Exploring Aquifers Lesson Three:
"Watersheds and Aquifers?"

Academic Questions: What is a watershed?
How does water move across a watershed and into an aquifer?
What are the origins, amounts, and quality of water in a watershed?

Objective(s):
- To understand what a watershed is
- To understand the relationship between a watershed and an aquifer

Key Terms: aquifer, watershed, topography, recharge zones, and drought
Click here for definitions to Exploring Aquifers vocabulary.

Process (Activities):

Note: This activity is a modified version of the Cyberways and Waterways curriculum Waterway Stories: Interpreting the Babblings of Water: Lesson Two Where Does the Water Go. You might consider using the Waterway Stories lessons as an overarching framework for your water classroom instruction.

1. Before you begin you will need to gather the following materials:
    a. A small-scale topographical map of a Texas county that is over a major aquifer. Eighty percent of Texas land is on top of an aquifer. If your county resides over an aquifer, select the topographical map of your county. Use the map of major Texas aquifers from lesson one as a resource. (Topographical maps can be obtained from the Bureau of Economic Geology of the University of Texas by contacting the Publications Sales Office at 1-888-839-4365 or 512- 471-7144.
    b. Colored pencils
    c. Transparencies
    d. A map symbol key for your map
    e. Cardboard or other thick materials that students can cut to create a relief map of the area
    f. Heavy duty aluminum foil, about 70 cm long
    g. Spray bottle filled with water
    h. A map of the average annual precipitation of Texas. This map can be found online at the University of Texas Online Library website: http://www.ocs.orst.edu/pub/maps/Precipitation/Total/States/TX/tx.gif

2. Make copies of the topographical maps to allow students to work in collaborative groups of three or four students. You may want to laminate the maps or attach transparencies to the maps so student can trace the watershed directly on the map. If you are working with older students, you may want to give each group a different topographical map or work with different waterways on the map. The resulting watershed created in this lesson will be placed on top of the aquifer model created in lesson two. Before you begin make sure that the scale of the watershed is small enough to allow for this. If the scale is so small that it becomes difficult to read the contour lines, allow students to first create a large-scale watershed and then recreate a smaller scale to place over the aquifer.

3. Have students place a transparency over the map. Explain to students what a topographic map is and allow students to identify elevated and flat areas on their maps using the lines of relief. Complete the following steps on the transparency:

a) Ask the students to locate a waterway on their topographic map. Have them trace the waterway in blue.
b) Ask students if any other waterways contribute to (flow into) this waterway.
c) Ask students to locate and mark the highest points surrounding the waterway.
d) Ask students to connect these high points together as they follow the ridgelines around the waterway. This will outline the watershed of the waterway.
e) Ask students to locate and label any major industries or agriculture areas within the watershed.
f) Once students have traced the watershed outline, they should then trace the contour lines within the watershed. If you are using a topographical map with very fine detail, students should only trace major contour lines.

4. Have students estimate the area of the watershed by placing the marked transparency over graph paper and count the number of squares. Help students calibrate the map scale to the graph square size to find the total area of the watershed.

5. Have students transfer these lines to paper that will act as the templates of the layers of the watershed model. Be sure the students number each template. (The easiest method for making templates is to photocopy the transparency enough times so that students can cut each topographical layer out individually.)

6. Use the numbered templates to cut each layer out of the cardboard. Once each layer is cut out, have students create the relief map that represents their watershed. They should also create representations of the homes and businesses they labeled on their transparency.

7. Have students create a mold of their watershed using the heavy-duty aluminum foil. Students should simulate how water flows over the watershed, into the waterways and into the aquifer by "raining" on top of the mold using the spray bottle.

8. Students can further explore and research their watershed using EPA's Enviromapper for watersheds: http://map2.epa.gov/enviromapper/. This interactive resource allows students to zoom in on their area of study, assess the water quality vulnerability, explore the different watershed tributaries, and much more. This web site can be used as a checkpoint for students to compare and contrast the boundaries of the watershed they traced to those mapped using the Enviromapper.

Product/Application: Have students place their watershed mold over the aquifer model created in Water Flow in Aquifers: Lesson Two and discuss the different ways water flowing over the watershed can enter the aquifer. (If the watershed mold is too large to place over the aquifer, allow students to create a smaller scale mold that will match the dimensions of the aquifer model.) Ask students to discuss the recharge zones of the aquifer and how this might be represented in the mold. (Most students will decide to make small holes on the mold in the recharge area of the aquifer.) Ask students to determine if any other features should be added to the watershed mold to represent its connection to the aquifer.

Assessment/Evaluation: Ask students where all the water within a watershed originates. All water, even that flowing through river and streams, originally fell to the Earth as some form of precipitation. Hand out copies of the Average Annual Precipitation map of Texas and ask the students to discuss how these rainfall amounts might affect the different major aquifers in Texas. Ask students to identify the aquifers that are most threatened by drought conditions. Ask students to identify the aquifers that are most likely to experience rapid recharge during non-drought conditions. As an extension activity that is particularly important if you will not have

time to complete Lesson Five: Water Threats to an Aquifer, ask the students the following questions about the connections between their watershed models and aquifers:

- Ask students to identify sources of nonpoint source pollution within their watershed model and how or if this pollution can impact an aquifer.
- Ask students to describe ways in which aquifer spring flow can become contaminated.
- Ask students to identify those types of aquifers that would do the best job of filtering nonpoint source pollution.
- Ask students to identify those aquifers that would do the poorest job of filtering nonpoint source pollution.
- Ask students to evaluate the risks associated with nonpoint source pollution in areas where recharge waters are contaminated with nonpoint source pollution and enter the different types of aquifers.

Resources:
USGS in Texas, Relations of the occurrence and magnitude of contaminants to selected environmental characteristics for watersheds in Texas:
http://txwww.cr.usgs.gov/project.asp?cc=4648&ac=19000

The Bureau of Economic Geology of the University of Texas has very inexpensive maps of Texas Geology, River Basins, Land Resources of Texas, Energy Resources, Mineral Resources, Geological Highway Map, and a Structure Map of the San Antonio Segment of the Edwards Aquifer and Balcones Fault Zone. For further information or to order, please contact the Publications Sales Office at 1-888-839-4365 or (512) 471-7144.

Time Frame: One week of 45 minutes lessons
Grade Level: 6th-12th

TEKS Correlation:
Science
Grade 6: 6.1, 6.2, 6.3, 6.4
Grade 7: 7.1, 7.2, 7.3, 7.4, 7.8, 7.12
Grade 8: 8.1, 8.2, 8.3, 8.4
Biology: (b)1, 12.D
Aquatic Science: (b)1, 4.B, 7B,C, 8.C,D
Environmental Science: (b)1, 5.A,B, C, E, F
Geology, Meteorology, and Oceanography: 10.C

Mathematics
Grade 6: 6.1, 6.8, 6.11, 6.12, 6.13
Grade 7: 7.3, 7.4, 7.9, 7.13, 7.14, 7.15
Grade 8: 8.5, 8.14, 8.15
Geometry: 6
Precalculus: 2

Technology Applications (Computer Literacy)
Grades 6-8: 2, 4, 5, 7, 8

Social Studies
Grade 6 6.21, 6.22, 6.23
Grade 7 7.8, 7.21, 7.22, 7.23

Grade 8 8.10, 8.30, 8.31, 8.32

English
Grade 6: 6.1, 6.2, 6.5, 6.13, 6.17, 6.20, 6.22, 6/24
Grade 7: 7.1, 7.2, 7.5, 7.13, 7.17, 7.20, 7.22, 7.24
Grade 8: 8.1, 8.2, 8.5, 8.7, 8.10, 8.13, 8.17, 8.18, 8.20, 8.22, 8.24
English I: 1, 4, 6, 8, 13, 15, 16, 21
English II: 1, 4, 6, 7, 8, 13, 15, 16, 21