The Ultimate Recyclable

All water on Earth, including the water that flows from our taps and the water we flush down the drain, is part of a natural cycle. You are drinking the same water that dinosaurs drank millions of years ago.

Chapter 2

Grade Levels/Courses

6th, 7th, 8th, Aquatic Science, Environmental Science

Chapter Objectives

Students will be able to:

1. Diagram and describe the path of water through the hydrosphere, geosphere and atmosphere (the water cycle).
2. Identify the sun's energy as the driver of the water cycle fueling evaporation and transpiration, which puts water into the atmosphere to form clouds.
3. Identify ways that the water cycle impacts the aquatic environment.
4. Identify ways that humans and other living things impact the water cycle.
5. Generate ideas for finding reliable weather information.
6. Use appropriate instruments and charts to measure and record weather at their school in preparation for measuring weather at an aquatic site.
7. Define and differentiate between weather and climate
8. Make a model of runoff and infiltration of rainwater in an aquatic environment.
9. Model how pollution gets into aquatic environments and generate a list of 5 ways people can help keep water clean.
10. Present information about runoff and pollution in aquatic systems with an illustrated song, a rap, or a children's story.
11. Identify the source of home and school tap water.
12. Identify how wastewater from home and school is treated.
13. Diagram water from the source to their home, through their drains, to wastewater treatment, and back into the environment.
14. Play a computer game to test their appropriate use of water in their homes.
15. Make a drawing with labels to show what they have learned about water in their homes and the environment.

16. Make a drawing with labels to show what they have learned about water in their homes and the environment.
17. Using a specific example, explain how a technological solution to a problem can have both benefits and drawbacks such as risks or unintended consequences to aquatic resources in Texas.
18. Explain how the availability of freshwater for humans and other living organisms is dependent upon the water cycle
19. Read *Chapter 2: The Ultimate Recyclable* to reinforce concepts and vocabulary and find new information.

Texas Essential Knowledge and Skills in Science

6.1 A, B; 6.2 C, D; 6.3 B, C; 6.4 A; 6.12 E; 7.1 A, B; 7.2 C, D; 7.3 B, C; 7.4 A; 7.8 B, C; 7.13 A; 8.1 A, B; 8.2 C, D; 8.3 B, C; 8.4 A; 8.10 A, B

Aquatic Science: 2 G, J; 4 A; 6 A; 7 A

Environmental Science: 2 H, I, K; 4 C; 5 B; 6 A;

Materials

For every activity students will need their science journals.

Lesson 2.1

Long strips of butcher paper

Crayons, markers, chalk, water colors

Copies of *Student Instructions* and *Rubric* for Water Cycle Story

Lesson 2.2

Student water cycle diagrams and answers to questions from yesterday

Copy of *Weather Terms and Measurements Table* for each student

Copy of *Wind Speeds and Descriptions Chart* for each student

Copy of *Weather Observations and Measurements* sheet for each student

Pens or pencils

Weather instruments

Computers and Internet access

Lesson 2.3

<u>For Each Group of 3 Students</u>

Runoff and Infiltration Activity:

3 large foil roasting pans

Pump sprayer containing water

Food coloring

Soil (use topsoil or freshly dug yard/garden soil—commercial potting soil is too light)
1-foot square of sod (grass with soil attached—available at lawn and garden supply store)
Paper towels for spills
Wooden blocks to prop up the ends of the pans
Science journals
Pencils/pens

Lesson 2.4

<u>For Each Group of 4 Students</u>

Building an Aquifer Activity:

6” X 8” clear plastic container such as a lettuce box
1 lb oil based modeling clay (not Playdough)
5 cups sand
6 cups small rocks (aquarium rocks)
Straw
Spray bottle
3” x 5” piece of green felt
¼ cup cocoa
Pipette
Bucket of water
Cup
Roll scotch tape
Bottle red food coloring

Lesson 2.5

Student Guide, Chapter 2
Notebook paper for notes
Student journals
Computer and Internet

Lesson 2.6

Chart paper
Pencils
Markers
Student journals
Crayons or colored pencils

Safety Precautions

Use lab equipment safely.

Vocabulary

- Abiotic
- Acid Rain
- Aquifer
- Atmosphere
- Biosphere
- Climate
- Condensation
- Evaporation
- Geosphere
- Groundwater
- Hydrosphere
- Infiltration
- NOAA (National Oceanic and Atmospheric Administration)
- Precipitation
- Recharge
- Runoff
- Saturated zone
- Surface water
- Transpiration
- Wastewater
- Water treatment
- Weather
- Wetlands

Enrichments

Project WET:

- Dust Bowls and Failed Levees
- Get the Ground Water Picture
- Incredible Journey
- Piece It Together
- Poetic Precipitation

- Poisoned Pump
- Sparkling Water
- Thirsty Plants
- Water Models
- Wet Vacation
- Where Are the Frogs?

Project WILD Aquatic:
- Alice in Waterland
- Water Wings
- What's in the Air?
- Where Does Water Run?

Guest speakers:
- Local drinking water treatment plant worker
- Local wastewater treatment plant worker
- Local weather reporter

Service learning:
- Storm drain stenciling
- Litter pickup

Additional Enrichments:
- School weather station
- Field trip: Wastewater treatment plant tour

(**Note: Check with your local water treatment plant for availability of tours.)**

Lesson 2.1: How Does Water Cycle?

Essential Concept

The water cycle encompasses water movement from the clouds in the atmosphere to Earth, the geosphere, and into streams, aquifers, lakes, rivers, and oceans, the hydrosphere.

Objectives

1. Students will demonstrate their understanding of the water cycle with labeled diagrams and descriptions.
2. Students will identify the sun's energy as the driver of the water cycle fueling evaporation and transpiration, which puts water into the atmosphere.
3. Students will indicate that water in the atmosphere condenses to form clouds and falls to Earth to either be absorbed into the soil as groundwater to fill aquifers, or to run off and accumulate in streams, or other bodies of water.
4. Students identify precipitation as the rainfall that brings liquid water back to Earth.
5. Students will identify ways that the water cycle impacts the aquatic environment.
6. Students will identify ways that humans and other living things impact the water cycle.
7. Students will apply what they learned to write a story about the water cycle.

TEKS

8.10 A

Aquatic Science: 4 A; 6 A

Environmental Science: 4 C; 6 A

Estimated Time

2 class periods and homework to finish story

Materials

Large pieces of butcher paper

Crayons, markers, chalk, water colors

Pencils/pens

Science journals

Procedure

1. Diagramming the Water Cycle

Provide large pieces of butcher paper, crayons, markers, colored pencils, or chalk for each group.

Ask students to work together in groups of 4 to create a mural showing how water cycles in our environment. Encourage students to think of places water might go in its cycle that others might not think about, such as water drunk from a pond by a raccoon and returned to the soil in urine to evaporate back into the atmosphere. Students will present their group diagrams to the class.

Allow students to add to their diagrams as they see and hear other groups presentations. At the end of the presentations, all groups should have included the following in their diagrams:

- evaporation
- condensation
- precipitation
- interception (plants catch and slow precipitation)
- infiltration or recharge (water soaking into the ground)
- transpiration (plants releasing water through photosynthesis)
- runoff of surface water or stream flow
- groundwater
- accumulation (water storage in ocean, atmosphere, icepack, groundwater or fresh surface waters)

Students should work in their groups to answer the following questions in their journals:

- **Where does water come from?**
- **Where does water go when it rains?**
- **Are clouds water?**
- **Where do clouds go, if it doesn't rain?**
- **Where does the energy to drive the water cycle come from?**
- **What does water have to do with weather?**
- **Do living things in the biosphere contribute in any way to the water cycle?**
- **What can happen to water in various parts of the water cycle that will change water for better or worse? (making it cleaner or dirtier)**

Application questions for higher order thinking:

- **Does polluted water stay polluted forever or can dirty water get clean again?**
- **What role does the water cycle have in an aquatic environment?**
- **Where does water go when we flush it down the drain?**

2. Reviewing Our Water Cycle Diagrams

Students will review the water cycle by presenting their diagrams from yesterday and share their ideas about answers for their questions. Teachers may wish to assign specific questions to each group for discussion to avoid duplication.

Students may add information to their diagrams as different groups present their diagrams. So that in the end all diagrams should have complete information.

3. Using What We Learned: Writing a Story

The water cycle is typically presented as a simple cycle of evaporation, condensation, precipitation, surface runoff, and accumulation. In reality a water molecule can follow many different possible paths and does not necessarily go through those steps in a particular order. Ask students to work in groups of three to write one of the following two stories and present it to the class to show the process of the water cycle. Be aware that water may stay in some places like glaciers and the ocean for long periods of time. All member of the group will participate in creating the story, illustrations, and presentation.

1) A single water molecule that passes through various parts of the water cycle. There should be at least 20 steps. The steps should be varied and should not all repeat the exact same pattern.

Or

2) Two or more water molecules that start out together, but become separated by following different paths in the water cycle and rejoin later There should be at least 20 varied steps altogether.

The story can be told in any of the following formats:

- written story with at least 3 illustrations
- poem with at least 3 illustrations
- song or rap with at least 3 illustrations
- comic strip or graphic novel with at least 3 panels

Be sure to use the proper terms.

Some possibilities to consider:

- Since it is a cycle, you can start at any point in the cycle.
- Evaporation can occur from rivers, lakes, oceans, plants, animals, cloud droplets, dew, fog, puddles, etc.
- Condensation or deposition can make clouds (liquid droplets or ice particles), fog, dew, frost, snow, etc.
- Not all water vapor condenses at the same time. Wind can move water vapor and clouds to different locations.
- Precipitation can be rain, snow, sleet, freezing rain, or hail. Have a particular season in mind.
- Not all clouds produce precipitation – cloud droplets can evaporate back into the atmosphere.
- Surface runoff can include flows of water across the surface or underground, water caught on or dripping from plants or other objects, puddles, streams, lakes, oceans, glaciers, etc.

- Plants and animals can take in and give off water.

Example :

Molly the water molecule had been in the ocean so long she didn't remember anything about the rest of the world. She loved the ocean and would have happily stayed there, but one day, the sun evaporated her into the atmosphere, she was caught up with many other water molecules as lost and confused as she was. They were all in a huge hurricane. For a few days the hurricane cloud got more and more crowded till at one point some of the molecules started to precipitate out of the cloud. The cloud blew on until it was above the San Antonio, Texas, area and Molly got pushed, shoved, and precipitated onto the zoo grounds. She soaked into the soil and was there for about a day when she… etc.

Vocabulary:

- Atmosphere
- Biosphere
- Condensation
- Evaporation
- Geosphere
- Hydrosphere
- Precipitation
- Transpiration

Student Page

Water Cycle Story

Due Date:_____

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- Condensation or deposition can make clouds (liquid droplets or ice particles), fog, dew, frost, snow, etc.
- Not all water vapor condenses at the same time. Wind can move water vapor and clouds to different locations.
- Precipitation can be rain, snow, sleet, freezing rain, or hail. Have a particular season in mind.
- Not all clouds produce precipitation – cloud droplets can evaporate back into the atmosphere.
- Surface runoff can include flows of water across the surface or underground, water caught on or dripping from plants or other objects, puddles, streams, lakes, oceans, glaciers, etc.
- Plants and animals can take in and give off water.

Student Page

Rubric for Stories

I. Story, Song, or Rap **20 points**

1. The beginning gets the reader/listener's attention.
2. The story is appropriate for young children.
3. The story is clear, detailed, and gives ways to improve the environment.
4. All members of the group participate in presenting the project.

II. Illustrations **20 points**

1. The pictures are neat and clean.
2. The pictures are colorful.
3. The illustrations help move the story along.
4. The illustrations help to show the components of the lesson (soil, plants, hard surfaces, precipitation, runoff, pollution, and human activities that harm and those that protect the environment).

III. Organization **15 points**

1. The title is interesting or catchy.
2. Information is clear and concise.
3. The story has a beginning, middle, and end.
4. The illustrations make the story easy to understand.

IV. Accuracy **15 points**

1. The story gives accurate information about all of the components in the lesson.

V. Grammar and Punctuation **10 points**

1. Stories, songs, or raps should be neatly written.
2. Uses complete sentences.
3. Uses appropriate punctuation.
4. Uses correct spelling.

VI. Cooperative Groups **20 points**

1. All students worked together well.
2. All students participated in the presentation.
3. All students made illustrations.
4. All students worked on the writing of the song, rap, or story.

Lesson 2.2: The Water Cycle
Weather and Climate

Essential Concept

Weather is movement of water through the water cycle and varies with the seasons and the location. Weather refers to short-term atmospheric and hydrologic conditions, while climate refers to long-term weather patterns.

Objectives

1. Students generate ideas for finding reliable weather information.
2. Students will use appropriate instruments and charts to measure and record weather at their school in preparation for measuring weather at an aquatic site.
3. Students use the Internet to investigate climatic information in their area.
4. Students explain how precipitation and evaporation are related to climate.
5. Students explain how evaporation and precipitation affect aquatic environments.
6. Students watch a video on the Internet, and make a diagram of how wind and water currents affect weather.

TEKS

6.1 A, B; 6.2 C, D; 6.4 A; 7.1 A, B; 7.2 C, D; 8.1 A, B; 8.2 C, D; 8.4 A; 8.10 A, B

Aquatic Science: 2 G

Environmental Science: 2 H

Estimated Time

Two class periods.

Safety Precautions

Use lab equipment safely.

Materials

Copy of *Weather Terms and Measurements Table* for each student

Copy of *Wind Speeds and Descriptions Chart* for each student

Copy of *Weather Observations and Measurements* sheet for each student

Pens or pencils

Weather instruments

Computers and Internet access

Science journals

Procedure

1. Finding Weather Information

Students brainstorm as a class to generate ideas for finding reliable weather information. Be sure that students include newspapers, Internet weather sites, television or radio stations and taking their own data. Have students discuss how weather affects their daily lives. Ask students to describe some ways weather affects the availability of fresh water in their area or water in bays and estuaries.

Distribute a *Weather Terms and Measurements Table and Wind Speed and Descriptions Chart* to each student.

Lead class discussion of the weather terms and measurements and wind speeds described in the tables.

Distribute a *Weather Observations and Measurements* sheet to each student.

Ask students to use the sheet to record the day's weather data from one of the sources generated above and bring the completed page to class the next day

2. Measuring and Monitoring Weather Conditions

Take measurements at the school of weather data with instruments that you have available. Include as many of the following as possible temperature, precipitation, cloud cover, wind speed and direction, barometric pressure, and relative humidity.

Have students make a data table in their journals for their information. Make a graph of each component that you can continue for a sustained period. (a week, month, semester)

Discuss the need to take weather data on field trips to your aquatic site. If you have an aquatic site on campus assign students to take the measurements every day, or every week (or as often as you go to your aquatic site) on a rotating basis. Use your data to make monthly line graphs of each of the weather measurements (temperature, precipitation, cloud cover, etc.) at your school or at your aquatic site. Point out that line graphs are used for continuous data such as weather data. Use your graphs at the end of each semester to compare various weather changes and to find any correlations between various weather measurements or between weather elements and aquatic conditions.

- **Why would weather measurements be important in an aquatic ecosystem?**
- **Do we see a dominant wind direction in our area? Why might we see that trend?**
- **How might the aquatic environment be shaping the weather in different areas of the country?**

3. Climate

Weather is what is happening today in the hydrologic cycle. Climate is the long-term weather patterns of an area. Look at the historical weather data of your nearest city including precipitation by going to the Internet, and, on Google, look for NOAA and the monthly annual precipitation of your city. For instance I put in "NOAA precipitation data

for Austin, TX for 20 years" and it took me to:
http://www.srh.noaa.gov/images/ewx/aus/ausmonrain.pdf.

This site gave me Monthly Annual Rainfall charts from 1942 to 2012 for Austin Bergstrom Airport including averages of the year. You can use any of these years to make graphs. In addition to this chart, there is another chart on this same page that breaks down the data into 30-year groups giving the normal precipitation for each month over 30 years and the average for the 30-year period.

Make graphs with whatever years that you choose and analyze these graphs for:

- time period covered
- range of precipitation
- average annual precipitation
- percent of time that precipitation exceeded average
- percent of time that precipitation was below average.
- **What does the data tell you about the climate in your area?**

4. Precipitation and Evaporation Patterns

Often precipitation and evaporation rates vary from region to region. Look at another Internet site http://www.twdb.state.tx.us/publications/state_water_plan/2012/04.pdf

Scroll down the page and you will find two maps side by side. One is a map of precipitation in various parts of the state from the Texas Water Board. The other is a map of lake evaporation from Texas Parks and Wildlife Department.

Note: As with all websites, check to be sure it is still active before assigning the students this activity.

Divide the class into groups and assign each group a region of the state and find the precipitation and evaporation for that area.

- **Does your assigned region have more precipitation or evaporation? Explain.**
- **What affect would this have on the aquatic ecosystems in your assigned region?**

Have students make a data table to record the Region, Precipitation, and Evaporation. Have each group report the data for their assigned region to the class to be recorded on their tables.

5. Assessing Our Learning

Have groups work together to answer the following questions in their science journals. Students should write at least one paragraph to answer each question.

- **How are precipitation and evaporation related to climate?**
- **How do the precipitation and evaporation affect aquatic ecosystems?**

Extension

To learn more about influences on the weather, look at an animation of wind and water currents in the tropics on the Internet at:

http://earth.rice.edu/mtpe/hydro/hydrosphere/topics/Ocean_Atm_Circ_ElNino.mov

Check website to be sure it is active before assigning activities to students.

Make a diagram in your journal of how wind and water currents affect weather.

Vocabulary:

- Climate
- Evaporation
- NOAA (National Oceanic and Atmospheric Administration)
- Precipitation
- Weather

Student Page

Weather Terms and Measurements Table

Term	Description or definition	Instrument of measurement	Units of measurement	Abbreviation
Air temperature (High = highest temperature of the day; Low = lowest temperature of the day	Hotness or coldness of surrounding atmosphere	Thermometer	Celsius or Fahrenheit degrees	^{o}C or ^{o}F
Wind speed	Velocity of air movement	Anemometer	Miles or kilometers per hour	mph, mi/hr or km/hr, kph
Wind direction	Compass bearing from which wind is moving	Vane or windsock	None	N, S, E, W, NE, SE, NW, SW
Beufort Scale	Description of wind conditions and speed	Chart	Description With a number and miles per hour	Calm, light air, slight breeze, etc. to hurricane 0-12 mph
Atmospheric or barometric pressure	Weight of the atmosphere over a unit area of Earth's surface	Barometer	Inches of mercury or millibars	Inches of Hg or mb
Relative humidity	Amount of moisture in the air as a percentage of the maximum possible	Hygrometer	Percentage	%
Precipitation	Amount of rain, snow, sleet or hail that reaches the ground	Rain gauge	Inches, feet or millimeters	in., ft. or mm
Cloud cover	Fraction of sky obscured by clouds	Direct observation	Description	Clear, scattered clouds, partly cloudy, mostly cloudy, overcast

Student Page

Wind Speed and Descriptions Scale

Adapted from the Beaufort Scale

Use this chart to help you describe wind conditions.

Smoke rises straight up. **CALM** Less than 1 MPH -- 0	Whole Trees are in motion; walking against the wind is difficult. **MODERATE GALE** 32-38 MPH -- 7
Smoke drifts, weather vanes still. **LIGHT AIR** 1-3 MPH -- 1	Twigs break off the trees. **FRESH GALE** 39-46 MPH -- 8
Leaves rustle and weather vanes move. **SLIGHT BREEZE** 4-7 MPH -- 2	Slight building damage **STRONG GALE** 47-54 MPH -- 9
Light flag extended, leaves & small twigs in constant motion **GENTLE BREEZE** 8-12 MPH -- 3	Trees uprooted; seldom happens inland. **WHOLE GALE** 55-63 MPH -- 10
Dust, dry leaves, loose papers raised & Small branches move **MODERATE BREEZE** 13-18 MPH -- 4	Very rare; much general damage **STORM** 64-72 MPH -- 11
Small Trees in leaf start to sway; crested wavelets form on inland waters **FRESH BREEZE** 19-24 MPH -- 5	Anything over 73 MPH **HURRICANE** 73+ MPH -- 12
Large Branches are in motion, telephone wires whistle **STRONG BREEZE** 25-31 MPH -- 6	

Student Page

WEATHER OBSERVATIONS AND MEASUREMENTS

Objective

Obtain, record, and present weather data.

Directions

1. Find a reliable source of daily information about the weather in your area.

2. Record today's weather data for your area. Be sure you report the source of each piece of data, the date and location for which it was reported.

Name: _____

Date: _____

Location: _____

Weather factor	Observation or measurement	Information source
High temperature		
Low temperature		
Wind speed		
Wind direction		
Atmospheric pressure		
Relative humidity		
Precipitation		
Cloud cover		

Lesson 2.3: Water Runoff and Infiltration

Essential Concept

Snow and ice-melt, and rain either run off of hard surfaces to accumulate in streams, rivers, and oceans or sink into the soil (infiltrate). The streams, rivers and oceans form our surface water, and the water that infiltrates provides water that may be used by plants or seep deeper underground to form aquifers where it is held as groundwater.

Objectives

1. Students will make a model of runoff of rainwater and infiltration in an aquatic environment.
2. Students will model how pollution gets into aquatic environments.
3. Students will present information about runoff and pollution in aquatic systems in the form of a news story.

TEKS

6.1 A, B; 6.2 C, D; 6.3 B, C; 6.4 A; 7.1 A, B; 7.2 C, D; 7.3 B, C; 7.4 A; 7.8 B, C; 8.1 A, B; 8.2 C, D; 8.3 B, C; 8.4 A

Aquatic Science: 2 H; 7 A

Environmental Science: 2 I; 5 B

Estimated Time

1 class period for building and using the model

Writing a news story can be done as homework or in another class period

Materials

<u>For Each Group of 3-4 Students</u>

Runoff and Infiltration Activity:

3 large foil roasting pans

Pump sprayer containing water

Food coloring

Soil (use topsoil or freshly dug yard/garden soil—commercial potting soil is too light)

1-foot square of sod (grass with soil attached—available at lawn and garden supply store)

Paper towels for spills

Wooden blocks to prop up the ends of the pans

Science journals

Pencils/pens

Special Instructions

If you have multiple classes using the runoff/infiltration materials, have students clean up their stations before they leave. They can dump all the soil in one container, stack the sod, and refill the water sprayers before they leave.

Procedure

1. Investigating Runoff and Infiltration

Today we will make a model to look at what happens when it rains. You will use pans to represent three different hills: one with plants growing on it, one with bare ground and one with pavement. The hills slope to streams, lakes, or wetlands, which are represented by clear spaces at the bottom of the hills.

Ask each group of 3-4 students to fill one foil pan with soil so that it comes half way up the side on one end and gently slopes to the bottom of the pan, stopping about 2 inches from the opposite end of the pan. Gently pack the soil. If the soil is very dry, you might want to spray it lightly with water so that it stays in place. Prop the pan up on wooden blocks or several textbooks to create a slope. Leave 2 inches clear to represent a small pool at the bottom of the hill.

Ask students to make a similar hill in the second pan, but put soil only about 1/3 of the way up and place the sod on top of the soil. Trim the sod to fit if necessary, leaving about 2 inches open at one end of the pan. Gently press the sod down. Raise the sod end of the pan on blocks. The bottom 2 inches represent a small pool at the bottom of the hill.

Leave the third pan empty to represent a parking lot and raise one end of the pan. The bottom 2 inches will represent a small pool at the bottom of the hill.

Have students use the pump sprayer to spray water onto the sod, the bare soil, and the paved surface. Have students count the number of times they squeeze the trigger before water runs off into the pool at the bottom of the hill. Students should keep a record of their number of squeezes for each soil condition.

- **What happens in each case?** (The water takes longer to run out of the sod-covered hill than the bare-soil hill, and runs off faster down the pavement than the soil. Also, more soil will flow into the small pool at the bottom from the bare-soil hill than from the sod-covered hill.)

Have students discuss with their groups what caused the differences in the results of their rain on each of the soil, sod, and pavement hills. Students should describe some situations in which soil might be washed into aquatic resources. (house or road construction, farming row crops, dirt from roads, sparsely grassed lawns, and parking lots etc.) Students should base their explanations on the data they collected during their experiment.

2. Pollution in Runoff

When rainwater runs off of surfaces it carries along with it any impurities that it picks up or dissolves along the way. Tell the class to imagine that a man has spilled used motor oil on the ground while changing the oil in his car.

Write in your journals a prediction of what will happen if oil were spilled on each of the three hills.

Place a few drops of food coloring on each hill. (Food coloring runs quickly off the bare surface, but is absorbed by the soil and the sod.)

- **What happens on each of the different soil conditions?**

Ask the class to write a prediction in their journals of what will happen when it rains on each hill. Use the pump sprayer to spray water onto the sod, the bare soil and the paved surface. (Colored water runs quickly off the bare surface, less quickly off the soil, and slowly from the sod.)

Have students discuss the results observed and their implications for local aquatic resources.

- **What is erosion? What causes it?** (Erosion is the washing away of soil. It is caused by water running over unprotected soil.)
- **What is sediment? Where does it come from?** (Sediment is soil that has washed into a body of water. It comes from places where erosion is happening or from other places where dirt collects such as parking lots.)
- **How does human activity affect erosion and sedimentation?** (Humans walk across places creating pathways of bare soil through plant material. They have farms where soil is plowed and left bare during a season of no growth. They bring dirt on their cars onto parking lots. They construct buildings where soil is cleared of plant material during construction, etc.)
- **What is the impact of erosion and sedimentation on aquatic resources?** (Erosion often takes fertile topsoil from places it is needed leaving less fertile soil exposed and causing sedimentation in streams, rivers, ponds, etc. This sedimentation makes water muddy and prevents sunlight from reaching plants, which normally put oxygen into the water. These plants may die, decay, and cause oxygen depletion, which in turn causes other aquatic organisms to become stressed or die.
- **What is pollution?** (Litter, heat, sediments, or chemicals that are deposited or come off the land.)
- **What would happen to the pond if every house in your community had someone spilling motor oil on the soil?**
- **What are the limitations of our models?** (The models are a much smaller size and cannot show the scale of problems represented, and materials for different types of pollution are more limited than what we would find in the real world.)

3. Runoff at the Gulf of Mexico

Look on line at satellite images of a river delta such as the Rio Grande, Neches, or Trinity Rivers to see how water flow moves materials to the ocean just as our water sent material to the pond.

Websites might include NASA
http://eol.jsc.nasa.gov/sseop/EFS/printinfo.pl?PHOTO=STS060-83-50

Where you will find Photo #: STS060-83-50 Date: Feb. 1994

STS060-083-050 Rio Grande Delta,

From Google Maps you can click on satellite images of Houston at

http://wwp.greenwichmeantime.com/time-zone/usa/texas/houston/map-houston/

to see the Trinity River. Or you can go near Port Arthur to see where the Neches River enters Sabine Lake.

You may wish to move down the coast on the satellite image and see if you can find other rivers emptying into bays or the Gulf of Mexico.

- **What do you notice about each of the rivers?** (The rivers all bring sediments to the Gulf, which change the color of the water and leave soil all around the mouth of the river.)

3. Assessing What We Learned

Ask students to write a news story to tell about pollution, such as sediment, chemicals, or organic matter flowing into groundwater such as aquifers, or flowing into the surface water in ponds, bays, or the Gulf of Mexico. Be sure to include in your storyline ways that humans can prevent this from happening. (Planting trees, grass, or gardens to hold soil, limiting use of herbicides and pesticides, picking up our dog poop, cleaning up litter, cleaning wastewater before it reenters the environment, etc.)

Include ideas about surface water, runoff, infiltration, groundwater, human activity, and pollution.

Illustrations can be on posters or included with the text of the story.

Students should use the Rubric at the end of the lesson to guide them.

Vocabulary

- Aquifer
- Erosion
- Groundwater
- Infiltration
- Sedimentation

Student Page

Rubric for Stories

I. News Story **25 points**

1. The beginning gets the reader/listener's attention.
2. The story is appropriate for a newspaper, or radio, or TV news broadcast.
3. The story is clear, detailed, and gives ways to improve the environment.

II. Organization **25 points**

1. The title is interesting or catchy.
2. Information is clear and concise.
3. The story has a beginning, middle, and end.
4. The illustrations make the story easy to understand.

III. Accuracy **25 points**

1. The story gives accurate information about all of the components in the lesson.

IV. Grammar and Punctuation **25 points**

1. Story is neatly written.
2. Story uses complete sentences.
3. Story uses appropriate punctuation.
4. Story uses correct spelling.

Total **100 points**

Lesson 2.4: Infiltration and Aquifers

Essential Concept

Rain either runs off of hard surfaces to accumulate in streams, rivers and the ocean to form surface water, or sinks (infiltrates) into the soil where it may be used by plants, or seeps deeper underground to form aquifers and to be held as groundwater.

Objectives

1. Students will model infiltration and pollution of aquifers
2. Students will generate a list of 5 ways people can help keep water clean.

TEKS

6.1 A, B; 6.2 C, D; 6.3 B, C; 6.4 A; 7.1 A, B; 7.2 C, D; 7.3 B, C; 7.4 A; 7.8 C; 8.1 A, B; 8.2 C, D; 8.3 B, C; 8.4 A

Aquatic Science: 2 H

Environmental Science: 2 I

Estimated Time

1 class period

Materials

For Each Group of 4 Students

Building an Aquifer Activity:

6" X 8" or larger clear plastic container such as a lettuce box

1 lb oil based modeling clay (not Playdough)

5 cups sand

6 cups small rocks (aquarium rocks)

Drinking straw

Spray bottle

3” x 5” piece of green felt

¼ cup cocoa

Pipette

Bucket of water

Cup

Roll scotch tape

Bottle red food coloring

Special Instructions

If you have multiple classes using these materials, have students clean up their stations before they leave. Ask students to remove and discard the felt, straw, sand, and rocks. They can ball the clay up for reuse, and fill water bottles.

Procedure

1. Aquifers

We looked at what happens when pollution gets into runoff, but what happens if the pollution goes underground?

- **What is groundwater?** (Groundwater is water that seeps into the ground and stays underground such as water in aquifers. Aquifers are like underground reservoirs of water. We drill wells into them and pump water from them, which we use in many ways, such as for drinking, for our farms, and in our cities.)
- **What happens to water as it moves through soil and rocks?** (Some of the pollutants are filtered out.)

If all the pollutants aren't filtered out in the soil and rocks, people set up water treatment plants to clean our drinking water by settling, filtering, or adding chemicals to kill bacteria or remove contaminants.

2. Building an Aquifer

Have students work in groups of 4 to build a model to look at how an aquifer fills, and how a well in an aquifer works.

Along the longest side of the clear plastic container toward one end, tape the drinking straw vertically to the inside of the container so it is 1/8" above the bottom. This will represent your well.

Pour a layer of sand about 1" deep so that it covers the entire bottom of the container, including part of your straw.

Pour water into the sand, wetting it completely but with no standing water on top of the sand. Notice how the water is absorbed by the sand, remaining around the sand particles as it is stored as groundwater in the aquifer.

Flatten the modeling clay like a pancake and cover half of the sand with the clay, gently pressing the clay along three sides of the container, making sure it surrounds your well. This represents the confining layer of rock that keeps water from passing through.

Pour a small amount of water over the clay and see how it remains on top.

Place rocks over the sand and clay, covering the entire container. Arrange the rocks so that on the straw end of the container there is a hill, with a valley on the other end of the container. Do not expose the layers below.

Pour water into the aquifer until the water in the valley is about 1" from the top of the hill. Notice how the water surrounds the rocks and is stored there. Your container now has both groundwater and surface water, which can be your drinking water.

Place the piece of green felt on top of the hill. This will be your lawn or your farm. You

may need to use a little clay to fasten it to three sides of your container.

Remove the top of the spray bottle and insert its stem into the straw, depressing the trigger will pull water up from your well.

- **How does your well water look?** (Some well water is clean enough to drink without treatment.)

3. Pollution in the Aquifer

Sprinkle some of the cocoa on top of the green felt. This represents fertilizers and other chemicals used on your farm or on your lawn.

Using your pipette squirt some of the red food coloring close to the felt, and on the surface water (This represents other pollution, perhaps from an industrial source or from septic tanks.) Watch as the pollution spreads around the surface water and into the aquifer.

Fill the spray bottle with water and make it rain on your lawn or crop, watch the water run off the hill and into the surface water, carrying the excess fertilizers and chemicals. It is also seeping through your lawn and down into the ground water.

Remove the top of the spray bottle and insert its stem into the straw, depressing the trigger will pull water up from your well.

- **Now how does your well water look? Would this water be safe to drink?** (The water should look discolored from the fertilizer and pollution. It is not safe to drink with fertilizer and industrial pollution in it.)
- **What measures are taken to try to keep the water in our aquifers clean?** (Strict regulations with high fines regulate septic tanks and industry in aquifer recharge zones.)

4. Assessing What We Learned about Runoff and Aquifers

Work with your group to generate a list of 5 things that you can do to help keep runoff and aquifers clean. Write your list in your science journal.

Vocabulary

- Aquifer
- Groundwater
- Infiltration
- Surface Water

Lesson 2.5: Reading and Research

Essential Concept

Water is cleaned as it evaporates and leaves behind pollutants as part of the water cycle, then it is reused over and over providing water for our homes and the environment. This cycle happens continuously.

Objectives

1. Students will read *Chapter 2: The Ultimate Recyclable* to reinforce concepts and vocabulary and find new information.
2. Students will find out where the water for their homes comes from and how their home wastewater is processed.
3. Students will draw a diagram and label the parts showing the source of water for their home and its path through the house and back into the environment.

TEKS

6.2 C, 7.2 C, 8.2 C;

Aquatic Science: 2 J

Environmental Science: 2 K

Estimated Time

Varies. Reading and research may be done in class or as homework. Allow at least 20 minutes for in class discussion and questions.

Materials

Student Guide, Chapter 2

Journals

Pens and pencils

Computer and Internet

Procedure

1. Student Reading

Have students read *Chapter 2: The Ultimate Recyclable*. Introduce vocabulary terms as needed.

2. Questions to Consider

Assign the *Questions to Consider* as homework or use them in a cooperative learning

activity.

1) What is the water cycle?

The water cycle is the movement of water through the atmosphere, geosphere, and biosphere.

2) Where does it start and where does it end?

The water cycle can start anywhere water exists in any form. Because it is a cycle, it has no beginning or end.

3) Where does water spend most of its time?

Water spends most of its time in the oceans.

4) What is weather?

Weather is the movement of water through the water cycle, or the observed atmospheric conditions in a given time and place.

5) What is climate?

Climate is the average atmospheric conditions in an area over many years.

6) How do water and climate affect the quality and quantity of our water?

Weather and climate affect the quality and quantity of our water in many ways, including:

- The water cycle is the natural process that purifies Earth's water.
- How much water there will be in a certain region in a given part of the water cycle depends on the amount of rainfall, the effect of temperature on evaporation, and the uptake of water by plants.
- Even small changes in the global cycle can cause droughts or floods locally.

7) What kind of climate does Texas have? *Answers may include:*

- Texas climate is very varied, with the wettest areas in the east and driest in the west.
- Texas is strongly influenced by the onshore flow of tropical air from the Gulf of Mexico. Coastal areas may receive abundant rain from hurricanes, especially in late summer and early fall, and may even experience flooding.
- Many areas of Texas, such as South and West Texas may receive little rain year-round and experience drought.
- While the Panhandle and North Texas may experience regular periods of below-freezing temperatures each winter, most of Texas has mild winters with only occasional periods of cold.

8) What is surface water?

Surface water is water that flows over the land.

9) What is groundwater?

Groundwater is water that soaks into and is present in the ground.

10) What happens to water after we've used it? Where does it go when we flush or it goes down the sink drain?

Wastewater goes to a water treatment plant or into septic systems.

11) How many systems can you identify in this chapter?

Water cycle, drinking water treatment, water distribution, weather, wastewater treatment, home plumbing, weather, etc.

3. Challenge Question

Ask students to discuss the following question to apply what they've learned:

- **If water is so recyclable, how can we use that characteristic to our long term advantage in creating a sustainable water future in Texas?**

4. Let's Find Out

Ask students to research and write the answer to one of the following questions in their journals.

- **Where does your water come from at home?** (a private well, municipal water system from a lake/river or aquifer/groundwater, or a rural water system from a lake/river, or groundwater, etc.)
- **Where does the wastewater from your home go to be processed?** (septic tank, water treatment plant, etc.)
- **Are there any aquifer recharge zones near the area where you live?**
- **If you are in a recharge zone, are there special regulations about septic tanks, or water treatment?**

Students may check with their parents, call the water utility office, or look on the utility website on the Internet for this information.

Use the information you found to draw a simple diagram in your journal showing the movement of water from your source through your house and back into the environment. Label the parts of your diagram.

Vocabulary:

- Acid Rain
- Aquifers

- Atmosphere
- Biosphere
- Evaporation
- Geosphere
- Groundwater
- Hydrologic cycle
- Precipitation
- Runoff
- Saturated zone
- Surface water
- Transpiration
- Wetlands

Lesson 2.6: Tap Water and Wastewater

Essential Concept

Water journeys not only through the water cycle, but also from a surface or groundwater source to our homes and schools, and down our drains and out of the building to be cleaned and returned to the environment.

Objectives

1. Students will identify the source of school tap water.
2. Students will identify how wastewater from school is treated.
3. Students will diagram water from the source to their school, through their drains, to wastewater treatment, and back into the environment.
4. Students will play a computer game to test their appropriate use of water in their homes.
5. Students will make a drawing with labels to show what they have learned about water in their home, school, and the environment.

TEKS

6.12 E; 7.13 A

Aquatic Science: 2 J

Environmental Science: 2 K

Estimated Time

1 period

Materials

Chart paper

Pencils

Markers

Journals

Crayons or colored pencils

Special Instructions

The teacher should conduct an investigation to determine where the school's tap water comes from, how the school's tap water is treated, where the school's wastewater goes, and how the school's wastewater is treated.

Procedure

1. Where Do We Get Our Water?

Using the information students learned from the "Let's Find Out" section of the last lesson, have students work together as a class to generate ideas about where they think their school tap water comes from. List ideas on the board or on an overhead or chart paper. Discuss each idea and then ask questions to fill in other information.

- **Do we all have the same water source? Do you think water we get at school is from the same source as the water you get at home?**
- **Do you get water at your home from untreated groundwater such as wells** (This may be the source for some students, especially in rural areas.)
- **Does anyone use treated groundwater?** (Some cities and rural water systems have wells into an aquifer where they get water for their water systems, and they treat this water.)
- **Does anyone use treated water from a surface water source?** (This would be like a municipal or rural water system using lake water.)

  Have students work in groups to talk through the steps water must take to get from a source to the tap.

- **What steps does water go through to get from this source to your faucet at your school or house?** (In some cases water is pumped from the source to the treatment plant and then to homes and schools. In other cases it may be pumped directly from wells to the house.)

  Have each group draw a diagram on chart paper of how they think this works for their home. (Ask students to leave room on their chart so that they can add more steps to their diagrams.)

- **Where do you think your school and home wastewater goes?** (Some possible ways that wastewater may travel include from the drain to septic systems or sewage lagoons of individual domestic systems in suburban and rural areas, small-scale treatment systems in domestic systems in suburbs, and large-scale treatment plants and wastewater wetlands in municipal systems.)

  Have students add the flow of wastewater from drains in their school to the water treatment facility to their diagrams.

- **What are the steps wastewater must go through to get from toilets back into the environment?** (Wastewater moves from drains to septic systems where organic material is broken down by bacteria, then the water slowly seeps back into the ground. It also can move from drains to sewers to water treatment plants where water is filtered, suspended material is allowed to settle, and chemicals are added to kill bacteria and other organisms. Then clean water is sent back to surface waters such as lakes and rivers, where it is reused by people and the environment.)

  Have students add the steps in treatment and water's return to the environment to their diagrams.

- **Where does water go when it runs off of a street? (**Stormwater runoff usually goes through storm drains or ditches, then directly into streams, lakes and wetlands without being cleaned or processed. Anything that is on the ground, streets or parking lots such as litter, grass clippings, fertilizer, pesticides, motor oil, or other chemicals goes directly into streams, lakes, and wetlands.)

  Have students add this runoff to their diagrams.

2. What Do You Think Goes Down the Drains in Your Home?

Have students go to the following site to play a game called *Down the Drain* to see if the things they have going down the drain at their homes are appropriate for their plumbing, and find out if they are conserving water. **Note: Websites come and go. Be sure you check to see if it is still active, before giving the web address to students.**

www.miwaterstewardship.org/youthstewards/onlinewatergames/downthedrainyougo

In this game students can choose an urban or rural home. They will see all the drains in the house and choose ways that they use their drains. They will get feedback on their use of water and the condition of their drains.

3. Assessing What We Learned: Water's Journey

Have students draw a picture and label the parts in their journals and write the story of water's journey.

Indicate the source of their water, the way it gets to their homes or school and out of the tap, down the drain, to the wastewater treatment system and back into the environment.

Water is an abiotic part of the ecosystem to which organisms react. Indicate in your drawing how organisms use water, and interact in water, and how organisms react to pollutants in the water.

Explain how something that seems beneficial, like plowing farmland, fertilizing your lawn or garden, changing the oil in your car, or paving roads can have unintended consequences for aquatic environments. (These activities add sediments, and chemical and thermal pollutants to our water.)

Vocabulary:

- Abiotic
- Groundwater
- Surface Water
- Wastewater
- Water treatment

Chapter 2 Assessment

Directions

Select the best answer for each of the following multiple-choice questions.

1. How does the water cycle purify water?

A Water flows through underground aquifers.

B Every time water evaporates it becomes pure again.

C Water vapor condenses to form raindrops.

D All of the above.

2. Where does the water cycle start?

A Anywhere water exists in any form

B Water vapor condenses in clouds

C When precipitation falls to the ground

D In the oceans

3. What is weather?

A Hot, damp summers and cold, dry winters

B The movement of water from soil through plant roots and stems, and out the leaves into the atmosphere

C Average atmospheric conditions in an area over many years

D The movement of water through the water cycle

4. What is climate?

A Hot, damp summers and cold, dry winters

B The movement of water from soil through plant roots and stems, and out the leaves into the atmosphere

C Average atmospheric conditions in an area over many years

D All of the above

5. What is surface water?

A Water absorbed by plants and released slowly into waterways

B Water that soaks into the ground

C Water that flows over the land

D Water frozen in glaciers, snowpacks, and polar ice caps

6. What is groundwater?

A Water absorbed by plants and released slowly into waterways

B Water that soaks into the ground

C Water that flows over the land

D Water frozen in glaciers, snowpacks, and polar ice caps

7. Where does water go when it runs off a street?

A To wastewater treatment plants for processing before being returned to the environment

B To drinking water treatment plants, then through pipes to our taps

C To pick up air pollution, forming acid rain

D Through storm drains or ditches, then directly into streams, lakes, wetlands, bays and estuaries without being cleaned or processed

8. Where does water go when it goes down the drain?

A To a wastewater treatment plant, septic system or lagoon for processing before being returned to the environment

B To drinking water treatment plants, then through pipes to our taps

C To pick up air pollution, forming acid rain

D Through storm drains or ditches, then directly into streams, lakes and wetlands without being cleaned or processed

Chapter 2 Assessment

Directions

Write your own answer for each of the following questions.

1. Define weather and climate and differentiate between the two. How are they related?
2. Describe Texas' climate.
3. Justify the following statement: The availability of water for humans and other living organisms is dependent upon the water cycle.
4. Assess how human activities affect the quality of water. Using a specific example, show how a technological solution (such as groundwater wells, paved roads and parking lots, sewer systems, use of fertilizers and herbicides, etc.) to a problem can have both benefits and drawbacks (such as risks or unintended consequences) to aquatic resources in Texas' fresh and marine waters.