairie, Oak Woods and Prairies, South Texas Brush, Gulf Coast Prairies.)*

F. Extension: Group Activity - Build a Watershed Model

1. Crumple up 1-2 pages of newspaper and put it on one end of the cake pan.
2. Take a 18 inch sheet of waxed paper. Color it with markers on one side, with approximately 5 inches in gray, then green, then red, green, tan and last yellow. These colors can represent the five Eco-Regions that the Guadalupe River Watershed overlies. If waxed paper is not available, just use 18 inches of aluminum foil without any color.
3. Crumple the waxed paper (or foil) from the sides and a little from the ends. Place the waxed paper in the cake pan with the gray end overlying the crumpled up newspaper. Use your fingers to make a larger crease down the middle of the waxed paper. The crease towards the middle represents the main river channel, and the other wrinkles represent smaller creeks and streams that feed into the river.
4. Spray water on the model (this represents rain). Students should observe how the water flows through the small creases in the waxed paper and then makes its way into the main river channel. (To help the students understand erosion and deposition, this is a good opportunity to use FOSS or LAB-AID kits* on stream tables and erosion. If using FOSS, this topic is found in the Landforms Module, 5-6. You can also view animations on the FOSS WebAids – Look under the Solid Earth Module, Geology section: http://www.fossweb.com/ca/modules3-6/SolidEarth/activities/geologylab.html

**GBRA has LAB-AID kits available for loan – email cthomas-jimenez@ gbra.org or for arrangement.*

G. Lab – Eco-Regions Soils Comparison



1. Cut three 1 or 2 liter soda bottles in half. Cover the mouths of the bottles with cheesecloth, old stockings, etc. – something that water will easily flow through. Secure with a rubber band. Invert the top half into the bottom half, creating a funnel.
2. Fill each of the funnels with a different material that will represent some of the Eco-Regions in the Guadalupe River Basin:
   - **Rock** (Gravel is fine) – this represents the Edwards Plateau
   - **Clay**-like Dirt (not potting soil) – this represents the Blackland Prairies
   - **Sand** – this represents the Gulf Coastal Prairies.
3. Instruct students speculate as to which of the three materials will allow water to pass through the fastest, and which one will retain the most water.

Materials:
- Student Workbooks

4. Pour 10 ml of water into each funnel, one at a time. Record the time it takes for the water to flow through the sample. Begin timing when all of the water has been poured and stop timing when the stream coming out of the bottom of the funnel becomes a drip.

5. Compare the times. Which was the fastest? (*rock*) Slowest? (*dirt*). How does the time compare to the student projections? Compare how much water actually drained through the samples – which one retained the most water? (*soil*)

H. Class discussion:

Discuss with students how the rivers have been the center of our civilizations for thousands of years. Make a list of different ways our ancestors could have used water from the river.

Note: If your class has finished its study of Native Americans and European explorers, take advantage of this opportunity to review the contributions of these groups to our culture: Native Americans that made the Guadalupe River Basin their home include (north to south): Comanche (Edwards Plateau), Tonkawas (Blackland Prairies), Karankawas (Coastal Plains). European explorers that traveled up and through the Guadalupe River Basin include: Early 1530's - Cabeza de Vaca (Spanish - Spain subsequently claimed the land); 1685 -Sieur de la Salle (French- this led to the settlement of Indianola and later Victoria) Later immigrants had a huge impact on colonization and development of central Texas and the Guadalupe River Basin; Spanish efforts resulted in two permanent settlements in the province of Texas: San Antonio (1718), La Bahía (Goliad, 1749); American Empresarios (early 1800s), led by Green DeWitt, Ben Milam and Stephen F. Austin; Mexican Empresario Martin DeLeon (1824) settled in the region around Victoria and Goliad to the coast; German efforts, largely led by Prince Carl Solms (1845) resulted in the purchase of land for the settlements of New Braunfels, Boerne, and Fredricksburg. German and Italian immigrants were also influential in early Victoria.

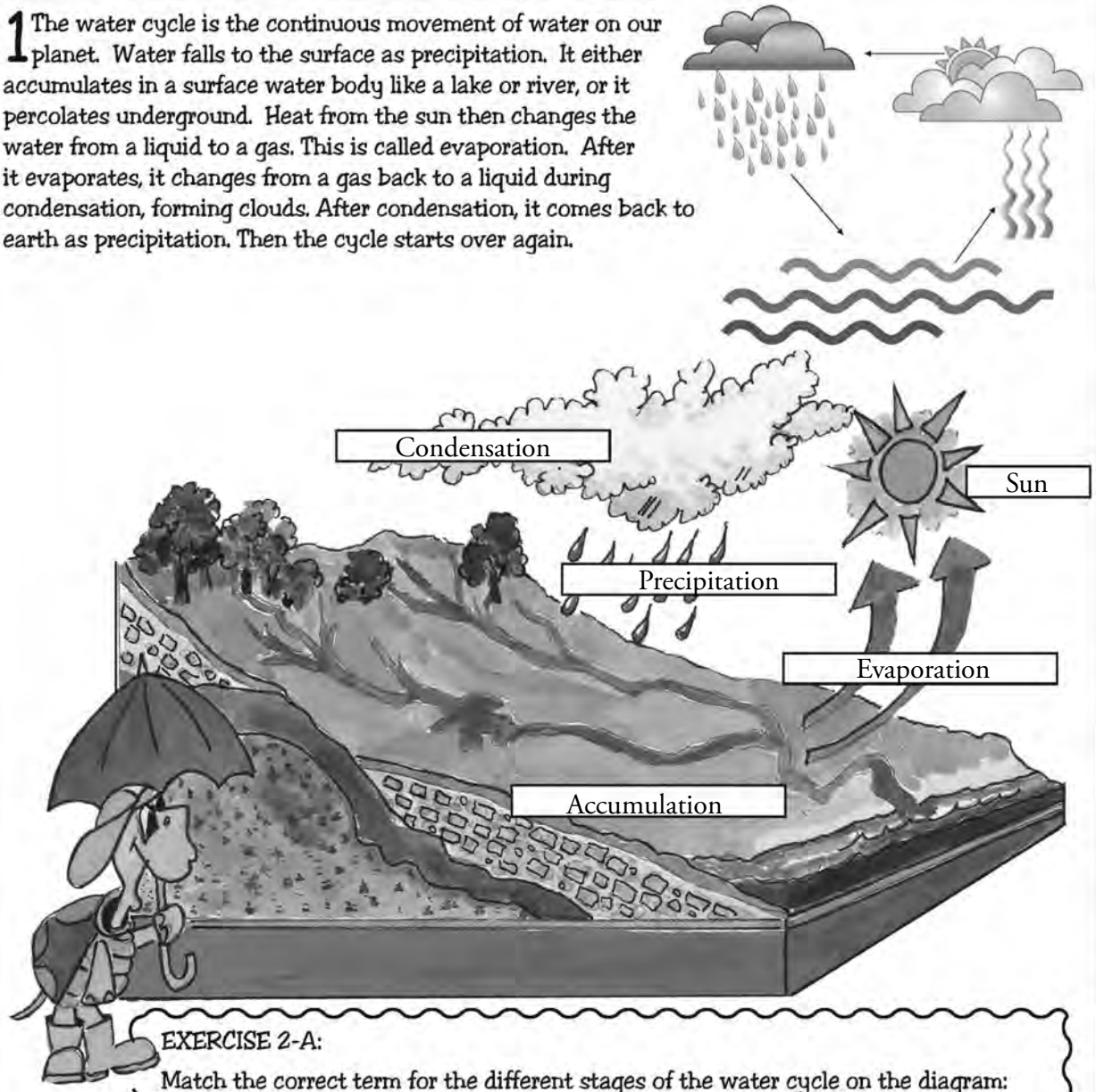
I. Complete the River Basin Timeline, Exercise 2-C, student workbook p. 6.

The answer key is found in the teacher's guide p. 14. This illustration is intended to challenge students to think about how our river has been the focal point of life for thousands of years. Use the discussion points below to assist you in discussion of the river timeline.

- 65 million BC - 65 million years ago, the present-day Guadalupe River Basin did not exist - this area of Texas was covered by warm, shallow seas. However, dinosaur tracks have been found in the Hill Country, indicating that dinosaurs did live in this region, along what would have been the 'coastal' areas. Some tracks have been found nearby Canyon Reservoir.
- 10,000 BC- Artifacts have been found along the San Marcos River from over 12,000 years ago, indicating primitive settlements.
- 1500s - Spanish explorers came through the region in the early 1500s.
- 1700s - Mission settlements were built along the rivers.
- 1800s - Colonization takes places through the Empressario system of land grants from the Mexican government. Cattle are raised in the plains and driven north along cattle trails. The power of the moving water in the rivers is harnessed to run grist mills and cotton gins.
- 1900s – Agricultural trade furthers the growth of small cities. Development of the railroad promoted additional growth as agricultural trade exploded.
- 2000's – Larger cities are located along the banks of the rivers, utilizing the water for agricultural, municipal, industrial and recreational uses.

LESSON 2: THE WATER CYCLE AND WATERSHEDS

1 The water cycle is the continuous movement of water on our planet. Water falls to the surface as precipitation. It either accumulates in a surface water body like a lake or river, or it percolates underground. Heat from the sun then changes the water from a liquid to a gas. This is called evaporation. After it evaporates, it changes from a gas back to a liquid during condensation, forming clouds. After condensation, it comes back to earth as precipitation. Then the cycle starts over again.



EXERCISE 2-A:

Match the correct term for the different stages of the water cycle on the diagram:

Use the following vocabulary terms: evaporation, condensation, precipitation, accumulation. Also label the sun, which is the source of all energy in the cycle and on the earth's surface.

2 A watershed is an area of land that water flows across. This water drains into a creek, stream or river. Look back at the diagram above... you can see that the precipitation moves to the rivers, and the rivers are flowing downhill. This is true of all rivers in Texas - the rivers all flow towards the south and east, towards the Gulf of Mexico. There are 23 major river watersheds in the state of Texas, and the Guadalupe River watershed is one of them.

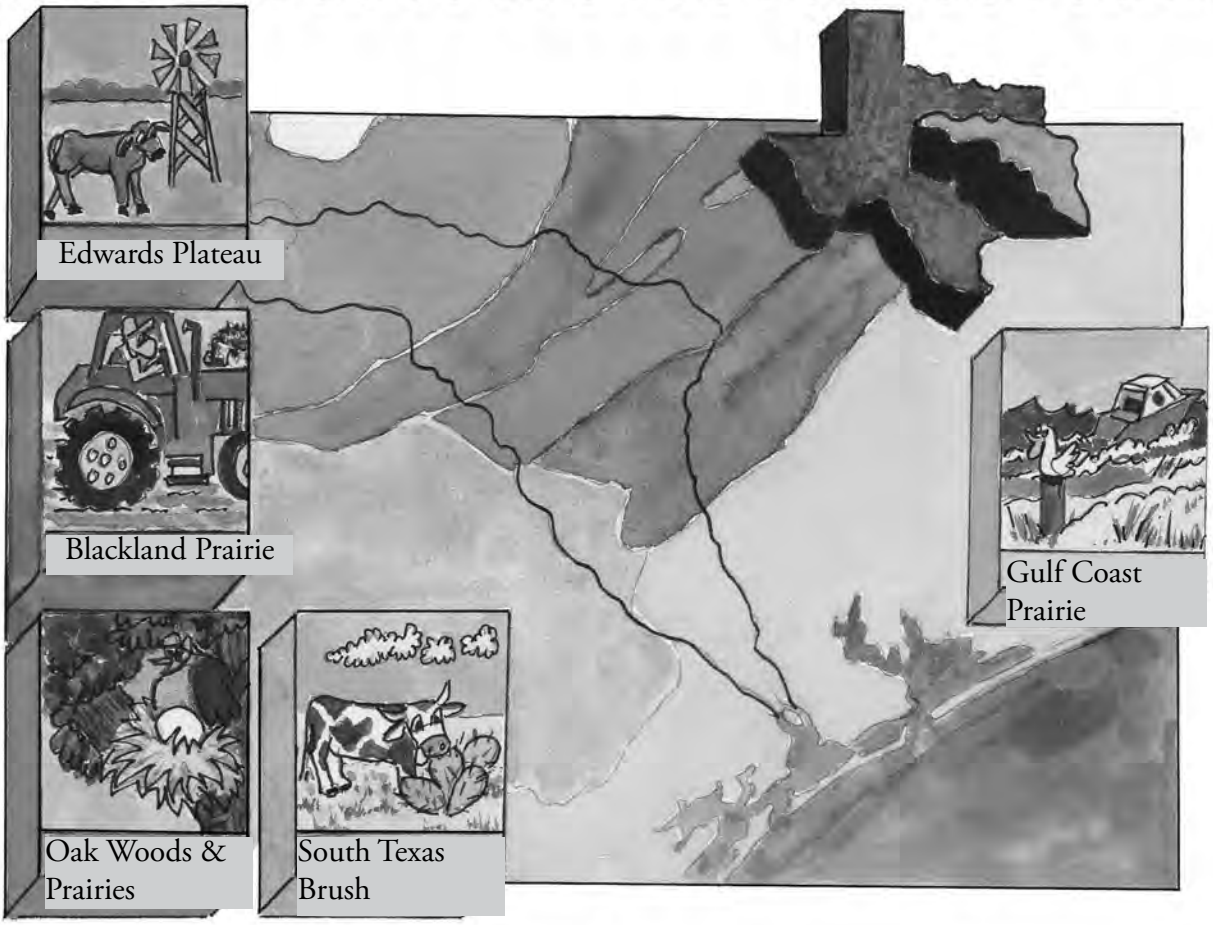
LESSON 2: THE WATER CYCLE AND WATERSHEDS

The land changes as the Guadalupe River flows through it. The river starts up in the hill country, and flows through five "Eco-Regions" before it flows into San Antonio Bay at the coast. The chart and map below will help you learn about these Eco-Regions.

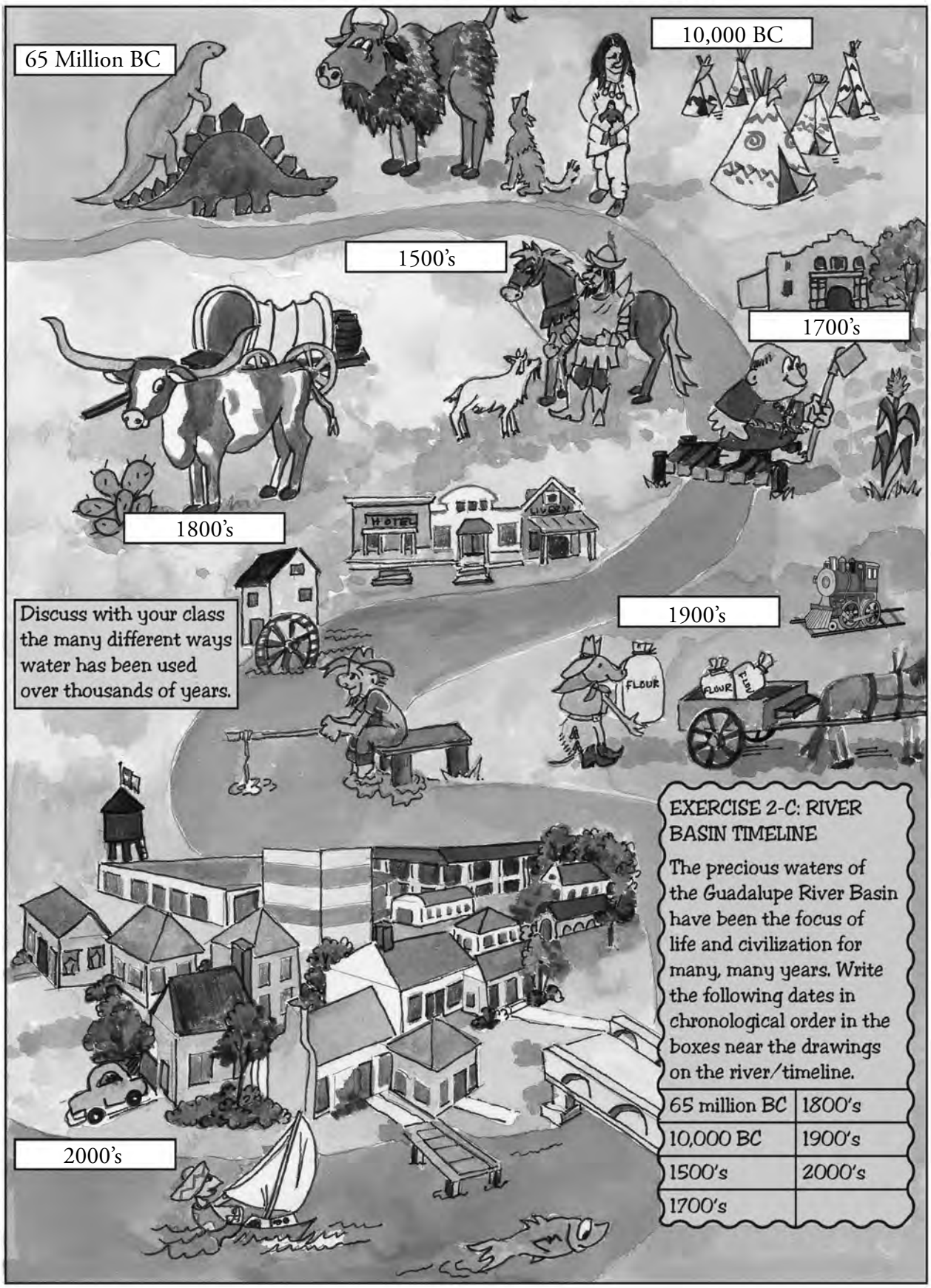
GUADALUPE RIVER BASIN ECO-REGIONS		
Eco-Region	*Physical Land Description*	*Economic Activities*
Edwards Plateau	Rocky land, thin soils and few trees; little water.	Cattle and goat ranching
Blackland Prairie	Dark fertile soil; plants and trees grow well.	Farming and ranching
Oak Woods and Prairies	Light sandy soils, gently rolling hills; abundance of wildlife.	Farming and hunting
South Texas Brush	Land is covered with grass and thorny plants such as mesquite trees and prickly cactus; dry.	Cattle ranching and hunting
Gulf Coast Prairies	Wetlands are mostly flat and low, with a mix of salty and fresh water caused by rivers flowing into the Gulf.	Sport fishing and bird watching

EXERCISE 2-B: ECO-REGIONS OF THE GUADALUPE RIVER BASIN

Directions: use the clues in the chart above to label the Eco-Regions of the Guadalupe River Basin. Write the name of the Eco-Regions in the colored boxes below the drawings. Note that the color of the box matches the Eco-Region on the map.



LESSON 2: THE WATER CYCLE AND WATERSHEDS



EXERCISE 2-C: RIVER BASIN TIMELINE

The precious waters of the Guadalupe River Basin have been the focus of life and civilization for many, many years. Write the following dates in chronological order in the boxes near the drawings on the river/timeline.

65 million BC	1800's
10,000 BC	1900's
1500's	2000's
1700's	

Time Requirements:
1 - 1 1/2 hours

Social Studies TEKS:
5(A), 6(A), 6(B), 7(A), 8(A), 8(B), 8(C), 9(A), 9(B), 9(C), 12(A), 12(B), 12(C), 21(B), 21(C), 21(E)

Science TEKS:
1, 2(C), 7(C)

Language Arts TEKS:
1, 2(B), 13(B), 19, 29

Materials:
- Index card for each child
- Four cards with vocabulary words
- Various items associated with water
- Computer and projector
- Journey through the Gudalupe River Basin Story Map: https://arcg.is/1n5LLX

Objectives:
1. Students will identify four of the uses of water in the Guadalupe River Basin: municipal, industrial, agricultural, and recreational. *Note: These four water uses can be for groundwater or surface water.*
2. Students will list specific water users in their community.

Vocabulary:
Municipal -Treated water that is used every day in cities and towns. Water is piped into our homes, schools and businesses for daily needs. A person uses between 80-100 gallons per day (gpd) in their homes, and 165 gallons of water daily per capita.
Industrial - Water used to create or make a product.
Agricultural - Water used to grow crops and raise animals.
Recreational - Water used for fun.

Procedures:

A. Motivation Activity:
Display items associated with water. Ask students what the items have in common and how they are used. *Examples: beach ball, mask, snorkel, sprinkler, glass, etc.*

B. Index Card Activity:
1. Ask students to think about the many ways we use water. Use the questions below to generate a variety of responses that include all four uses of water.
   - Municipal – How do we use water every day?
   - Agricultural – Can you think of ways farmers and ranchers use water?
   - Recreational – How do you have fun in the water?
   - Industrial – How do industries (factories) use water? *Note: most students will not know industrial uses of water. Teacher may tell students some industrial uses, such as the generation of electricity, production of fabric, plastics, medicines and metals, etc.*
2. Distribute one index card to each student. Instruct students to write down one important use of water. Put aside to use later in the lesson.

C. Students read "Four Uses of Water," page 7 in student book.
Discussion questions:
- What is municipal water? *(water that is used by people in cities for various things)*
- What are some ways we use municipal water? *(cooking, laundry, drinking, bathing, flushing toilets, watering lawns & washing cars)*
- How much water is used for these activities? *(Note: gpd = gallons per day)(cooking 4 gpd, laundry 25 gpd, drinking 4 gpd, bathing 25-35 gpd, flushing toilet 30 - 40 gpd, and watering lawn 56 gpd)*
- Who uses industrial water? *(factories and industries)*
- What do industries use the water for? *(to make a product or for cooling equipment, machinery)*
- Who buys the products that are made in factories? *(ultimately, we do!)*
- What do we call water used to grow crops and raise animals? *(agricultural water)*
- What is water used for fun called? *(recreational water)*
- What are some examples of recreational water use? *(fishing, swimming, boating, water skiing, tubing, etc.)*
- Why do counties use water differently? *(they have different needs, depending on population size, location, and ways people earn a living)*
- How do we modify the environment in order to be able to use water for these various reasons? Discuss cost and infrastructures. *(We build dams and canals that change the natural flow of the river. We dig ditches in the ground and put in pipelines, we build water treatment plants, distribution systems, water towers and tanks, cooling facilities, etc.)*

Materials:
- Computer and Projector
- Devices i.e., Chromebooks, iPads, tablets.
- Student copies of *Puzzling Future*

D. Return to Index Card Activity.

1. Ask students to look at their individual responses on their index cards again, and think about what category of water use is shown on their card.
2. Tell students to hold up their card if their answer is a municipal use of water. Check for incorrect responses, and reteach if necessary. Continue in the same manner with the other three uses.
3. Using a bulletin board or chalkboard, have the children come to the front of the room individually to place their card in the correct column under the four vocabulary words, creating a bar graph.

E. Discussion of Specific Local Water Uses.

Challenge students to determine the main municipal, industrial, agricultural and recreational water users in their community or county. Listed below are examples of some of the types of businesses that pump water from the rivers. There are many other users who draw groundwater from wells who are not listed but may be applicable in your discussion.

Municipal - cities or water suppliers that have treatment plants/distribution systems that provide water to homes and businesses for use in drinking water, watering the lawn, washing clothes, washing dishes, bathing and showering.

Industrial - generation of electricity (hydroelectric plants, coal burning plants and natural gas burning plants; production of textiles, steel, bricks, chemicals, filters, plastics.)

Agricultural - pecans, hay, rice, row crops.

Recreational - tubing, canoeing, rafting, skiing, fishing and eco-tourism.

F. Journey Through the Guadalupe River Basin Story Map:

Using a computer and projector, show students the Journey Through the Guadalupe River Basin Story Map: https://arcg.is/1n5LLX. Students can also access it independently on devices. This is a very easy and interactive program. You navigate through the Story Map either by scrolling on the left side of the screen (the "story"), or clicking on the dots on the left. If you scroll on the right side of the screen, it will zoom in and out on the "map". The Story Map takes you from the headwaters of the river in Kerr County, and follows the river(s) all the way to the bay. There are several videos imbedded in the program - each county will have a Heritage Trail video, highlighting history and local culture. There is also a drone video of the Canyon Lake Gorge and videos about the Springs. To access a video, click on the red wording above the video image. To finish a video, you must PAUSE the video, then click on the back button.

G. Evaluation: Exercises 3-A and 3-B, student book p. 8

Before students complete the exercise, hold a class discussion on how using water from the rivers can modify the natural environment (use discussion points below). Correct the exercises as a class, using the answer key found in the teacher's guide p. 18.

Discussion Points:

- Pumping water from the rivers means there is less water in the rivers….. a lot of this water is re-introduced to the rivers after we have used it and cleaned it up again in wastewater treatment plants. (aka sewage treatment plants).
- Wastewater treatments plants are currently highly regulated and discharge clean water, but years ago the water that was reintroduced to the rivers was of very poor quality. Some critics think the treated wastewater standards should be more strict, saying that aquatic life can suffer downstream of the plants.
- When we pump water from the river for use, we typically have to build an infrastructure to support that use in the way of pumps, pipelines and water storage facilities. Land must be cleared, ditches dug, and pipes placed in the ditches and covered up again with dirt.
- Recreational water use can disturb the natural ecosystems of the rivers through the introduction of pollutants and trash.

H. Extension: *Puzzling Future*

Blackline master found on p. 19 in the teacher's guide. The answer key to the *Puzzling Future* is found on p. 20 in the teacher's guide.

LESSON 3: FOUR USES OF WATER

MUNICIPAL

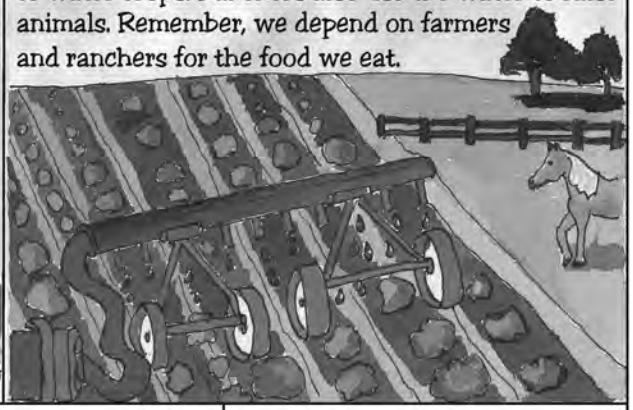
In the Guadalupe River Basin, some cities and towns pump water directly from the rivers. Others get their water from aquifers. First, the water is "treated" to remove dirt and bacteria. Then, it is piped into homes, schools, and businesses for drinking, cooking, cleaning, laundry, flushing toilets, baths and showers, watering lawns and washing cars.

INDUSTRIAL

Some factories and industries need large amounts of water to make a product. Special pipes bring water directly to them. This water is used to create electricity or to make plastics, textiles, metal products and many other items.

AGRICULTURAL

When there isn't enough rain, farmers use water from rivers and aquifers. Irrigation systems, like huge sprinklers on wheels, or long plastic pipes help to water crops. Ranchers also use the water to raise animals. Remember, we depend on farmers and ranchers for the food we eat.



RECREATIONAL

Swimming, boating, fishing, rafting, and tubing are all recreational uses of water. This is when we use the water just for fun.

Each county uses water differently. Your county's water needs depend upon its population, location, and how the people make a living. Some communities have large factories that use water for industry. Other communities have many farms and ranches that need it for agricultural uses. Recreation is an important business in some communities. But every county uses municipal water.

LESSON 3: FOUR USES OF WATER

EXERCISE 3-A

Directions: Circle the letter of the word that best completes each sentence. Then write the word in the blank.

EXAMPLE: Turtles can *hide* in their shells.
a) have parties b) fly c) hide

1. Agricultural water is used to grow crops and raise animals.
a) Recreational b) Agricultural c) Municipal

2. Industrial water is used to create or make a product.
a) Agricultural b) Municipal c) Industrial

3. Municipal water is treated water used by cities or for household use.
a) Municipal b) Agricultural c) Industrial

4. Recreational water is used just for fun.
a) Industrial b) Recreational c) Municipal

EXERCISE 3-B

Directions: Identify which type of water use each activity is by checking under the Municipal, Industrial, Agricultural or Recreational box. Then describe how humans had to modify the environment to get the water to the location for use.

Water Use activity	Municipal	Industrial	Agricultural	Recreational	How did we modify the environment to get the water for this activity?
Water used in a home for bathing	✓				Building pumps, treatment plants and pipelines.
Water used in an office bathroom	✓				Building pumps, treatment plants and pipelines.
Water used in restaurant's kitchen	✓				Building pumps, treatment plants and pipelines.
Water used to cool heavy machines		✓			Building pumps, treatment plants and pipelines.
Water used to irrigate crops			✓		Building pumps, ditches, irrigation devices
Water played in at a swimming pool				✓	Building pumps, treatment plants and pipelines.
Water in a tank for cattle to drink			✓		Building pumps and ponds.

_____Name

Puzzling Future

Help Edward rope up the answer to a mysterious challenge that we face in the future..... He is curious to find out more about our water, and what problems we face in coming decades. Help him figure out the biggest challenge facing the Guadalupe River Basin in the next 30 years!

Fill in the answers below with words from pages 3 and 7. Match the letter with the numbers on the lines at the bottom to solve this puzzle.

1. A body of water, such as a lake, that stores water.

1	12		12	1		9	11	1

2. Water used to create or make a product.

11	2	6	7		14	1	11	8	10

3. Treated water that is used every day in cities and towns - mostly for drinking water.

	7	2	11		11	5	8	10

4. The name of the river basin that you live in!

	7	8	6	8	10	7	5	12

5. The land area where rainfall runoff drains to a river.

3	8		11	2

6. Water use when farmers use water from rivers and aquifers when there is not enough rain.

8		1	11		7	10	14	7	1	8	10

Answer the puzzle:

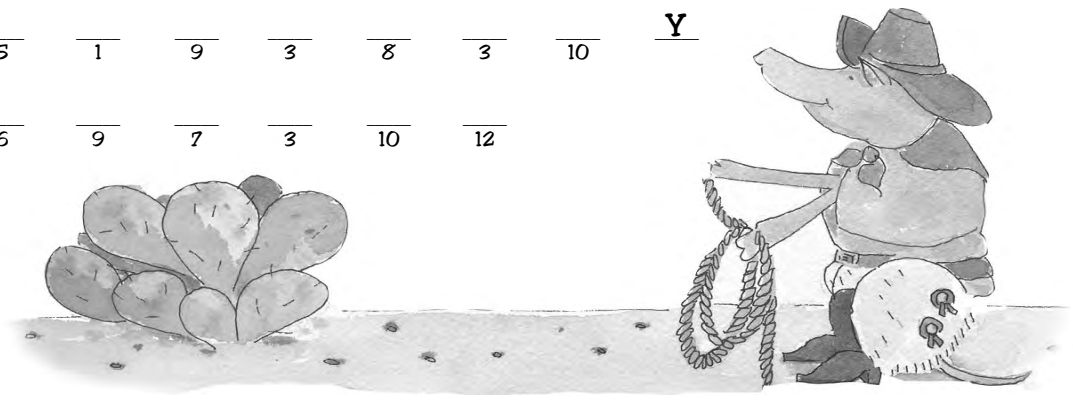
9	7	1

5	9	5	7	10	8	14	11	9	2

W			
	11	10	10

5	1	9	3	8	3	10	Y

6	9	7	3	10	12



TEACHER'S KEY

Puzzling Future

Help Edward rope up the answer to a mysterious challenge that we face in the future..... He is curious to find out more about our water, and what problems we face in coming decades. Help him figure out the biggest challenge facing the Guadalupe River Basin in the next 30 years!

Fill in the answers below with words from pages 3 and 7. Match the letter with the numbers on the lines at the bottom to solve this puzzle.

1. A body of water, such as a lake, that stores water.

R	E	S	E	R	V	O	I	R
1	12		12	1		9	11	1

2. Water used to create or make a product.

I	N	D	U	S	T	R	I	A	L
11	2	6	7		14	1	11	8	10

3. Treated water that is used every day in cities and towns - mostly for drinking water.

M	U	N	I	C	I	P	A	L
	7	2	11		11	5	8	10

4. The name of the river basin that you live in!

G	U	A	D	A	L	U	P	E
	7	8	6	8	10	7	5	12

5. The land area where rainfall runoff drains to a river.

B	A	S	I	N
3	8		11	2

6. Water use when farmers use water from rivers and aquifers when there is not enough rain.

A	G	R	I	C	U	L	T	U	R	A	L
8		1	11		7	10	14	7	1	8	10

Answer the puzzle:

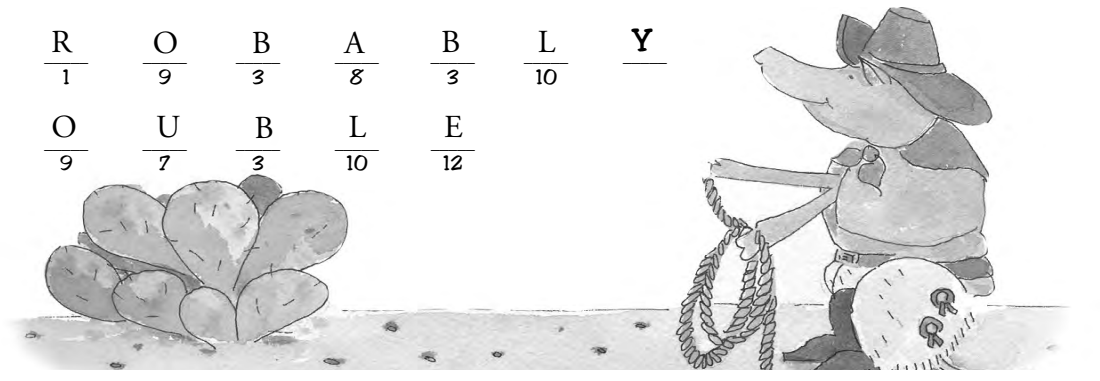
O	U	R
9	7	1

P	O	P	U	L	A	T	I	O	N
5	9	5	7	10	8	14	11	9	2

W	I	L	L
	11	10	10

P	R	O	B	A	B	L	Y
5	1	9	3	8	3	10	

D	O	U	B	L	E
6	9	7	3	10	12



Time Requirements:
1 - 1 1/2 hours

Social Studies TEKS:
5(A), 6(B), 7(B), 8(A), 8(C), 9(A), 9(B), 9(C), 21(B), 21 (C), 21(E)

Science TEKS:
3(B), 7(C)

Language Arts TEKS:
1, 2(B), 13(B), 16, 27, 29

Materials:
- Student Workbooks

Spring/Aquifer Model:
- Empty milk gallon or water container
- Gravel
- Duct tape
- Water
- Stopwatch
- Funnel
- Empty container or sink to catch water

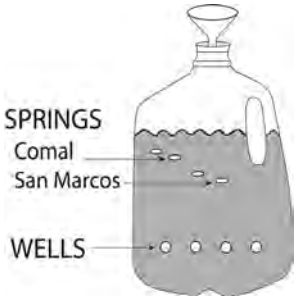
Objectives:
1. Students will explore the unique relationship between the Edwards Aquifer and the Guadalupe River Basin, and the importance of springflow to this relationship.
2. Students will learn how changes in the aquifer affect springflow.

Vocabulary:
Aquifer – An underground area of sand, gravel, or rock with spaces filled with water.
Percolates – The ability of water to seep through rock.
Recharge – When rainwater or runoff refills an aquifer.
Springs – Natural openings that bring water from underground to the surface.
Springflow – Water flowing through springs from an underground source.
Well – A hole drilled down into an aquifer.

Procedures:

A. Aquifer Springflow Model.

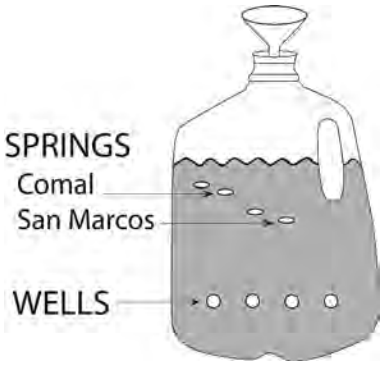
Note: Teacher will prepare the model ahead of time. Fill the jug with rocks or gravel to the middle of the handle - this represents the limestone of the Edwards Aquifer. Poke holes in milk jug, label with a waterproof marker, and place tape over the openings ***before*** *starting the activity with students.*



1. Tell students they are going to learn how the Edwards Aquifer is special. Ask if any students have heard of the Edwards Aquifer. Some students may have heard of the aquifer because of the aquifer level reading reported daily on the news stations in San Antonio.
2. Using the model, lead students in a discussion about aquifer springflow.
   - What is in an aquifer? *(sand, gravel, or rocks holding water underground)*
   - How does an aquifer fill with water? *(when it rains in the drainage area or the recharge zone, water enters the aquifer through percolation)*
3. Using a funnel, pour water into the model to represent water recharging into the aquifer.

B. Students read "The Importance of Springflow," student book page 9.

Discussion questions:
- How is the Edwards Aquifer different from other aquifers? *(Surface creeks, rivers and streams provide recharge to the aquifer. The most significant recharge streams are in the western part of the Hill Country, in Uvalde and Medina counties. Once the water enters the aquifer, it flows eastward fairly rapidly towards the large natural outlets of the Comal and San Marcos Springs. These springs are the largest springs in Texas, providing significant flow to the Guadalupe River.)*
- How does water get from underground in the aquifer to the surface in the Comal and San Marcos Rivers? *(through natural outlets called springs)*
- What is springflow? *(water flowing through springs from an underground source)*
- Where does the water in the Guadalupe, Comal and San Marcos Rivers come from? *(springflow and surface runoff from rainfall)*
- What is a well? *(a hole drilled down into an aquifer-a pump is placed on a well to pull up water to the surface)*
- What two things can make the aquifer level change? *(the amount of recharge [rainfall] and pumping from wells)*
- Why are the Comal and San Marcos Rivers special? *(they depend primarily on springflow - when there is little rainfall, springflow is down and the rivers could go dry)*
- How is it that the Guadalupe River is so dependent upon the Comal and San Marcos Springs? *(it relies upon springflow for a large percentage of its flow during periods of drought)*



C. Return to Aquifer Model.

1. Be sure the aquifer model is placed over a plastic bucket or sink. Ask one student to use a stopwatch to time how long it takes for water to stop coming out of the springs holes. At this point, remove the tape from the springs area in the model.

Discussion Questions:

- Where will this spring water go? *(it flows into rivers)*
- What do we call this water *(springflow)*
- What will happen if the water level drops below the springs? *(springs will stop flowing)*
- What would be needed to start springflow again? *(rainfall = recharge)*
- Challenge question: Besides lack of rain, what else makes the aquifer level go down? *(pumping)*
- Challenge question: There are numerous Endangered Species that are dependent upon the springs for their survival. What could happen to these species of the water level dropped below the springs? *(the Endangered Species could become extinct)*

2. Put tape back over the springs openings. Refill the model with water (recharge). Inform students that most wells reach deeper in the aquifer than the springs. Before removing tape, again ask one student to time how long it takes for water to stop coming out of the springs holes. Pull tape off of the springs area, **AND** remove tape from the area representing wells.

Discussion Questions:

- What effect do the wells have on springflow? *(wells can continue pumping even after springflow has stopped)*
- How will this affect the Comal and San Marcos rivers? *(with excessive pumping and no recharge, the springs could go dry - which means very little water for these two rivers!)*
- How much faster did the springs go dry when the wells were 'pumping'? *(refer to student with data for numbers)*
- Challenge question: If the springs went dry because of pumping and/or lack of rainfall, how would this affect the Guadalupe River? *(The Guadalupe River would contain a great deal LESS water)*
- Challenge question: Why is it important that we do what we can to prevent the springs from going dry? *(the Endangered Species could become extinct; and we humans would have a great deal LESS water for our needs)*

D. Closure - Teach Song: (to the tune of "I've Been Working on the Railroad")

I've been floating down the river *All the live-long day*
I've been floating down the river *Lupe and Edward have led the way*
Don't you hear the river rushing *The water is flowing through the springs*
Don't you hear the river rippling *Thank you rivers, for the water you bring!*

E. Extension Activity: Edwards Aquifer Close-Up.
Student reading: *Edwards Aquifer Close-Up. (Blackline master, p. 26* teacher's guide)

Discussion Questions:

- How many people rely on the Edwards Aquifer for their drinking water *(About 1.7 million people.)*
- Does this include you? *(Yes, - you use water from the river, and a lot of water in the Guadalupe River comes from the Edwards Aquifer.)*
- Where does Edwards Aquifer water emerge naturally at the surface? *(at the Comal Springs and the San Marcos Springs in the Guadalupe River Basin)*
- During a drought, how much of the water in the Guadalupe River comes from the Edwards Aquifer?*(almost 3/4 or 75% of the water)*
- What are the three areas of the Edwards Aquifer? *(Drainage, Recharge, and Artesian)*
- In what area does the water enter the Edwards Aquifer? *(the Recharge Zone)*
- What is another name for the Recharge Zone? *(the Balcones Fault Zone)*
- In what area is the water trapped underground where we drill wells to pull the water out? (*the Artesian Zone)*
- How would it affect you if the people using the Edwards Aquifer pumped too much water out, and the springs went dry? *(Answers will vary)*
- What is the largest city that depends on the Edwards Aquifer for its water supply? *(San Antonio)*
- Who are the "Downstream Users"? *(people, industries and agricultural users downstream of the springs - they are also dependent on the Edwards Aquifer)*

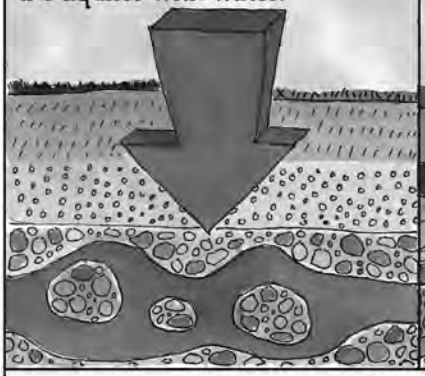
F. Evaluation: Exercises 4-A and 4-B, student workbook p. 10. The answer key is found in the teacher's guide, p. 25.

G. Enrichment Activities:

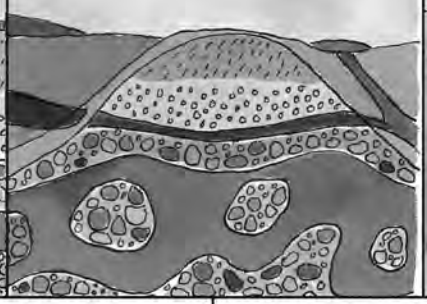
1. Writing Prompt - *Tell what happened to the people and animals on the day the springs went dry.*
2. Plan a field trip to the springs, rivers or a reservoir.
3. If you live in an area where the aquifer level is reported on the television or radio weather programs, have students keep track of the aquifer levels on a line graph.
4. Invite a guest speaker from GBRA to tell more about the importance of springflow to the rivers.
5. Divide class into small groups (three or four people). Students then write a commercial (1 - 2 minutes) to promote the importance of springflow to the rivers. Students may then present them to a class (or cooperating class). Teacher may videotape and play back.

LESSON 4: THE IMPORTANCE OF SPRINGFLOW

1 An aquifer is an underground area of sand, gravel or rock where spaces are filled with water. Surface runoff percolates (seeps) through the ground to fill the aquifer with water.

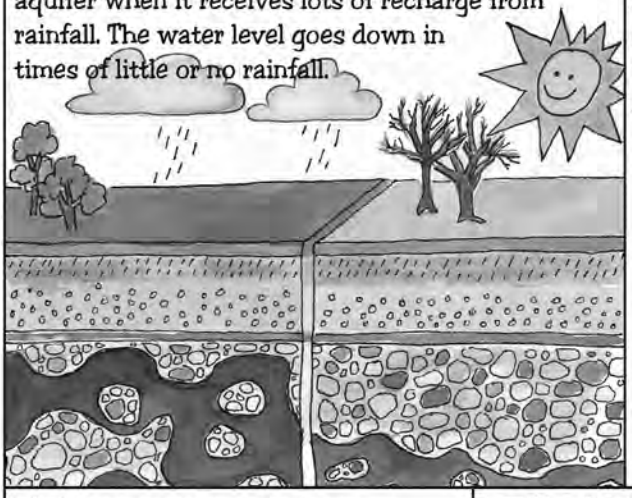


2 The Edwards Aquifer is the largest and most important aquifer in central Texas. When it rains in the Hill Country, hundreds of creeks, streams and even large rivers help to recharge (refill) the Edwards Aquifer.



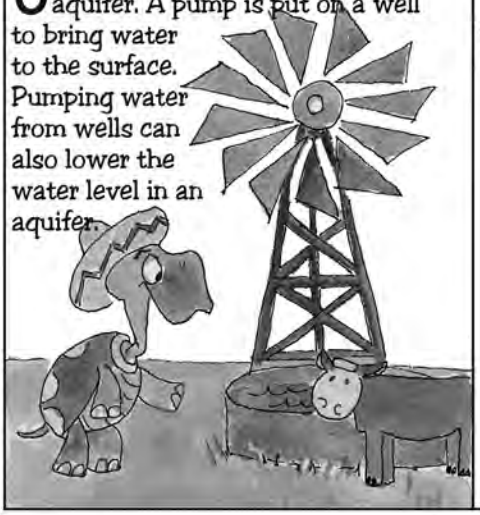
3 Some of the water that percolates into the Edwards Aquifer comes out at the surface through natural openings called springs. This 'springflow' supplies much of the water in the Comal, San Marcos and Guadalupe Rivers.

4 The amount of springflow depends on how full the aquifer is. There is more water in the aquifer when it receives lots of recharge from rainfall. The water level goes down in times of little or no rainfall.

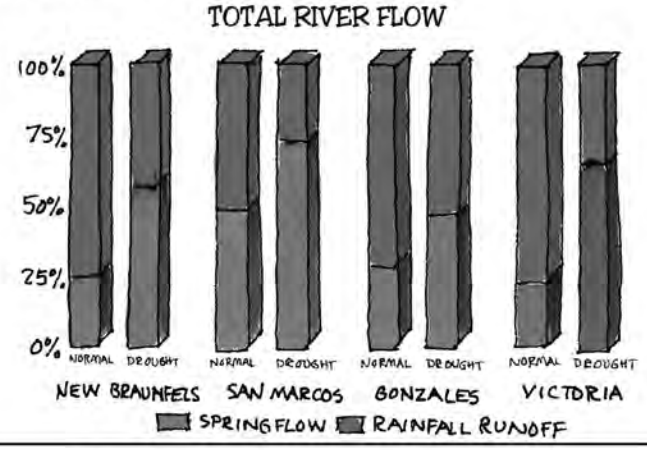


5 In the Guadalupe River Basin, some municipal, industrial and agricultural users get their water supply from aquifers such as the Trinity, Edwards, Carrizo-Wilcox, and Gulf Coast. Others rely on runoff from rainfall into streams. In the Guadalupe River Basin, you may rely on both.

6 A well is a hole drilled into an aquifer. A pump is put on a well to bring water to the surface. Pumping water from wells can also lower the water level in an aquifer.



7 The Guadalupe and San Marcos Rivers are special because they depend mainly on springflow when there is little rainfall in the watershed.



LESSON 4: THE IMPORTANCE OF SPRINGFLOW

EXERCISE 4-A: SPRINGFLOW VOCABULARY

Directions: Circle the letter of the word that best completes each sentence. Then fill in the blank.

1. A ___spring___ is a natural opening that brings water from underground to the surface.
   (a.) spring b. springflow c. well

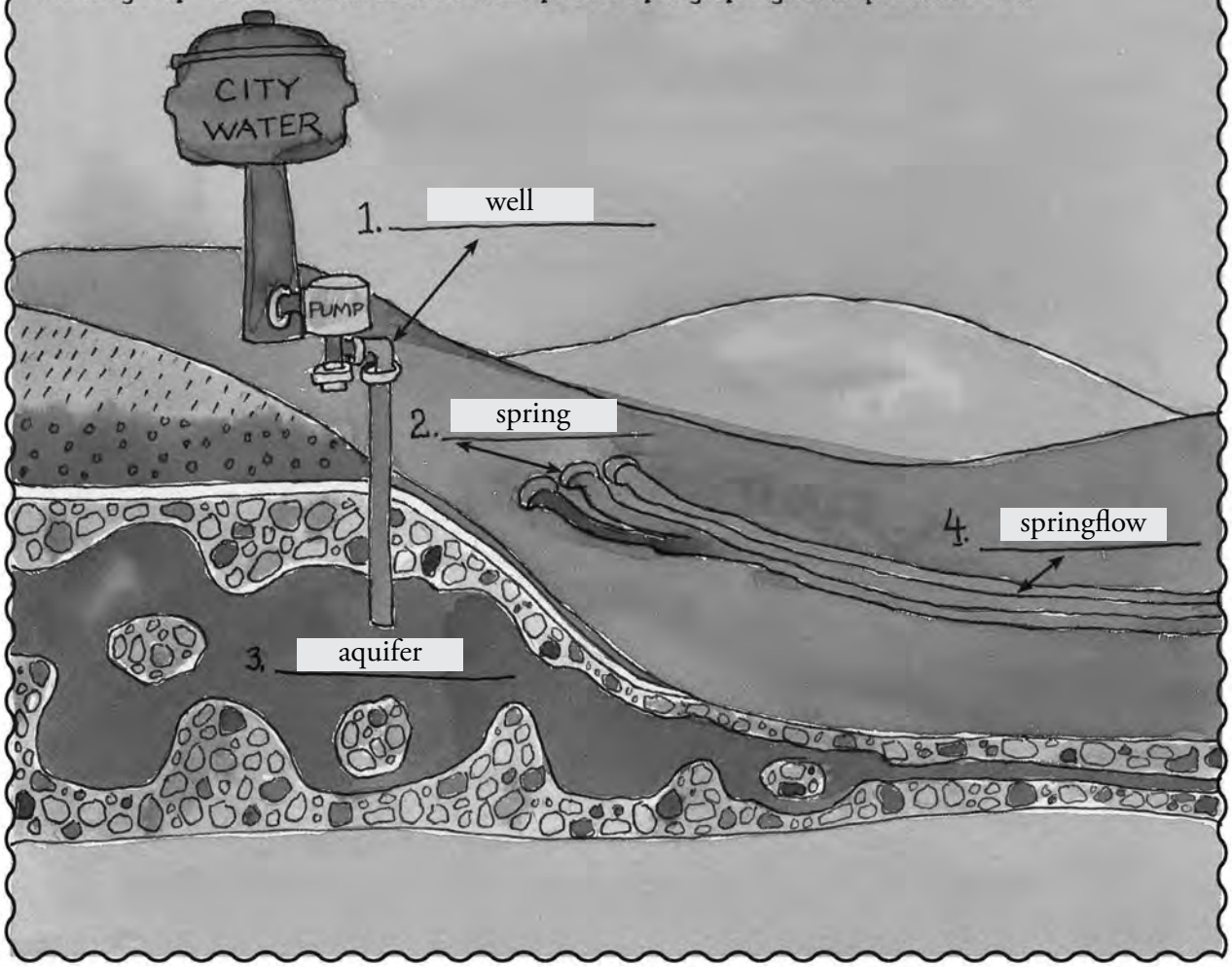
2. A(n) ___aquifer___ is an underground area of sand, gravel or rock where spaces are filled with water.
   a. well (b.) aquifer c. spring

3. A(n) ___well___ is a hole drilled into an aquifer to bring water to the surface.
   a. spring b. aquifer (c.) well

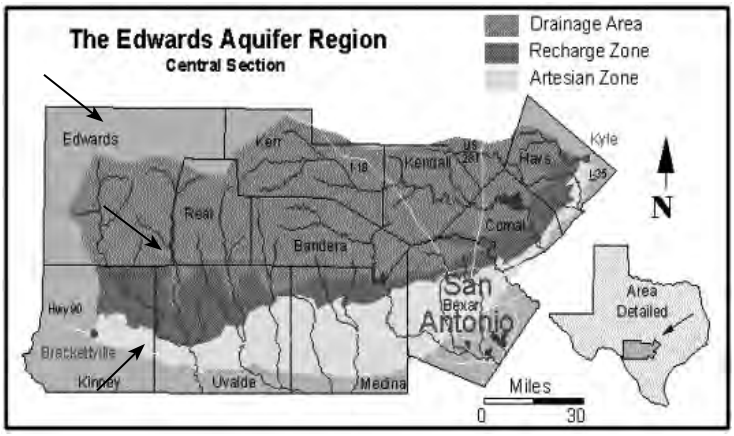
4. ___springflow___ is water flowing through springs from an underground source.
   a. well (b.) springflow c. aquifer.

EXERCISE 4-B:

Labeling Map - Use these words to label the picture: spring, springflow, aquifer, and well.



Edwards Aquifer Close-Up



Most of you use surface water from the Guadalupe River for your needs. But you rely on groundwater as well. You may not realize it, but the Edwards Aquifer is very important to you and the Guadalupe River. The Edwards Aquifer is one of the best-known aquifers in the nation. It is a plentiful aquifer that supplies water to over 1.7 million people, including you!

One of the things that make it so famous is the natural springs where water leaves the aquifer. The Comal Springs in New Braunfels are the largest springs in the state of Texas. The San Marcos Springs are the second largest springs. Eventually, all of the water that leaves the aquifer from these two sets of springs ends up in the Guadalupe River. The Comal Springs feed the Comal River, which joins up with the Guadalupe River in New Braunfels. The San Marcos Springs feed the San Marcos River, which joins up with the Guadalupe River in Gonzales.

So, you do rely on the aquifer -- even without realizing it! If water levels in the aquifer go down, the springs could dry up. This would mean less water in the river for your community and its needs. Scientists say that during a drought, almost 75% of the water in the Guadalupe River comes from the springs.

It is important that we learn as much about the Edwards Aquifer as we can. We should start by understanding where the aquifer is located, and how it works.

The Edwards Aquifer is 176 miles long. It starts in the west at the town of Brackettville in Kinney County. It continues east to the town of Kyle in Hays County. Altogether, the artesian aquifer underlies six counties in Texas. There are three major areas within the aquifer region -- The Drainage Area, the Recharge Zone, and the Artesian (Reservoir) Area.

The Drainage Area is located on the Edwards Plateau and is commonly known as the "Texas Hill Country." Many rivers and streams start up in this area. The rivers fill up when it rains and then flow south into the Recharge Zone.

The Recharge Zone is also known as the Balcones Fault Zone. The permeable Edwards Limestone is at the surface in the Recharge Zone, and then stair-steps down underground. Water flowing from the Drainage Area enters the Recharge Zone and percolates down through the exposed limestone, entering the Artesian Area.

The Artesian (Reservoir) Area is where the Edwards Limestone is underground, confined between two layers of impermeable rock. Since the limestone is confined, the water is under pressure. Natural springs push water out of the aquifer. In addition, many wells have been drilled into the Artesian Area. These wells provide most of the water for the city of San Antonio and the surrounding region. The country between the Texas coast and the springs also depends on Edwards Aquifer water. This region and the people living in it are often called "Downstream Users."

Remember - even though you don't live in the Artesian Area of the Edwards Aquifer, you do rely on it for some of your water supply. From the springs southward, there are hundreds of thousands of people and jobs that depend on water from the Edwards Aquifer.

Time Requirements:
2 hours

Social Studies TEKS:
5(A), 7(A), 8(A), 9(A), 9(B), 9(C), 21(B), 21(C), 21(E)

Science TEKS:
2(C), 2(F), 3(B), 7(C)

Language Arts TEKS:
1, 2(B), 13(A), 16, 29

Materials:
- Student Workbooks
- Student copies of *Pollution Isn't Always as Clear as it Seems;* blackline found in teacher's guide p. 30, and the answer key is on p. 31

Objectives:
1. Students will identify the differences between point source and nonpoint source pollution.
2. Students will list and describe three main types of surface water pollution.
3. Students will classify contributors to the three types of surface water pollution.

Vocabulary:
Point Source Pollution - pollution that can be traced to a single point source, such as a pipe or culvert (for example: industrial and wastewater treatment plant discharges).
Nonpoint Source Pollution - pollution that cannot be traced to a single point, because it comes from many places or a widespread area (for example: urban runoff or agricultural runoff).
Nutrient Water Pollution - an unhealthy abundance of elements or compounds that stimulate plant growth (for example: nitrogen, phosphorus, and potassium).
Toxic Water Pollution - harmful, chemical contamination in water.
Bacterial Water Pollution - pollution that comes from human and animal waste.

Procedures:

A. Read aloud Sections 1-3, Lesson 5: Water Quality (p. 11 in student workbook). Discuss point-source pollution and non-point source pollution.

Discussion questions:
- What is pollution? *(answers will vary)*
- What is pointsource pollution? *(pointsource pollution is pollution that can be traced back to a single origin, or point, such as a pipe)*
- What is nonpoint source pollution? *(pollution that cannot be traced to a single point, or origin, because it comes from many different places)*
- What are some examples of the many different places that nonpoint source pollution can come from? *(examples include runoff from streets, parking lots, yards, agricultural runoff, etc.)*
- True or False: Nonpoint source pollution is a direct result of everyday land use activities. (*True)*

B. Instruct students to complete Exercise 5-A, student workbook p. 11.
The answer key is found in the teacher's guide p. 29.

C. Supplemental Reading: *Pollution Isn't Always as Clear as it Seems*
The blackline master is found in the teacher's guide p. 30 and the answer key is found on p. 31. Put students into pairs to decode the reading. Pass out one worksheet for every pair. Give students 10 minutes to decode the reading. While students are working, list the six situations below on the chalkboard, (minus the answers in italics). When students are finished with the activity, read aloud and discuss the reading. To reinforce the reading, read aloud one item at a time from the list on the chalkboard, and have students discuss to determine whether these are examples of point source or nonpoint source pollution.

- Factory with discharge pipe into river *(Point Source)*
- Corn, cotton, and bean fields within the river's watershed *(Nonpoint Source)*
- Parking lot at mall within 2 miles of river *(Nonpoint Source)*
- Subdivision on river's edge *(Nonpoint Source)*
- Old leaking septic tanks located on river's edge *(Nonpoint Source)*
- Leaking gasoline storage tank *(Point Source)*

- Bill Bass cards, laminated and in sets

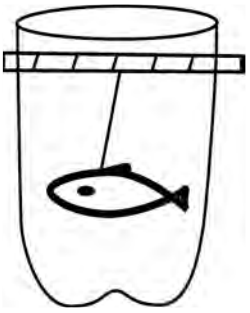
Bill Bass Model Materials:

- Large soda bottle (2 liter), top cut off
- Sponge cut into the shape of a fish (~ 2 inches). Add a weight to it to hold it down in the water.
- String
- Ruler
- Small containers, such as baby food jars
- Yellow and red food coloring
- Soil (represents bacterial pollution)
- Paper scraps
- Brown sugar (represents nutrient pollution)
- One gallon of clean water
- Molasses (represents petroleum byproducts toxic pollution)
- Detergent (represents nutrient pollution)

D. Read aloud Sections 4-6, Lesson 5: Water Quality (p. 12 in student workbook). Introduce *Surface Water Pollutants* (Bacterial, Toxic, Nutrient), and use the discussion points below to help students understand WHY these pollutants could be a problem. Have students brainstorm about different things that contribute to the three pollutants.

Discussion points:

- What kinds of challenges would the municipal water treatment plants have if the water they pulled from the river had large amounts of pollution? *(It would be much more difficult for them to treat the water to make it clean enough for human consumption.)*
- How would agricultural water users be affected if the river water had high levels of toxins? *(The water used for irrigation could harm the crops and animals.)*
- Could high levels of bacteria or toxins affect recreational water users? *(Yes – if bacteria or toxin levels are too high, the river would be designated as unfit for swimming and eating fish caught in the river would be discouraged.)*
- How could high nutrient levels hurt the aquatic life that lives in the river? *(Algae blooms could take place, which may result in the death of aquatic life due to lack of oxygen.)*



E. Bill Bass' Guadalupe Adventure.

1. With students still in pairs, pass out baggies containing the Bill Bass activity cards. Instruct students to shuffle the 12 square cards. Students will then sort the seven smaller rectangular cards with letters into two stacks (one for WWTP and one for NPS), and place to the side. (Blackline master for cards is found on teacher's guide p. 33)
2. Inform students that they will listen as you read aloud a story about Bill Bass. Read aloud the Bill Bass story from p. 32 in the teacher's guide. (Leave out the instructions in bold!)
3. Listening carefully to the story, students will study the illustrations on their cards for clues, and put them in chronological order to visually portray the story of Bill Bass. They are making a 'storyboard' of Bill's adventures. *(Note: be sure to familiarize yourself with the drawings, so that you can place emphasis on some of the words on each drawing to assist students.)*
4. After the story, students will determine where a wastewater treatment plant was used to clean up water that discharged, thus preventing point source pollution, and place the corresponding rectangular cards in those places. Students will also determine where non-point source is occurring, and place the corresponding cards in the proper places.
5. Following the teacher's supervision, pick students to 'act' out the story with a container of water (representing the river) and a sponge fish hanging from a string into the water. *(Use materials listed at left for pollutants.)* After each passage is read aloud, different students can come up and add the 'pollutants' to the water as the story progresses.

F. Evaluation: Students complete Exercise 5-B, student workbook p. 12. The answer key is found in the teacher's guide p. 34.

G. Enrichment Activities:

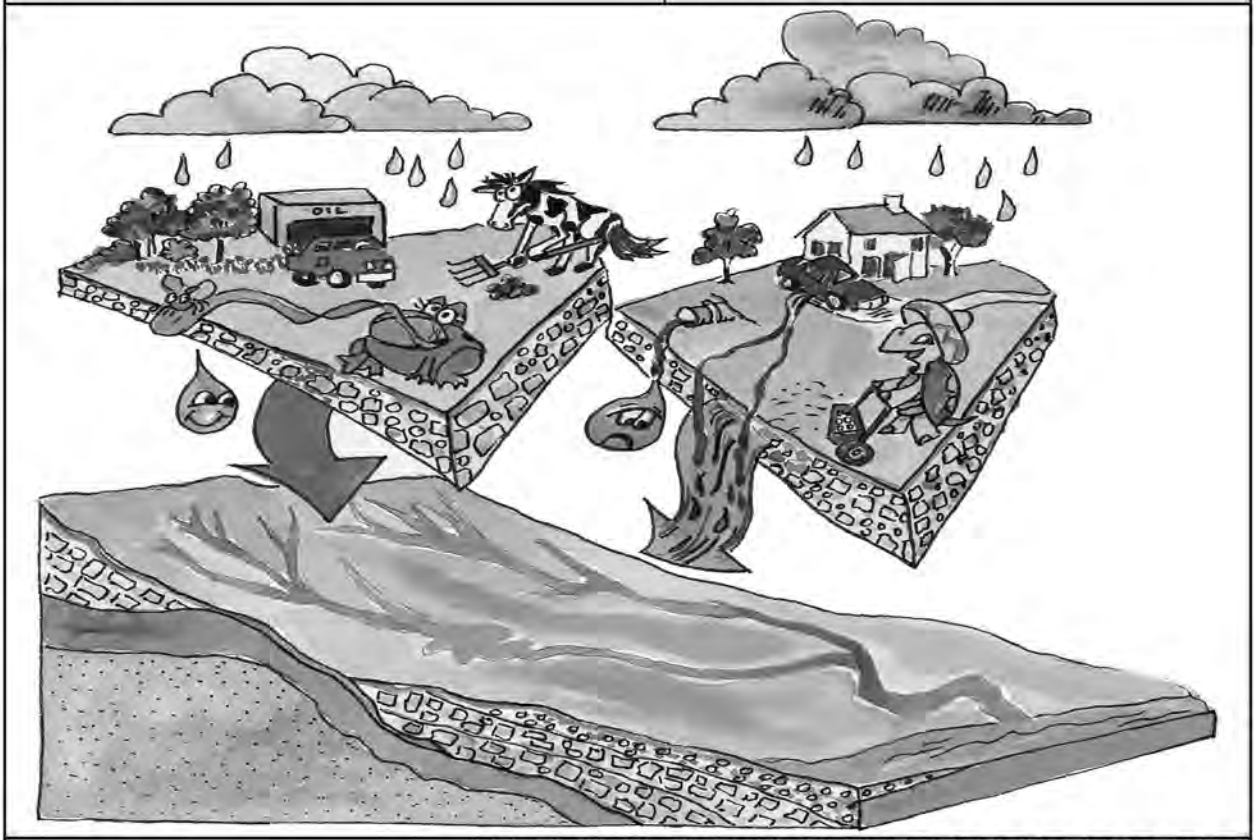
1. Writing Prompt – *Write a story about what happened to a family when they arrived at a river park on a summer day for swimming and found a sign that said there were high bacterial levels in the river .*
2. Schedule a field trip to your community's drinking water treatment plant.
3. Invite an expert from GBRA or another agency to come talk to the class about water quality.

LESSON 5: WATER QUALITY

1 As we learned in Lesson 4, we use water for many different reasons. Sometimes when we USE water, we MISUSE it and can damage our environment. A few decades ago water pollution was a severe problem because of something called Point Source Pollution, which was mostly due to industrial users. Now that the industrial users have "cleaned up their act," we are more concerned about something called Non-Point Source Pollution.....which is mostly due to you and me!

2 Point Source Pollution -- pollution that can be traced to a single point source, such as a pipe or culvert (for example: industrial and wastewater treatment plant discharges).

Nonpoint Source Pollution -- pollution that cannot be traced to a single point, because it comes from many places or a widespread area (for example: urban runoff or agricultural runoff).



3 On the diagram above, you can see that there are two different scenarios taking place. Remember that non-point source pollution means that there is no single person or source to blame for the pollution.... it is all of us! Non-point source pollution is simply the result of things that we do outside everyday, such as using chemicals in our yards or littering. Simple activities such as changing the oil in our cars can be bad for the environment if we make the wrong choices about disposal of the wastes.

EXERCISE 5-A

Directions: Use the diagram above to identify the choices made for the activities as good or bad for the environment. Circle Good or Bad after the sentences.

1. Clearing of animal wastes ..... (Good) Bad
2. Taking a vehicle to a business for an oil change that properly disposes of the oil..... (Good) Bad
3. Changing the oil in your vehicle and dumping the used oil on the ground..... Good (Bad)
4. Using chemicals on the lawn..... Good (Bad)
5. Using organic or natural pest control..... (Good) Bad
6. Not taking care of a leaking septic tank..... Good (Bad)

_____Name

Pollution Isn't Always as Clear as it Seems

Directions: Use the drawings at the bottom of the page to decode the reading. After you find the drawing, write the word in the blank. You will use some of the words more than once. After you fill in the blank, read the sentence aloud to make sure it makes sense.

No one wants pollution in the Guadalupe River Basin. But, understanding pollution isn't as clear as it may seem. What we think is pollution may not be harmful, and what looks okay can sometimes be bad. To make it easy, let's discuss two types of pollution: point source pollution, and nonpoint source pollution.

A  _____ that pours toxic  _____ on the ground or in the water would be uncontrolled point source  _____, because we can easily "point" to or  _____ the source and  _____ the problem. Point source pollution is regulated by the Texas Commission on Environmental Quality and monitored by the Guadalupe-Blanco River Authority. Because costly  _____ are charged to people and companies that violate their permits by polluting, it doesn't happen very often. When it does, we can find the  _____ source and  _____ it quickly. Point source pollution is not a big problem in the Guadalupe River Basin because the river is very well-managed. Cities, factories and wastewater treatment plants are examples of permit holders that must clean the water they use before piping it back into the river. Many times, the water they discharge is cleaner than the water they originally used!

Nonpoint source pollution gets its name because it is almost impossible to  _____ the "point" where it begins. It is a result of our everyday activities. For example, if we  _____ the runoff from  _____ as it moves across the ground, we find that it often picks up leftover fertilizers and pesticides on peoples' lawns. These  _____, as well as oil, grease and other pollutants from  _____ and parking lots are a big part of nonpoint source pollution. Covering up natural land with paved  _____ _____, sidewalks, parking lots and  _____ can make runoff water dirty with  _____. These paved areas also remove the natural soil and plants that normally filter some of the  _____ from runoff water before it enters the river.

 pollution

 identify

 pipe

 chemicals

 fines

 examine

 buildings

 streets

 rainfall

 fix

TEACHER'S KEY

Pollution Isn't Always as Clear as it Seems

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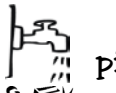
Nonpoint source pollution gets its name because it is almost impossible to  identify the "point" where it begins. It is a result of our everyday activities. For example, if we  examine the runoff from  rainfall as it moves across the ground, we find that it often picks up leftover fertilizers and pesticides on peoples' lawns. These  chemicals, as well as oil, grease and other pollutants from  streets and parking lots are a big part of nonpoint source pollution. Covering up natural land with paved  streets, sidewalks, parking lots and  buildings can make runoff water dirty with  chemicals. These paved areas also remove the natural soil and plants that normally filter some of the  pollution from runoff water before it enters the river.

 pollution

 identify

 pipe

 chemicals

 fines

 examine

 buildings

 streets

 rainfall

 fix

Bill Bass' Guadalupe Adventure

1. Bill Bass was born in the Texas state fish hatchery in San Marcos. He lived there in a controlled environment for months. The tank was very clean and he was well-fed.
2. One day Bill Bass was loaded into a large truck with his friends. They were taken to the Guadalupe River below Canyon Lake. Bill Bass was very happy - he had never felt so much freedom! And there were lots of new things to eat.
3. Bill Bass realizes he is going on an adventure downstream when he goes tubing towards New Braunfels, where he meets lots of tourists tubing down the river.
4. Bill Bass swims into ranching country. It begins to rain, and soil and animal waste from nearby goat ranches erodes into the river. Bill Bass has difficulty dealing with the bacteria and extra soil in the water. (NPS)

   Pour soil into the water
   Pour clean water into the water (rain)

5. Bill Bass enters an area of the river where there are homes along the river. Most of these homes have septic tanks. Unknowingly, a few of the septic tanks leak. Bill Bass now has to deal with more bacteria. (NPS)

   Squirt a little yellow food coloring into the water

6. Bill Bass swims further downriver past a large housing development. Many of the homeowners 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. Bill Bass has trouble breathing - there is not enough oxygen! (NPS)

   Sprinkle brown sugar into the water
   Pour clean water into the river (rain)

7. Bill Bass makes it past the subdivision, and enters a stretch of the river where a city pumps water out of the river for their drinking water, and for other uses in their homes. After people use the water, it is cleaned by a wastewater treatment plant and returned to the river. (potential PSP- regulated by a Wastewater Treatment Plant)

   Pour clean water into the water

8. Bill Bass swims further downstream, and enters farming country. The farmers have problems with insects and have applied pesticides to their crops. As it begins to rain, Bill Bass now has to deal with toxic pollution. (NPS)

   Squirt a little red food coloring into the water
   Pour clean water into the river (rain)

9. Bill Bass 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 toxic pollution! Bill Bass temporarily feels a little weak. (NPS)

   Pour molasses into the water

10. Bill Bass swims past a state park. Some holiday picnickers didn't 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. More bacterial and nutrient problems to deal with! Bill Bass is feeling queasy again, until it starts to rain. (PSP)

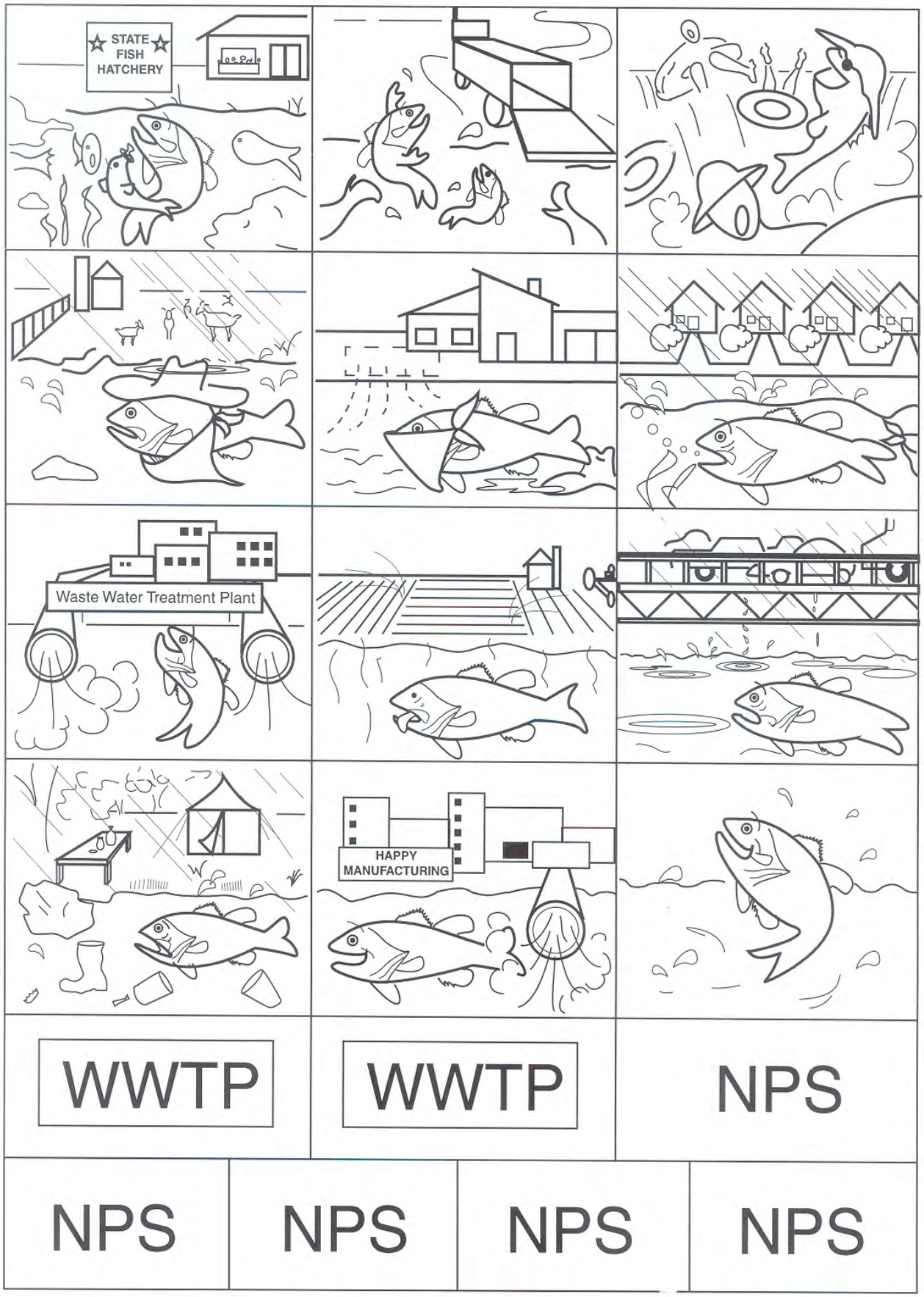
    Drop small pieces of shredded paper and some detergent into the water
    Pour clean water into the river (rain)

11. Bill Bass is almost all the way down the river. He passes by several factories. Some of the factories are discharging clean water into the river. State regulations keep industrial sites from polluting the river. This prevents more toxic pollution. One concern, though, is the temperature of the discharged water. Sometimes it is very warm, which can affect aquatic life.(potential PSP- regulated by a Wastewater Treatment Plant)

    Pour clean water into the water

12. Bill Bass swims down the pleasant Guadalupe River living a healthy life.

Bill Bass Cards



LESSON 5: WATER QUALITY

4 Bacterial Pollution comes from human and animal wastes. Sometimes, lakes are closed to swimmers because of high counts of fecal coliform bacteria from raw sewage (human waste) and feedlot runoff that makes its way into rivers and streams that empty into lakes. Coliform bacteria itself is not harmful, but it usually indicates that pathogens (disease-causing organisms) are present.

5 Toxic Pollution is the presence of poisonous chemicals in water. Toxic pollution can come from point sources, such as industrial discharges or accidents in transportation (such as oil spills, train derailments or truck wrecks on highways). It can also come from nonpoint sources such as runoff from urban areas, as well as fallout from the atmosphere (acid rain).

6 Nutrient Pollution comes from fertilizers. Although plants need nutrients for growth, if there is too much nitrogen and phosphorous in water then algae and other aquatic plants grow. This uncontrolled growth in water means that more plants die and decay, using up the oxygen dissolved in the water. When this happens fish and other aquatic life can die.

EXERCISE 5-B

First, match the picture to the pollution description by putting the number in the box. Second, classify pollutants as nonpoint or point. Then classify pollutants as bacterial, toxic or nutrient.

1


2

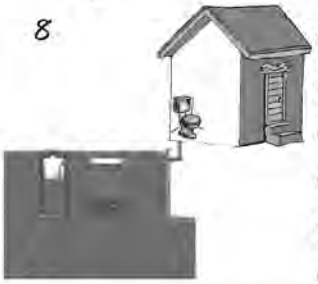

3


4


5


6


7


8


Picture number?	Pollution Description	Point Source	Nonpoint Source	Bacterial	Toxic	Nutrient
6	Animal Waste (Ranches)		✓	✓		
8	Human Waste (Leaking Septic Tanks)		✓	✓		
2	Human Waste (Poorly Operated Wastewater Treatment Plant)	✓		✓		
3	Fertilizers (Lawns and Farms)		✓			✓
1	Pesticides (Lawns and Farms)		✓		✓	
5	Petroleum Byproducts (Automobiles Leaking or Improper Disposal)		✓		✓	
7	Improper Disposal of Trash by People		✓		✓	
4	Chemical Waste (Factories)	✓			✓	

Time Requirements:
1 hour

Social Studies TEKS:
5(A), 12(C), 21(B), 21(C), 21(E)

Science TEKS:
2(C), 7(C), 10(A)

Language Arts TEKS:
1, 2(B), 19, 29

Materials:
- Character cards copied onto construction paper or regular paper then laminated; or cardstock cut apart into individual cards. *(Blackline master in teacher's guide pp. 38-40)*

Objectives:
1. Students will review the four water uses.
2. Students will identify the difference between regulated and non-regulated water.
3. Students will understand the importance of water regulation.
4. Students will identify the priorities for water usage.
5. Students will identify the Endangered Species that are dependent upon pumping regulations.

Vocabulary:
Regulation - a rule.
Surface water - water in rivers, lakes or streams.
Groundwater - water that percolates or flows underground.
Permit - written permission.
Endangered Species - plant and animal species that are in danger of becoming extinct.

Procedures:

A. "Little Springs" Activity

1. Introduce the fictitious city of Little Springs: "Imagine a city on the banks of a river - Little Springs, Texas. Little Springs is a happy, growing city with homes, schools, businesses, churches, factories, farms, and ranches. It is probably much like where you live. Most people in Little Springs depend on the city for their water. The city has a permit to pump water from the river, purify it at their water treatment plant, and deliver it to homes and businesses. Not everyone gets their water from the city -- some people in Little Springs use wells. Today, I am going to ask you to pretend that you are a citizen of Little Springs."

2. Distribute character cards. Ask students to think about what kind of water user their character represents. Instruct students to stand up and introduce their character to the class, including what type of water user they are. *(Give choices: Municipal, Industrial, Agricultural, Recreational.)*

3. Discuss the following to evaluate rights to water use in the town:
   - Who has the right to the water? *(everyone should raise their hand)*
   - Why does your character have that right? *(answers will vary)*
   - Point out that all of the characters have a valid right to use water. However, because of occasional water shortages the state has to determine what uses are most important.

B. Students read "Water Regulation," page 13 in student book. Tell students they will now learn what the law says about water rights.

Discussion questions:
- Who decides who can use surface water? *(the Texas Commission on Environmental Quality)*
- What is regulation? *(a rule)*
- What is surface water? *(water that is on the surface of the ground such as water in rivers, lakes, and streams)*
- What is groundwater? *(water that percolates, flows, or is stored underground)*
- What is a permit? *(written permission)*
- Is a permit required to use surface water? *(yes)*
- Who can use surface water without a permit? *(people who live next to the river and take the water only for personal use)*
- Do you need a permit to pump water from a well drilled into the Edwards Aquifer? *(Yes - since 1996, the Edwards Aquifer is strictly regulated. Only household wells are exempt.)*
- Do you need a permit to pump water from a well in other aquifers in Texas ? *(Most groundwater is non-regulated, with the exception of the Edwards Aquifer. Some other aquifers are partially regulated through county or multi-county groundwater conservation districts. For the most part, all household and livestock wells are exempt from pumping restrictions.)*

Materials:

- USB Drive with *Endangered Species of the Guadalupe River Basin* Power Point
- Computer and projector
- Student copies of *Who Am I* (blackline master p. 43)
- Student copies of *Crossword Puzzle,* blackline master found in teacher's guide pp. 45

C. Elaboration - "Little Springs" Activity

1. Identify who should have the right to the water first. *(In priority order: municipal cards #1-8, industrial cards #9-15, agricultural cards #16-23, and recreational users' cards #24-30.)*
2. Identify the characters that required a permit before water could be pumped from the river (or Edwards Aquifer). Then, identify the users who do not need permits. *The city needs a permit to take water from the river. This water is then treated and piped to homes and businesses. Factories and electric plants that use large amounts of water also need a permit.*

   Therefore, all municipal users (#1-8) and industrial users' (#9-15) use "permitted" water. Agricultural users #16, 17, 18, 19, 20, 21, 22, and 23 also need permits because they use water for commercial agricultural production. None of the recreational users (#24-30) need permits as long as the water is not diverted for other uses.

D. Extension Activities:

1. There are two ways students can explore the Endangered Species in the river basin. There is a PowerPoint titled Endangered Species of the Guadalupe River Basin on the USB drive. The teacher could present this to the class as whole, or provide it to individual students to explore on their own. This will introduce students to the Endangered Species that are dependent upon Springflow for their survival. The outline for the presentation is found on pp. 41-42 in the teacher's guide. The second way students can explore Endangered Species is through the Story Map. The PowerPoint as a movie is embedded in the Story Map, in the sections about Comal County and Hays County.

2. To reinforce their learning, consider having students complete the worksheet *Who Am I?* while they are watching the presentation. The blackline master is found in the teacher's guide p. 43, and the answer key is on p. 44.

   Note: The topic of Endangered Species is approached in this lesson because of the pumping regulations that are in place for the Edwards Aquifer. These pumping restrictions are designed to protect the species by ensuring springflow from the Comal Springs and the San Marcos Springs. All of these species are entirely dependent upon springflow for their survival – without the springflow, their habitat would cease to exist, as they are not found anywhere else on the planet. Some of the species are subterranean species (these live underground in the aquifer itself), some are river species (these live in the springfed rivers), and there is one coastal specie (that is dependent upon downstream flow from the springfed rivers).

E. Evaluation - Crossword Puzzle.

The blackline master is found in the teacher's guide. p. 45, and the answer key is found on p. 46.

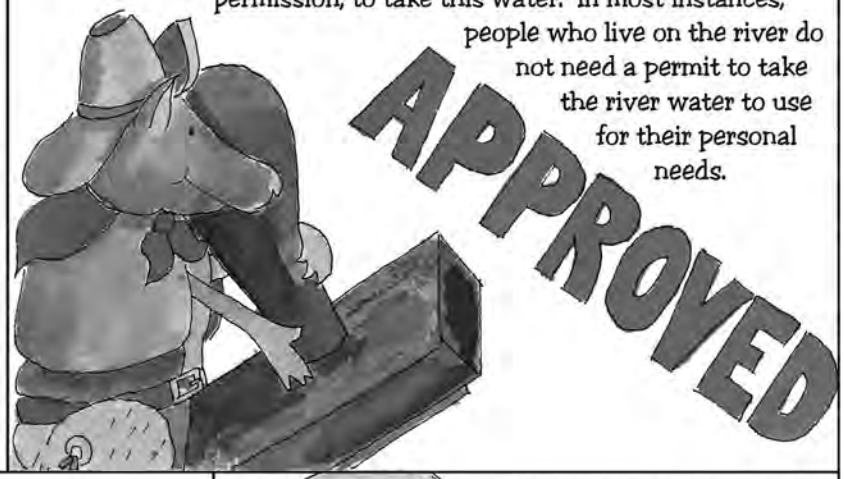
F. Enrichment Activity:

Writing Prompt: *Write a composition that persuades people to use less water so we can save the Texas Blind Salamander.*

LESSON 6: WATER REGULATION

1 All people in the Guadalupe River Basin need water. To make sure everyone has water, the State of Texas has made regulations, or rules, to decide who can use the water.

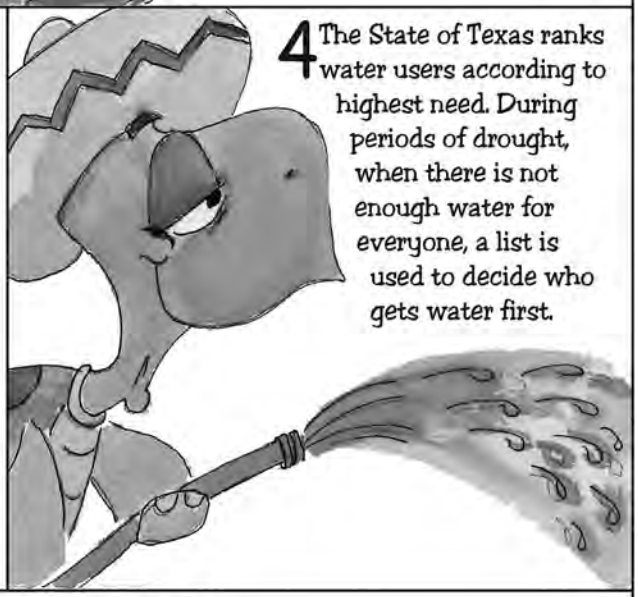
2 Surface water -- or water in rivers, lakes and streams -- is regulated. This means that you must have a permit, or written permission, to take this water. In most instances, people who live on the river do not need a permit to take the river water to use for their personal needs.



3 In some parts of Texas, groundwater is not regulated. Anyone can drill a well and pump water. No permit is needed.

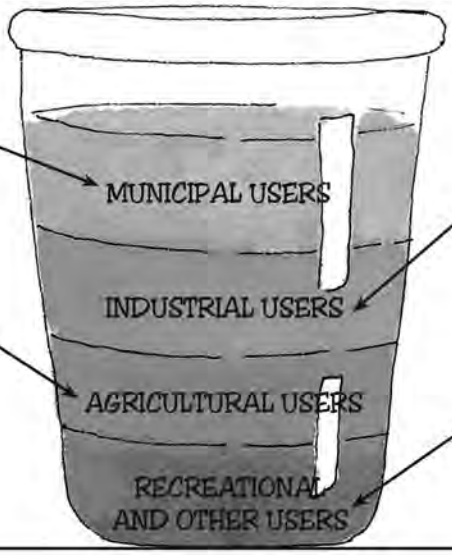
The Edwards Aquifer IS regulated because Comal and San Marcos Springs supply water to people downstream and are also the home to a number of Endangered Species. A permit is required to pump water from the Edwards Aquifer.

4 The State of Texas ranks water users according to highest need. During periods of drought, when there is not enough water for everyone, a list is used to decide who gets water first.



5 First in this order is you! Individuals, cities and towns have the right to use the water first. Water is a basic human need.

Agricultural users are third in line because water is needed to grow crops and raise animals.



Industrial users are second, because they provide products and jobs to our communities.

Recreational and other users who want water for fun are last. Can you guess why?

1. Hi! My name is: _____ I use water everyday in my home for cooking, cleaning, bathing, and watering the lawn.	2. Hi! My name is: _____ I am a teacher at Little Springs Elementary. I use water to do art and science projects with my students.
3. Hi! My name is: _____ I am a firefighter. My job is to protect people. I use water to put out fires.	4. Hi! My name is: _____ I am a jogger, and I will run in the Little Springs 10K race. I drink water before, during and after running so I won't get sick.
5. Hi! My name is: _____ I cut hair at Little Springs Beauty Shop. I use water to wash and style hair.	6. Hi! My name is: _____ I am a cook at the Little Springs Cafe. I use water to prepare food and keep my kitchen clean.
7. Hi! My name is: _____ I own the Little Springs car wash. I use water to keep cars clean and shiny.	8. Hi! I am Dr.: _____ I am a dentist. I use water to keep my patients' teeth clean and healthy.
9. Hi! My name is: _____ I own a textile mill. I use water to make fabric.	10. Hi! My name is: _____ I own a factory that uses water to make bricks for homes and buildings.

11. Hi! My name is: _____ I work at a hydroelectric plant. We use water to make electricity for the people of Little Springs.	12. Hi! My name is: _____ I own a steel mill. I use water to make metal products.
13. Hi! My name is: _____ My company uses water to make tires for cars and trucks.	14. Hi! My name is: _____ My factory uses water to make medicine.
15. Hi! My name is: _____ I own a factory that uses water to make many kinds of plastic products.	16. Hi! My name is: _____ I am a farmer and use water from the river to raise watermelons.
17. Hi! My name is: _____ I am a rancher. I dug a well into the Carrizo-Wilcox aquifer so I would have enough water for my cattle, sheep, and horses.	18. Hi! I am Dr.: _____ I raise catfish in ponds. I use water from the Edwards Aquifer to fill the fish ponds.
19. Hi! My name is: _____ I am a farmer who draws water from the river to soak my rice fields.	20. Hi! My name is: _____ I am a corn farmer. I have dug a well into the Edwards Aquifer so I can water my crops during dry times.

21. Hi! My name is: _____ I grow Christmas trees on my farm and use water to keep the trees green and healthy.	22. Hi! My name is: _____ I grow pecans on my farm. I use water for my trees
23. Hi! My name is: _____ I am a farmer who uses water for my hay crop.	24. Hi! My name is: _____ I teach people to swim at Little Springs Lake.
25. Hi! My name is: _____ I rent inner tubes to people who want to float down the river.	26. Hi! My name is: _____ I am a guide on canoe trips down the river.
27. Hi! My name is: _____ I love to go fishing at Little Springs Lake.	28. Hi! I am Dr.: _____ I like to relax by boating on Little Springs Lake.
29. Hi! My name is: _____ My hobby is water skiing on Little Springs Lake.	30. Hi! My name is: _____ I like to take my mask and snorkel down to the river. I can look at fish and plants under the water.

Power Point Presentation Outline

Endangered Species of the Guadalupe River Basin

Guadalupe-Blanco River Authority

Note to teachers: The Power Point Presentation is included on the USB Drive in your packet. It is also included in the Story Map and can be found in both of the Comal and Hays Counties sections.

In order to experience the full educational value of the presentation, you will want to present it in *Slide Show* mode – that way the text and animation will come up only when you click on the mouse (or the return button) once, and you will have time for discussion between photos. If you are not certain how to get into *Slide Show* mode, it is very simple – you have two options:

1. When you first open the presentation, the screen has a number of icons across the bottom. Push the one that looks like a small podium (when you put the cursor on it, it will label the icon *Slide Show*).
2. On the menu bar, select *View* and Scroll down to *Slide Show*.

Once launched into *Slide Show* mode, one click of the mouse will forward you to the next slide. The script below is information for you to preview and then discuss with the students while viewing the presentation.

1. Title Slide: *Endangered Species of the Guadalupe River Basin*, presented by the Guadalupe-Blanco River Authority.

2. What are "Endangered Species?"--- Endangered Species are plants and animals that are "in danger" of becoming extinct. The U.S. Fish & Wildlife Service or National Marine Fisheries Service determine which species to put on the list. Determination factors include:
   - Concerns about preserving an organism's habitat.
   - Concerns are often because of humans changing the nearby environment.
   - If the habitat is destroyed or greatly changed, the organism could become extinct.

   PHOTO: Collage of Endangered Species.

3. Where do the Endangered Species Live That are Dependent Upon the Guadalupe River Basin?

   PHOTOS: Comal Springs and river, Guadalupe Estuary
   - All of the species are dependent upon the clean, cool (70-72 degrees Fahrenheit all year long) and constant flow of water from the Edwards Aquifer.
   - The species' habitats are in the caves and springs of the aquifer, and the spring-fed rivers.
   - One specie is dependent upon the fragile ecosystem of the coastal wetlands.

4. The Habitat of these Endangered Species is a Very Specialized *System*

   MAP: Guadalupe River Basin, with location of Comal and San Marcos Springs
   - This system is a complicated interaction between the aquifer, springs and the spring-fed rivers.
   - These conditions are perfect for the species, and cannot be found **anywhere else** on earth.
   - If any part of the system is changed or removed, it would probably mean the end of these species.
   - The quality of the water (how clean it is) in the aquifer could be changed by pollution. Concerns about building on the aquifer's Recharge Zone often fuel pollution concerns.
   - The amount of water leaving the springs could decrease or even cease because of drought or because of pumping too much water out of the aquifer.
   - If the springs were to go dry, this could affect the food web for the species.

5. What are the Needs of These Endangered Species?
   - Their habitat must remain undisturbed .
   - A constant supply of food is important.
   - Constant shelter and temperature.
   - The quality of their habitat is also important – pollution could harm these species.

6. CHART: Guadalupe River Basin Threatened and Endangered Species

7. PHOTO: Texas blind salamander
   - Habitat: The Edwards Aquifer in Hays County.
   - Since they live totally underground where it is pitch dark, they have adapted to creatures that have no color to their skin, nor do they have eyes.
   - They eat smaller aquatic organisms in the aquifer, often blind and colorless themselves.
   - These are determined to be a very good indicator of water quality in the San Marcos area of the aquifer.
   - Texas Blind salamanders grow to be about 3-4 inches in length. There are many in captivity.

8. PHOTO: Comal Springs riffle beetle
   - Habitat: The Comal Springs aquatic ecosystem.
   - Lives nearby the spring openings, and in the Comal River very close to the springs.
   - The riffle beetle is dependent upon constant flow of water from the springs, purity of this water and constant temperature.
   - Is a recent addition to Endangered Species list.
   - Riffle beetles are only about 1/8 of an inch in size.

9. PHOTO: Comal Springs dryopid beetle
   - Habitat: The Comal Springs aquatic ecosystem.
   - Lives underground in the Edwards Aquifer, near the Comal Springs openings and in the Comal River close to the springs.
   - The dryopid beetle requires the constant, pure flow of water from the springs for survival.
   - Is a recent addition to Endangered Species list.
   - Dryopid beetles are only about 1/8 of an inch in size.

10. PHOTO: Peck's Cave amphipod
   - Habitat: Comal Springs Ecosystem.
   - The Peck's Cave crustacean amphipods live primarily in the Edwards Aquifer in the Comal Springs area.
   - Since the specie lives totally underground (where there is no sunlight), it has no color to it's skin.
   - Since they only live underground in dark caves, they have no eyes.
   - These subterranean crustacean amphipods are only about 1/8 inch in length.

11. PHOTO: San Marcos salamander *(Threatened)*
   - Habitat: San Marcos Springs Ecosystem.
   - These salamanders live at the surface near the major openings of the San Marcos Springs, and nearby in the headwaters of the San Marcos River.
   - They are dependent upon the clean, clear water flowing from the aquifer that is a constant temperature.
   - They eat insect larvae, young insects and aquatic snails.
   - There are many in captivity.

12. PHOTO: Fountain darter
   - Habitat: Comal Springs & San Marcos Springs Ecosystems.
   - Fountain darters live in the Comal & San Marcos Rivers, and require clear, clean water of a constant temperature and flow.
   - The fish has no dorsal fins – it darts around on the river bottom, hiding in river foliage.
   - During the drought of the 1950s, the Comal Springs and River dried up... the specie was reintroduced to the Comal in 1975.
   - There are many fountain darters in captivity and in breeding programs.

13. PHOTO: Texas wild-rice
   - Habitat: San Marcos Springs Ecosystem.
   - Texas wild-rice grows only in the stretch of the river between the springs and where the Blanco River joins the San Marcos River.
   - The wild-rice requires springflow with a constant temperature, clean water, and an undisturbed stream bottom.
   - Tubers and other recreational users can uproot the plant.

14. PHOTO: San Marcos gambusia
   - Habitat: San Marcos Springs ecosystem, in the upper part of the San Marcos River.
   - San Marcos gambusias are plain, with a yellow-orange or bluish color.
   - San Marcos gambusias have not been sighted or collected since 1981.
   - This species is probably extinct, but other types of gambusias exist.

15. PHOTO: Whooping Crane
   - Winter Habitat: The marshes of the Aransas National Refuge at San Antonio Bay and Aransas Bay.
   - These large birds migrate to the Texas coast from Canada each winter.
   - The ecosystem of the bay is dependent upon springflow in the Guadalupe River.
   - Almost extinct in the 1940's, there are now more than 300 birds.

16. PHOTO: Cagle's map turtle (candidate for listing)
   - Habitat: Downstream in the riverine portion of the Guadalupe River.

17. PHOTO: Freshwater Mussels
   - Golden Orb, Texas Fatmucket, Texas Pimpleback, False Spike (candidates for listing)

18. Acknowledgements

_____Name

Who Am I?

Directions: While viewing the PowerPoint Presentation "Endangered Species of the Guadalupe River Basin", match the name of the specie to its description. The names are listed at the bottom of the page.

1. I am a 'threatened' salamander that lives in the headwaters of the San Marcos River, very close to the major spring openings.
   Who am I? _____

2. I am a plant that can only be found in the beautiful San Marcos River. Sometimes tubers uproot me by mistake.
   Who am I? _____

3. I am a small fish that lives in the Comal River and the San Marcos River, and am dependent on water from the Edwards Aquifer for my habitat.
   Who am I? _____

4. I am a subterranean amphibian specie. I have adapted to living in deep, dark, underground water-filled caves only near the San Marcos Springs.
   Who am I? _____

5. I am a small aquatic beetle that lives in springruns near where water exits the Edwards Aquifer at Comal Springs and the San Marcos Springs.
   Who am I? _____

6. I am a subterranean beetle that lives right around the spring openings at the Comal Springs.
   Who am I? _____

7. I am a crustacean who lives underground in the Edwards Aquifer in the Comal Springs area.
   Who am I? _____

8. I am a very small fish, about the size of a guppy. I haven't been sighted since the early 1980's, and am likely already extinct.
   Who am I? _____

9. I am a bird that is dependent upon flow from the spring-fed waters of the Guadalupe River for my winter breeding grounds.
   Who am I? _____

Texas wildrice	fountain darter	San Marcos gambusia
San Marcos salamander	Texas blind salamander	Comal Springs riffle beetle
Peck's Cave amphipod	Whooping Crane	Comal Springs dryopid beetle

Who Am I?

Directions: While viewing the PowerPoint Presentation "Endangered Species of the Guadalupe River Basin", match the name of the specie to its description. The names are listed at the bottom of the page.

1. I am a 'threatened' salamander that lives in the headwaters of the San Marcos River, very close to the major spring openings.
   Who am I? San Marcos salamander

2. I am a plant that can only be found in the beautiful San Marcos River. Sometimes tubers uproot me by mistake.
   Who am I? Texas wild-rice

3. I am a small fish that lives in the Comal River and the San Marcos River, and am dependent on water from the Edwards Aquifer for my habitat.
   Who am I? fountain darter

4. I am a subterranean amphibian specie. I have adapted to living in deep, dark, underground water-filled caves only near the San Marcos Springs.
   Who am I? Texas blind salamander

5. I am a small aquatic beetle that lives in springruns near where water exits the Edwards Aquifer at Comal Springs and the San Marcos Springs.
   Who am I? Comal Springs dryopid beetle or riffle beetle

6. I am a subterranean beetle that lives right around the spring openings at the Comal Springs.
   Who am I? Comal Springs dryopid beetle or riffle beetle

7. I am a crustacean who lives underground in the Edwards Aquifer in the Comal Springs area.
   Who am I? Peck's Cave amphipod

8. I am a very small fish, about the size of a guppy. I haven't been sighted since the early 1980's, and am likely already extinct.
   Who am I? San Marcos gambusia

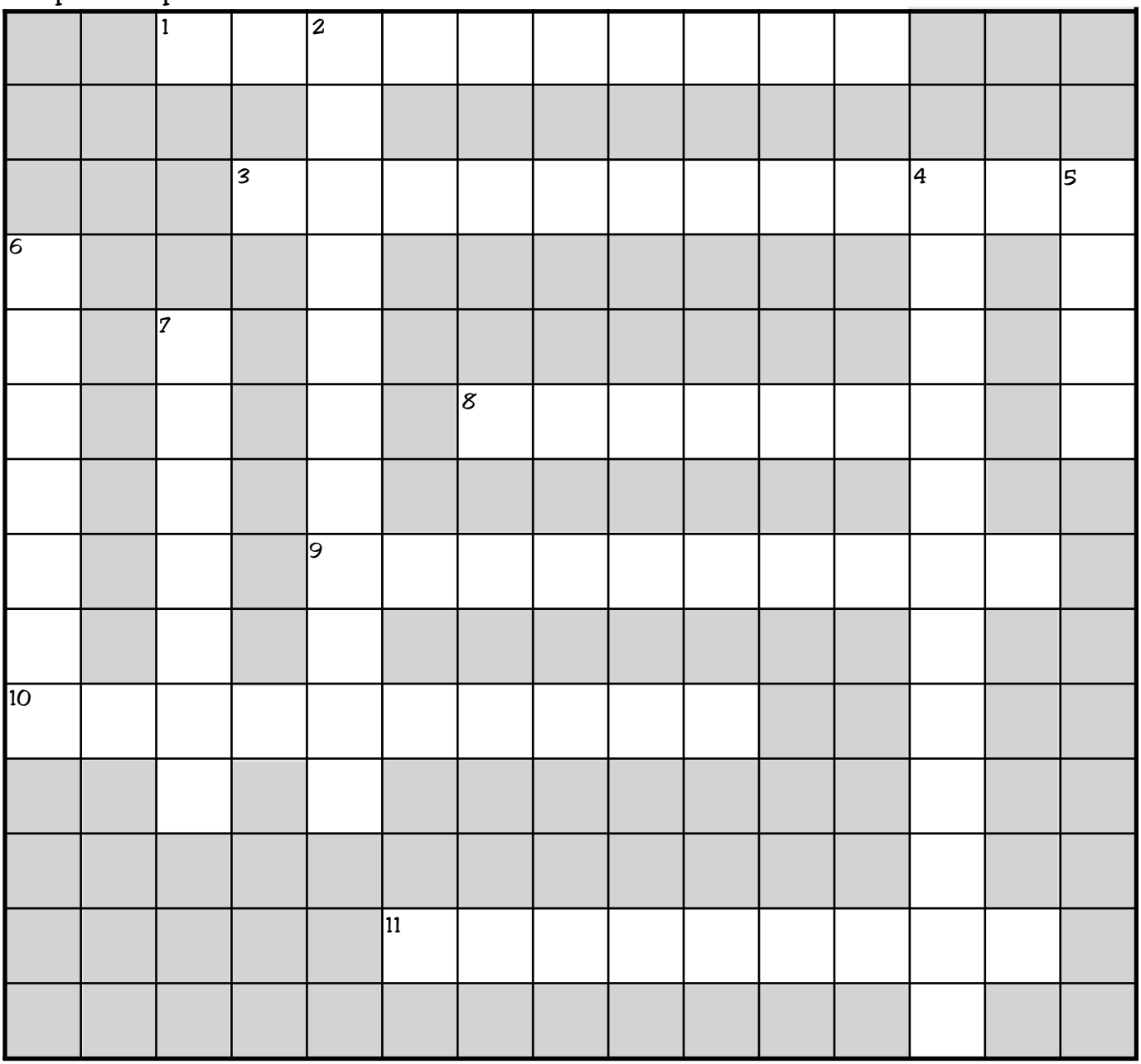
9. I am a bird that is dependent upon flow from the spring-fed waters of the Guadalupe River for my winter breeding grounds.
   Who am I? Whooping Crane

Texas wild-rice	fountain darter	San Marcos gambusia
San Marcos salamander	Texas blind salamander	Comal Springs riffle beetle
Peck's Cave amphipod	Whooping Crane	Comal Springs dryopid beetle

_____Name

Journey Crossword Puzzle

Complete the puzzle.



Down

2. Another word for rules.
4. The last category of importance for water use during a drought.
5. The name of the turtle in your workbook.
6. This type of water is regulated in Texas.
7. One aquifer in Texas that IS strictly regulated.

Across

1. Water flowing through springs from an aquifer.
3. This water use is important because it provides food for us to eat.
8. An underground area of sand or rock filled with water.
9. This category of water use is second in importance, providing products and jobs.
10. Species that could become extinct.
11. The most important category of water use, providing water to cities.

Journey Crossword Puzzle
Answer Key

		1 S	P	2 R	I	N	G	F	L	O	W			
				E										
			3 A	G	R	I	C	U	L	T	U	4 R	A	5 L
6 S				U								E		U
U		7 E		L								C		P
R		D		A		8 A	Q	U	I	F	E	R		E
F		W		T								E		
A		A		9 I	N	D	U	S	T	R	I	A	L	
C		R		O								T		
10 E	N	D	A	N	G	E	R	E	D			I		
		S		S								O		
												N		
					11 M	U	N	I	C	I	P	A	L	
												L		

Down

2. Another word for rules.
4. The last category of importance for water use during a drought.
5. The name of the turtle in your workbook.
6. This type of water is regulated in Texas.
7. One aquifer in Texas that IS strictly regulated.

Across

1. Water flowing through springs from an aquifer.
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8. An underground area of sand or rock filled with water.
9. This category of water use is second in importance, providing products and jobs.
10. Species that could become extinct.
11. The most important category of water use, providing water to cities.

Time Requirements:
1 hour

Social Studies TEKS:
5(A), 21(C), 21(E)

Science TEKS:
1(B), 2(C), 2(F), 7(C)

Language Arts TEKS:
1, 2(B), 13(B), 17, 19, 29

Materials:
- Student Workbooks

Objectives:
1. Students will identify activities using water at home, and compare amounts of water used for different activities.
2. Students will examine and develop attitudes towards water conservation.
3. Students will recognize good and bad water use habits.

Vocabulary:
Conservation- a reduction in water use or water loss.
Water saving device- new attachments for plumbing fixtures that will decrease the amount of water used.

Procedures:

A. Brainstorming:

Divide students into groups. Instruct groups to brainstorm and list as many ways that they and their families use water. The teacher may want to lead the initial discussion, giving them categories (places) around the home and school where people use water. Students should then list as many water uses as they can. After about 10 minutes, call for answers from the groups and list on the board or an overhead projector. List the water uses on the board, and then ask students to rank them according to which use the most water, which uses the second most, etc.

Discussion questions:
- Is water a limited resource? Explain. *(yes - explanations may vary)*
- How much water do individuals use at home each day? *(about 80 - 100 gallons)*
- People use the most water in what room in the house *(bathroom)*
- What is a person's per capita use? Per capita means the total amount of water used throughout the day, whether at home, at school or at work. *(approximately 165 gallons per person, per day)*
- During what season do we typically use the largest amounts of water? Why? *(Summer - since we do not receive a great deal of rain, people typically use extra water to keep lawns and plants alive)*
- Are there ways that you as individuals can conserve the amount of water you use during a typical day? How? *(answers will vary)*

B. Read aloud Sections 1 and 2 from Lesson 7: Water Use and Conservation (student workbook p. 14). Discuss, using questions below. Instruct students to complete Exercise 7-A at the bottom of the page. The answer key is found in the teacher's guide, p. 49.

Discussion questions:
- What room do you use the most water in at home? *(the bathroom)*
- Doing what? *(brushing teeth, washing hands, flushing toilet, taking a bath or a shower)*
- Which household water use has the highest percentage? Does this surprise you? *(flushing the toilet)*
- Did you have it on your list from brainstorming? *(answers will vary – usually students do not list flushing the toilet as a household water use)*
- Which household water use has the second highest percentage? *(bathing and showering)*
- Do you think all baths and showers use 30 gallons, or would it vary from person to person? Explain. *(It varies. Some people take short showers, some take long showers. Some people fill the tub to the top for a bath, some just use a few inches of water.)*
- What are some examples of using water outdoors? *(watering plants, animals; watering the lawn)*
- Do you think this graph includes summer lawn watering? *(No it does not – if it did, the outdoor water use would be much higher.)*

Materials:

- Group sets of *Puddles and Muddles* (using blackline master, teacher's guide p. 51; teacher will make group copies and cut apart cards.)

C. Read aloud Sections 3-4 from Lesson 7: Water Use and Conservation (student workbook p. 15). Evaluate the information on the chart. Discuss, using questions below. Instruct students to complete Exercise 7-B at the bottom of the page. The answer key is found in the teacher's guide, p. 50.

Discussion Questions:

- What particular routine uses the most water? *(flushing the toilet)* Can we conserve water while using the toilet? *(Yes - we can install a low flow toilet that uses less than 2 gallons, or we can put in a water displacement device to cut down on the amount of water that is used each time we flush. Also - don't use the toilet as a trash can!)*
- Which uses more water, a bath or a shower? *(A bath typically uses more water, about 30 gallons. An average shower is usually 25 gallons or less, depending upon how long you stay in the shower.)*
- Can we cut down on the amount of water we use in the shower or bath? *(Yes - we can take shorter showers, or we can take baths with less water.)*
- Is it possible to cut down on the amount of water that comes out of your faucets? *(Yes - you can purchase inexpensive water saving devices at most hardware stores and cut in half the amount of water that comes out of your faucet and showerhead.)*
- What are the ways we use the most water out-of-doors? *(During the summer, almost half the water we use goes on our lawns. We also use large amounts of water washing cars.)*
- Can we cut down on the amount of water we use on our lawns? *(Yes - you should only water early in the morning or late in the evening. Only water when the grass needs it! It would also be a good idea to use native plants that don't need much water. This is called 'xeriscape'.)*
- What is an easy way to cut down on water use while washing the car? *(Purchase and use a water nozzle at the end of the hose. You can save hundreds of gallons each time you wash the car!)*
- What are some ways that you will try to conserve water? *(Answers will vary)*

D. Evaluation - Puddles and Muddles

1. Divide students into groups. Pass out sets of *Puddles and Muddles* cards. Blackline master is found on p. 51 in the teacher's guide.
2. Discuss the meaning of "muddle." (Muddle refers to a dilemma, or a situation where someone is not certain what to do.)
3. Instruct groups to read aloud and discuss each predicament, deciding on the best soltion to the muddled situation.
4. After 10 minutes, ask groups for their answers and have them defend their decisions!

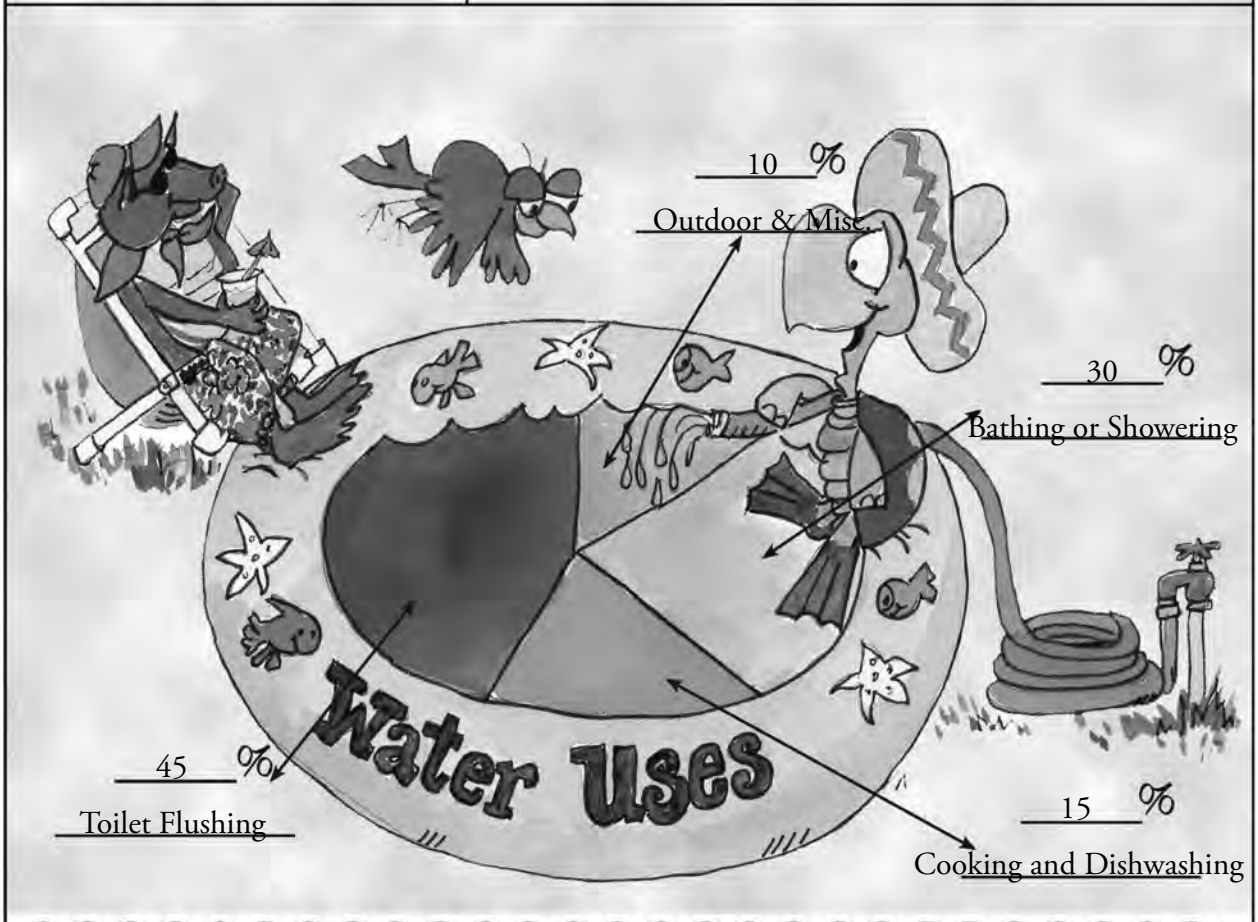
E. Enrichment Activity:

1. Writing Prompt: *Write a composition that tells why water is important, and why we need to conserve it.*
2. Direct students to GBRA's water trivia quiz at www.gbra.org/watertriviaquiz to have them check their knowledge of the importance of water and water conservation. If they submit answers to the quiz, a prize (a 'stress' water drop) will be mailed to them at the school in the teacher's name.
3. Make copies of the Home Water Use Inventory (blackline master p. 52) for the students to take home and complete with their parents. This is a great way to let the parents know that the students have been studying water and water conservation, and provides an opportunity for child and parent to collaborate on a project. Encourage students to share their water conservation knowledge with their parents.

LESSON 7: WATER USE AND CONSERVATION

1 Each of us uses quite a bit of water each day...often without even realizing it! Our personal water use at home is about 100 gallons a day! Just picture 100 milk jugs filled with water... believe it or not, that is how much YOU use each and every day at your home! Incredible!

2 How is this possible? It is pretty easy if you stop and think of all the ways you use water each day. You use the most water in the bathroom- washing your hands, showering or bathing and flushing the toilet. You also use water in the kitchen -cleaning and cooking. And it may not be YOU that washes laundry, but it is likely that someone washes clothes! In addition, we water our plants and animals, and WE drink water too! It all adds up!



EXERCISE 7-A

Directions: The swimming pool represents 100 gallons of water. Each section of the pool represents the percentage of water used in different parts of our home. Use the table below to label the pie graph above. Put the percentage on the top line and write the water use on the second line.

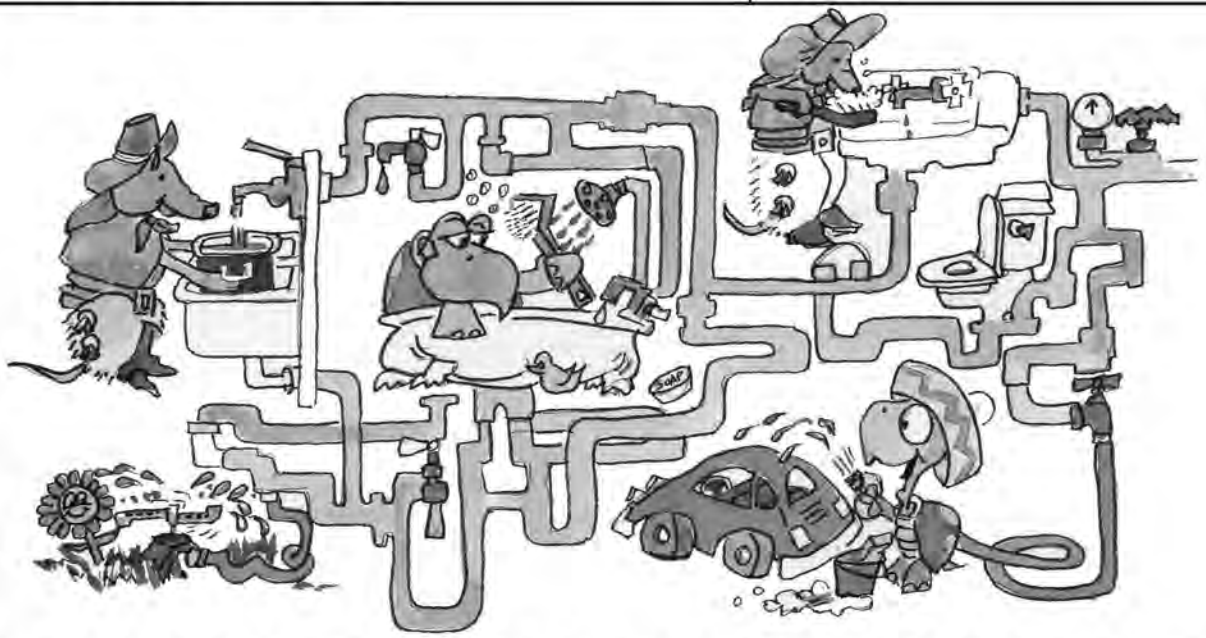
Toilet Flushing	45 gallons
Outdoor and miscellaneous	10 gallons
Cooking and Dishwashing	15 gallons
Bathing or Showering	30 gallons

LESSON 7: WATER USE AND CONSERVATION

3 Water is brought to your home through a simple system of pipes called a 'distribution system.' Once it gets to your home, the pipes within your home form a smaller distribution system, taking the water to your kitchens (sinks), bathrooms (tubs, sinks and toilets), washing machines, and outdoor faucets.

In some parts of the United States, people have found very innovative ways to capture the water they have used, and use it again. This is called "reclaiming" or "recycled" water. Can you think of any ways to re-use water?

4 As time goes on and our population continues to grow, we will need to find ways to use our water more efficiently. We call this water conservation. By taking simple steps in our everyday water uses, we can save quite a bit of water. And saving water means saving money... remember, that water is not free!



EXERCISE 7-B: WATER CONSERVATION SAVINGS CHART

Water Uses	Typical Action/Gallons Used	Conservation Action/Gallons Used	H2O Savings
Showers/Baths	15 minute shower, or bathtub full. Uses about 20 gallons.	5 minute shower or bathtub halfway full. Uses about 10 gallons.	10 Gallons
Washing Hands	Water left running while washing/brushing. Uses about 2 gallons.	Turn off water while soaping or brushing. Uses about ½ gallon.	1 1/2 Gallons
Toilets	Older toilets use 6 gallons a flush.	Install low-flow toilets using about 2 gallons.	4 Gallons
Washing Cars	Water running uses over 300 gallons.	Use a nozzle to shut off water while soaping. Uses about 30 gallons.	270 Gallons
Cleaning Dishes	By hand, with water running for rinse. Uses 50 gallons. Older dishwasher uses about 20 gallons.	If you shut the water off while washing by hand, you use about 10 gallons. A full load in a water efficient dishwasher uses 5 gallons.	40 Gallons 15 Gallons
Outdoors Watering Lawn	Watering without a timer. Uses over 2,500 gallons.	Water with a timer. Uses about 1,200 gallons.	1300 Gallons

Puddles and Muddles

Your dad washed the car this weekend. He turned on the water to wet the car down and then left the hose running on the driveway while he soaped the car. You are water-wise and know that this is a waste of water.

What should you do?

1. Tell dad he could save money on the water bill by purchasing a spray nozzle for the hose to use while washing the car.
2. Get some empty milk gallons and fill them up while the water is running so he can see how much water he is wasting.
3. Create a series of charts to compare the amount of water and money that is being wasted in instead of just turning the water off while soaping.

Puddles and Muddles

Your neighbor has just installed an automatic sprinkler system. He has programmed it to come on everyday promptly at 2:00 p.m. for 2 hours. You are water-wise and know that people should only water early in the morning or late at night.

What should you do?

1. Sit down with your neighbor and patiently explain that most of his water is evaporating, and he should consider reprogramming.
2. Call the water company to report him.
3. Invite a water conservation expert to come to speak at a neighborhood meeting.

Puddles and Muddles

Your teenage cousin visiting from Dallas has the bad habit of taking very long showers. Last night she was in there for 30 minutes! You are water wise and know that this takes lots of excess water.

What should you do?

1. Explain that water is a precious resource in this part of Texas, and that we all try to conserve.
2. Tell mom its about time you went to the store and purchased that low-flow showerhead.
3. Turn the water off while she is in the shower.
4. Ask your cousin to help you write and video-tape some water conservation ideas for a contest. Maybe she'll get the hint.

Puddles and Muddles

Your toilet makes so much noise leaking that it keeps you awake. You have asked the landlord to fix it, but he hasn't. The water is included in your rent, so really it is the landlord who pays the bill.

What should you do?

1. Have an adult in your family ask a leak detection crew from your water company to come talk to the landlord about the benefits of toilet repairs.
2. Figure out how much water the toilet is wasting everyday. Then figure out how much money is being wasted. Present these facts to the landlord. Money usually talks.
3. Ask your mom or dad to purchase the toilet repair kit, and fix it yourselves.
4. Don't worry about it - it's not costing you a thing!

Puddles and Muddles

Your aunt is visiting from another state, and she is famous for her homemade potato salad. She starts to peel 2 bags of potatoes by hand, but lets the water run the whole time she is peeling. You know this wastes water.

What should you do?

1. Explain that water is a precious resource in this part of Texas, and that we all try to conserve.
2. Tell your aunt you will be more than willing to help make the salad - you will peel and rinse the potatoes. Rinse them all at once.
3. Tell your aunt you read somewhere that it is good to leave the peeling on the potatoes for potato salad.

Puddles and Muddles

Tomorrow you are going on a field trip, and you want to wear your favorite jeans. They are dirty, so you decide to wash them yourself. You place the jeans alone in the washer without checking the setting, and then see the washer is full of water and soap with only one pair of jeans.

What should you do?

1. Not say anything and let the 50 gallons just waste away.
2. Stop the washer, tell your mom or dad about the situation, and ask them if any other clothes need washing.
3. Just throw a bunch of other clothes in with your jeans, without reading the labels.

Home Water Use Inventory

Your child has been learning about water and the Guadalupe River Basin. As a way to reinforce what your child has learned, take a few minutes to work through this Home Water Use Inventory with your family. You might be surprised how much water your family uses use each day! Your child can discuss some water conservation ideas that the class has learned.

Water Use	How Many Times a Day	Number of Gallons Per Use	Total Gallons Used
Toilet Flushing 		5 gallons / flush	
Dishwasher: Automatic By Hand 		20 gallons load tap running - 30 gallons	
Washing Machine 		40 gallons / full load	
Shower 		# of minutes water is run x 6 gallons / minute	
Bath 		# of minutes water is run x 6 gallons / minute	
Open Faucet: Washing hands  Brushing Teeth		# of minutes water is run x 6 gallons / minute	

WAYS YOU CAN CONSERVE WATER

- Test for a leaky toilet by adding food coloring to the tank. Without flushing, check to see if any color appears in the bowl after 15 minutes. If color appears, you have a leak!
- Run your dishwasher only when you have a full load. If washing by hand, make sure you don't let the water continually run for rinsing.
- Wash clothes only when you have a full load. Set the water level control to the proper setting.
- Install a low-flow showerhead. They are inexpensive and can reduce flow by at least 25%.
- Take short showers instead of a bath.
- Do not let water run in the sink while brushing your teeth, shaving or washing your face and hands.
- Water your lawn during the coolest part of the day, and only water once every 5 to 7 days.

To learn more about Water Conservation, call the Public Communications Department at the Guadalupe-Blanco River Authority at 830-379-5822, or 800-413-5822.

Time Requirements:
1 hour

Materials:
- Post Test Master found in appendix. Answer key in the teacher's guide pp. 56-57
- GBRA pencils

Procedures:

A. Review Unit - "Around the World" Game:

Select a child to start the game. He/she stands by the desk of the person who is next to him/her. The teacher asks a question. The first child to answer correctly then moves to the next desk and stands by it, while the other child sits down. Play continues until one child has made it back to his desk or "around the world."

Questions for "Around the World"

1. What is the natural area that provides rainfall runoff to a river? *(basin)*
2. Where do the Guadalupe and San Marcos Rivers meet? *(near the city of Gonzales)*
3. What large body of water does the Guadalupe River flow into? *(San Antonio Bay at the Gulf of Mexico)*
4. What agency plans ways to make sure people in the Guadalupe River Basin have enough water? *(GBRA---Guadalupe-Blanco River Authority)*
5. What is the name of the large reservoir in the northern part of the Guadalupe River Basin? *(Canyon Reservoir)*
6. How many counties are in the Guadalupe River Basin? *(eleven)*
7. How many counties are in the GBRA district? *(ten)*
8. What is a watershed? *(an area of land that water flows across)*
9. What is water used in households, businesses and schools called? *(Municipal)*
10. What do we call water used to grow crops and raise animals? *(Agricultural)*
11. Name the two water uses that have the highest percentages in our homes. *(flushing the toilet and taking a bath or shower)*
12. What is water used for fun called? *(Recreational)*
13. What kind of pollution tells us there are poisonous chemicals in the water? *(toxic pollution)*
14. Name the four steps of the water cycle: *(evaporation, condensation, precipitation, accumulation)*
15. How many Eco-Regions does the Guadalupe River Basin overlie? *(Five: the Edwards Plateau, Blackland Prairie, Oak Woods and Prairies, South Texas Brush, and Gulf Coast Prairies)*
16. What is water flowing out of springs called? *(springflow)*
17. What two springs originate from the Edwards Aquifer? *(the Comal Springs in New Braunfels and the San Marcos Springs)*
18. The water in the Guadalupe River comes from two sources. One is springflow. What is the other? *(surface runoff that comes from rainfall)*
19. What do we call a hole drilled down to the layer of ground containing water? *(well)*
20. What is the name of the aquifer that feeds the Guadalupe, Comal and San Marcos Rivers? *(Edwards)*
21. Where does bacterial pollution come from? *(human and animal wastes)*
22. What is the source for all energy on the earth? *(the sun)*
23. What is another word for regulation? *(rule)*
24. How much water do the Comal and San Marcos Springs contribute to the Guadalupe River downstream during a drought? *(Seventy percent)*
25. Who makes our water regulations? *(State of Texas)*
26. What do we call "written permission" to draw surface or ground water? *(permit)*
27. An animal or plant found naturally in an area is called what? *(native)*
28. What do we call a body of water, such as a lake, that stores water? *(reservoir)*
29. What do we call the process of making electricity using the force of water? *(hydroelectricity)*

30. What do we call dirt, rock, or other material placed across a river or stream to control the flow or raise the level of water? *(dam)*
31. What do we call the land area that provides rainfall runoff to the Guadalupe River? *(Guadalupe River Basin)*
32. What kind of pollution comes from the application of too much fertilizer? *(nutrient pollution)*
33. What do we call water used to produce food or raise animals? *(Agricultural)*
34. What do we call water used to create or make a product? *(Industrial)*
35. What is a natural opening that brings water from underground to the surface? *(spring)*
36. What is pollution called that we cannot pinpoint where it came from? *(nonpoint source pollution)*
37. What is water on the surface of the ground such as water in rivers, lakes, and streams called? *(surface water)*
38. What do we call water that percolates and is stored underground? *(groundwater)*
39. Two things can make the aquifer level change. One is rainfall. What is the other? *(pumping from wells)*
40. What is your county? *(answers will vary)*
41. What do we call an underground area of sand, gravel, or rocks where spaces are filled with water? *(aquifer)*
42. How much water do you typically use each day at home? *(100 gallons)*
43. During times of little rainfall, which water users have the first right to the water? *(municipal)*
44. What do we call pollution that we can trace back to a specific site? *(point source pollution)*
45. What is the only aquifer in Texas that requires a permit to pump water? *(Edwards Aquifer)*
46. What is water conservation? *(taking simple steps to use less water in our everyday lives)*
47. What do we call the system of pipes that bring water to your house from the water treatment plant? *(a distribution system)*

B. Individual Review - Word Search

Students can complete the Word Search on the back cover of the student workbook.

C. Administer Post-Test

Print post-test (found in appendix). Teachers key found on pp. 56-57.

Please record student scores on the program record sheet (found in appendix) and forward to:
Cinde Thomas-Jimenez
Environmental Education Administrator
Guadalupe-Blanco River Authority
933 E. Court Street
Seguin, TX 78155

D. Award Pencils

Journey Through the Guadalupe River Watershed Word Search

Directions: Find the words in the grid.
Words can go horizontally, vertically, and diagonally. Words may be spelled forward or backward.

Agricultural
Aquifer
Basin
Blanco
Comal
Condensation
Conservation
Dam
Drought
Edwards
Evaporation
GBRA
Groundwater
Guadalupe
Hydroelectric
Industrial
Municipal
Native
Nonpointsource
Permit
Pointsource
Pollution
Precipitation
Recharge
Recreational
Regulations
Reservoir
Runoff
San Antonio
San Marcos
Springflow
Springs
Surface Water
Texas
Water Cycle
Well

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

Hey Kids!

Learn more about water and WIN A COOL PRIZE by completing the Guadalupe-Blanco River Authority Water Trivia Quiz!

Go to: www.gbra.org/watertriviaquiz

GOOD LUCK

GBRA

933 East Court Street • Seguin, Texas 78155 • (830) 379-5822
www.gbra.org

TEACHER'S KEY

Post Test

A. Matching: Place the letter of the word(s) in the blank that matches the correct definition.

A. native	B. Guadalupe	C. basin	D. dam
E. hydroelectricity	F. water cycle	G. Edwards	H. Edwards Plateau
I. reservoir	J. Guadalupe River Basin	K. spring	L. bacterial

1. ___C___ The land area where rainfall run-off drains to a river.

2. ___I___ A body of water, such as a lake, that stores water.

3. ___E___ The process of making electricity using the force of water.

4. ___D___ Dirt, rock, or other material placed across a river or stream to control the flow or raise the level of water.

5. ___A___ An animal or plant found naturally in an area.

6. ___B___ The river that joins with the San Marcos River near the city of Gonzales.

7. ___J___ The area which provides rainfall runoff and springflow to the Guadalupe River.

8. ___K___ A place where water naturally flows out of an aquifer.

9. ___G___ The aquifer that feeds the Comal, Guadalupe and San Marcos Rivers.

10. ___H___ The Eco-Region (natural area of Texas) where the Guadalupe River begins.

11. ___L___ This type of pollution comes from human and animal waste.

12. ___F___ The continuous movement of water on this planet.

B. Fill in the Blank:
Write the letter of the word that best completes the sentence in the blank.

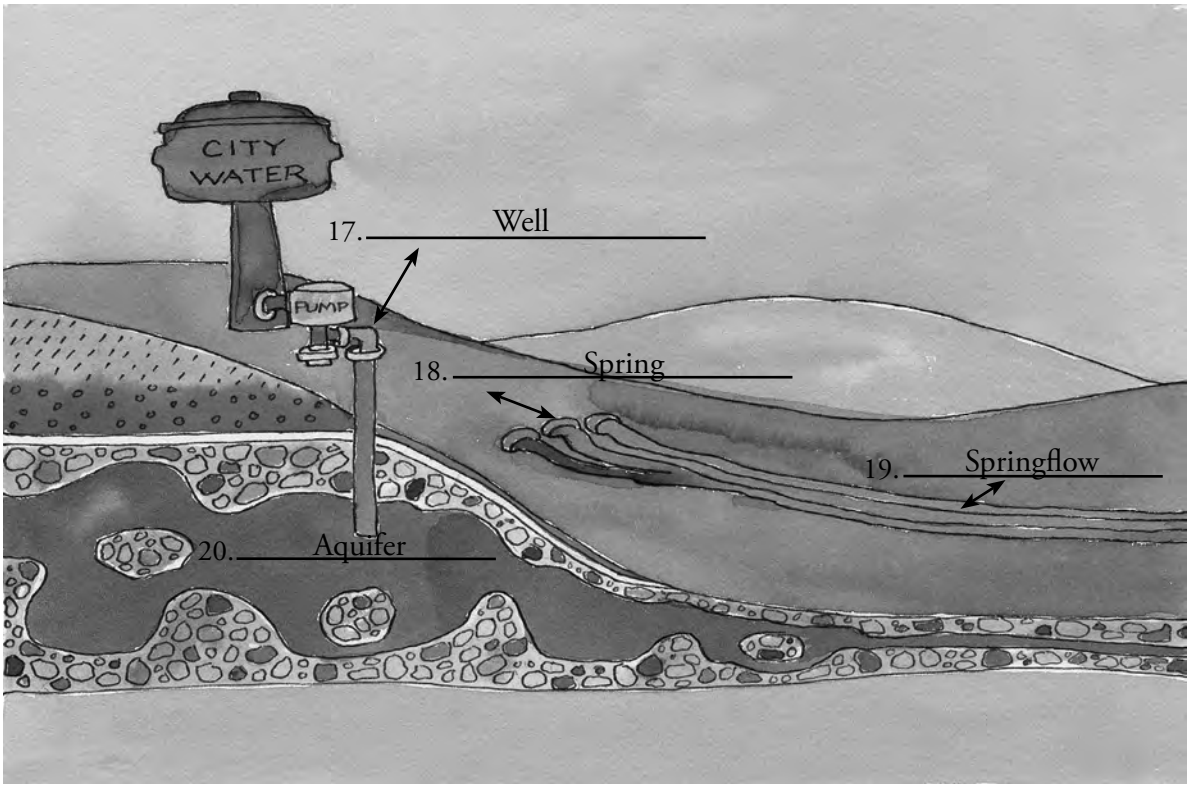
13. Water used to create or make a product is _____C_____ water.
A. Recreational B. Municipal C. Industrial

14. Water used to produce food or raise animals is _____C_____.
A. Industrial B. Recreational C. Agricultural

15. _____A_____ water is used by cities or for household use.
A. Municipal B. Industrial C. Agricultural

16. _____B_____ water is used just for fun.
A. Agricultural B. Recreational C. Industrial

C. Label the picture using these words: spring, springflow, aquifer, well



D. Identify whether these two examples are point source or nonpoint source pollution. Circle the answer.

21. Factory with discharge pipe into the river. (Point Source) Nonpoint Source

22. Parking lot at mall within one mile of the river. Point Source (Nonpoint Source)

E. Fill in the Blank: Write the letter of the word that best completes the sentence in the blank.

23. Over half of the water that you use during the day is used in _____C_____ .
A. the kitchen B. the bedroom C. the bathroom

24. During the _____A_____ season, your outdoor water use is much greater.
A. summer B. fall C. spring

F. List at least two ways you can conserve water:

25. _____Answers will vary_____

26. _____Answers will vary_____

G. Fill in the blank using these words: regulation, surface water, groundwater, permit

27. Water that percolates underground is _____groundwater_____.

28. Another name for a rule is a _____regulation_____.

29. Water in rivers, lakes and streams is known as _____surface_____ _____water_____.

30. A _____permit_____ is written permission.

APPENDIX

A JOURNEY THROUGH THE GUADALUPE RIVER BASIN

Fourth Grade Water Education Program

PROGRAM RECORD SHEET

Teacher_____ Date_____

School Name_____ ISD _____

School Mailing Address_____

City_____ State _____ Zip_____

Phone:_____ FAX:_____ email:_____

After you finish teaching this program, please fill in the information requested and email a copy to:
cthomas-jimenez@gbra.org

Student First Name or Number	Pre-Test Score	Post-Test Score

Pretest / Post Test

A. Matching: Place the letter of the word(s) in the blank that matches the correct definition.

A. native	B. Guadalupe	C. basin	D. dam
E. hydroelectricity	F. water cycle	G. Edwards	H. Edwards Plateau
I. reservoir	J. Guadalupe River Basin	K. spring	L. bacterial

1. _____ The land area where rainfall run-off drains to a river.

2. _____ A body of water, such as a lake, that stores water.

3. _____ The process of making electricity using the force of water.

4. _____ Dirt, rock, or other material placed across a river or stream to control the flow or raise the level of water.

5. _____ An animal or plant found naturally in an area.

6. _____ The river that joins with the San Marcos River near the city of Gonzales.

7. _____ The area which provides rainfall runoff and springflow to the Guadalupe River.

8. _____ A place where water naturally flows out of an aquifer.

9. _____ The aquifer that feeds the Comal, Guadalupe and San Marcos Rivers.

10. _____ The Eco-Region (natural area of Texas) where the Guadalupe River begins.

11. _____ This type of pollution comes from human and animal waste.

12. _____ The continuous movement of water on this planet.

B. Fill in the Blank:
Write the letter of the word that best completes the sentence in the blank.

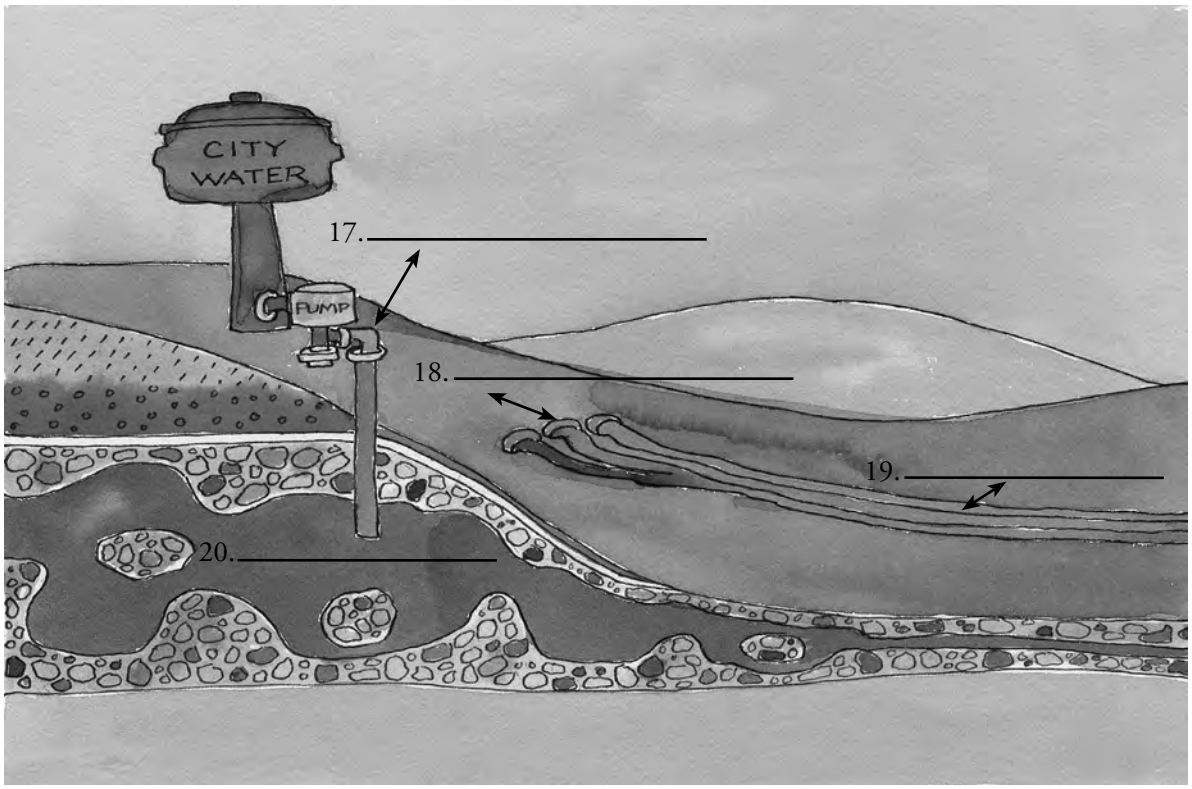
13. Water used to create or make a product is _____ water.
A. Recreational B. Municipal C. Industrial

14. Water used to produce food or raise animals is _____.
A. Industrial B. Recreational C. Agricultural

15. _____ water is used by cities or for household use.
A. Municipal B. Industrial C. Agricultural

16. _____ water is used just for fun.
A. Agricultural B. Recreational C. Industrial

C. Label the picture using these words: spring, springflow, aquifer, well



D. Identify whether these two examples are point source or nonpoint source pollution. Circle the answer.

21. Factory with discharge pipe into the river. Point Source Nonpoint Source

22. Parking lot at mall within one mile of the river. Point Source Nonpoint Source

E. Fill in the Blank: Write the letter of the word that best completes the sentence in the blank.

23. Over half of the water that you use during the day is used in _____ .
A. the kitchen B. the bedroom C. the bathroom

24. During the _____ season, your outdoor water use is much greater.
A. summer B. fall C. spring

F. List at least two ways you can conserve water:

25. _____

26. _____

G. Fill in the blank using these words: regulation, surface water, groundwater, permit

27. Water that percolates underground is _____.

28. Another name for a rule is a _____.

29. Water in rivers, lakes and streams is known as _____ _____.

30. A _____ is written permission.