AGRISCIENCE EXERCISE

PHYSICAL SCIENCE/ENVIRONMENTAL RESOURCE SYSTEMS

Key Concept: The Physical Environment / Water Resources

Sub-Concept: Understanding Soil & Water / Groundwater

Agricultural Context: Agriculturalists depend on an abundance of available, usable water for efficient production of food and fiber.

Exercise: **Identify Surface and Ground Water Supplies**

Applied Principle: Surface and ground water are the sources of available water for human and animal use.

Goals:
1. Identify state surface and ground water supplies.
2. Identify and discuss community water sources and availability.

Preparation Time: Allow time to order maps and to call your local water supplier for information on water sources if necessary.

Materials:
- State highway maps
- Student data sheets
- State groundwater maps

References: Chilson, J., Hehn, D., and Sivertsen, D. (1994). "Identify surface water supplies." South Dakota AgriScience Lab Manual.

Oviatt, J. and Steichen, J. (1993). Curriculum Units for Water Resources. Manhattan, KS: Department of Secondary Education, Center for Science Education, College of Education.

Teacher Preparation:

- The questions in this activity may need to be tailored more specifically to your particular group of students and your local situation.
- You may find additional information regarding water sources at your local S.C.S. office, such as groundwater reservoir maps.
- From your city water department, find out about local water sources (what they are, their condition, etc.)
- This activity is a good lead-in for a study of how groundwater moves, and how groundwater supplies are affected by wells.

Procedures for Conducting the Activity:

1. Divide students into pairs, and provide each pair with a state map, an aquifer map, and a data sheet.

2. Instruct students to complete their data sheets by locating lakes, rivers, streams, dams, reservoirs, and aquifers in your area of the state.

3. When everyone has completed the data sheets, engage the class in a discussion of each question covered. The instructor should interject relevant information from the Background Sheet as appropriate during this discussion.

AGRISCIENCE EXERCISE

Identify Surface & Groundwater Sources

STUDENT DATA SHEET

Using your own paper, answer the following questions from the two maps provided by your instructor. Be prepared to fully discuss your answers with the rest of the class.

<u>State Surface Water Sources</u>

1. From the maps provided, locate the lakes, rivers, and reservoirs in your state. Record these and state what their significance as water sources are to the area they are located.

2. What are the feeder streams or rivers of each surface water source listed above?

<u>State Groundwater Sources</u>

1. Using the map of your state aquifers provided, indicate which effect your community, if any.

2. What are the two largest aquifers in your state?

3. How many of the groundwater areas on the map are interconnected? What are they?

4. How many surrounding states share groundwater sources with your state? List them.

<u>Community Water Sources</u>

1. Of the surface water sources discussed in Part 1, which directly affect your community?

2. Which groundwater sources are available to your community?

3. Where does your city's water come from?

4. How many homes in your community get water from wells?

5. How does the water for residential use get from the point of origin to the point of use in your community?

6. Is there an abundance of usable water in your area? If not, where else would your community get water?

<u>General Discussion Questions</u>

1. Of all the areas in your state, which area is most likely to experience water shortages?

2. How could this be remedied?

2. Considering all geographic, climatic, and topographic conditions, explain why some areas of your state have fewer (or smaller) sources of water than others.

3. What effects could be felt in your state that would result from the abuse of underground or surface water resources?

4. Explain what and where certain industries are located and explain how this may be connected to water supplies.

5. Identify the areas of your state located far enough away from a water source that they may experience difficulty in the transport of water to their area. If there are any, state some social, economic, and living hardships which those areas might encounter.

6. Looking at both maps provided, how many major cities or communities in your state are centered around water sources?

7. Identify two or three environmental issues in your state (or area) that may relate to water sources. What are some possible solutions to these problems?

TEACHER BACKGROUND SHEET

Identify State & Local Water Supplies

GROUNDWATER

"**Groundwater**" is the water underneath the Earth's surface. Understanding water tables is the first step in understanding groundwater.

In a water table, there are two zones, the "**saturated**" zone and the "**unsaturated**" zone. The saturated zone is the zone at the bottom of the water table where the gravel is completely covered with water. All of the spaces between the soil and gravel are full of water. The gravel is saturated.

The unsaturated zone is the upper layer of the water table where the spaces between the chunks of soil or gravel are full of air, not water. Water passes through the unsaturated zone but does not stay there.

The water table is at the top of the saturated line and separates the saturated zone from the unsaturated zone. A well is a hole dug through the unsaturated zone into the saturated zone.

If water is pumped out of the saturated zone, nearby groundwater will move in to take its place. Wells take groundwater out of the earth ("**discharge**"). Unless more water is put into the ground ("**recharge**"), the water table will eventually fall below the level of the well and water will not be available to pump out. Pumping too much of the water from the well is over withdrawal. Over withdrawal can cause a **cone of depression**, and can cause nearby wells to go dry. The pore spaces in the rock my collapse making recharge impossible. If the water table is to remain the same, the water going into the ground must equal the water coming out of the ground. A spring bubbling out of a hillside is also groundwater coming out. Ponds and lakes may also be fed by groundwater and/or surface water.

Any time the surface of the ground dips below the water table groundwater seeps out. Sometimes it seeps into lakes, ponds, rivers, streams or even the ocean. It is then surface water because it is no longer below the ground level but is now on the surface.

It is not just a matter of how much recharge an area gets (rainfall, melting snow, etc.), but also a question of how quickly the water can move into and through the ground. All of that depends upon the type of soil and rock the water is moving through.

A common misconception that many people have about groundwater is that there are large underground lakes or vast systems of underground rivers or streams. This is not true. Groundwater is the water within the cracks, crevasses, and pore spaces of the soil and rock material that makes up the Earth's outer surface layer. These "open" pores in the ground can be filled with either air or water depending on the location and the amount of water that is present in the material. If these pores are interconnected and water can travel through them, then the ground is said to be **permeable**. The fact that there are pores makes the ground **porous.** This groundwater is capable of changing locations within the ground, able to take on the characteristics of the soil or rock in which it is stored (i.e., flavors, mineral content or hardness, etc.), and can be in an almost constant depletion/replenishment cycle.

AQUIFERS

Any layer of the Earth's rock or sediment that will store and release water in a quantity usable to a well or a spring is referred to as an "**aquifer**." These are not underground lakes of water, but more like underground sand or gravel piles that are saturated with water.

An aquifer in which the upper level of water is free to rise and fall as the water level changes or as the topography of the Earth's surface changes is called an "**unconfined**" aquifer. The water level in a well drilled into an unconfined aquifer will indicate the water table (the top of the aquifer).

An aquifer that is full and is overlaid by a layer of material that is confining (impervious or resistant to water movement) is called a "**confined**" or "**artesian**" aquifer. A well drilled into a confined aquifer will have a water level that will rise above the top of the aquifer itself. The level to which the water rises in a well drilled in a confined aquifer depends upon the elevation of the recharge area (location at which water enters into the material that makes up the confined aquifer) in relationship to the ground level of the well. If the recharge area is higher in elevation than the level of the well drilled into that aquifer, then water will flow freely from the well. This is called an artesian well or free-flowing well.

The amount of water in an aquifer and the ability of that water to be removed from the aquifer is determined by a variety of factors. The factors may include the precipitation of the area, depth of the aquifer, soil type, material the aquifer is composed of, and the type of pore space in the aquifer material.

The major aquifers in the state of Kansas, which are also found in many high plains states and low plain states, from east to west are:

a. **OZARK** Located in extreme southeast Kansas, this aquifer covers parts of three counties. Water from this aquifer is very hard in nature, like much of the ground water found in Kansas. This water is used for rural domestic and public water supplies. There is a growing concern that this aquifer may become contaminated by water found above it that has accumulated in abandoned lead, zinc, and coal mines. This water is high in dissolved minerals, especially sulfur. pH values as low as 2.2 have been found in these flooded mine shafts. While the Ozark aquifer is deeply buried beneath the mines, there is a growing concern about contamination occurring through drill holes and fractures.

b. **DOUGLAS** This aquifer is located in a narrow band from Leavenworth County southwest through Douglas, Coffey, Osage, Woodson, Wilson, Elk, and Chautauqua Counties on the southern border of the state. This is a relatively shallow aquifer that is used for rural and public water supply when it is near the surface. Water from this aquifer is relatively hard and in some areas is likely to be saline.

c. **GLACIAL-DRIFT AQUIFERS** These aquifers are scattered across the seven to eight counties found in far northeast Kansas. This area was greatly impacted by glacial action during the Ice Age period. Because of this, there is a great variety between soils and underlying rock in the area. Glacial-drift aquifers are found in pockets of porous or coarse substrate. Wells drilled into shallow aquifers are used for rural or public supply. Wells drilled into the deeper aquifers many times have high concentrations of dissolved solids, which make them unsatisfactory for human consumption or use.

d. **CHASE & COUNCIL GROVE** This aquifer is found underlying the area of the state known as the Flint Hills. Starting in Cowley County and continuing north through Butler, Chase, Morris, Geary, and Dickinson counties it is the largest aquifer in terms of area covered of any of the aquifers found in eastern Kansas. This water is used for rural domestic and public water supplies. The hardness of the water is high and there are areas that are unusable because it is briny and has high chloride concentrations.

e. **ALLUVIAL AQUIFERS** These aquifers are located in the primary and secondary flood plains of the major rivers of the state. They are recharged from sites located above the river valley and may vary in depth depending upon the level of water in the river. Primary uses of water from alluvial aquifers are for public, industrial, and agricultural use. In some areas of the state, alluvial aquifers are contaminated by up flow of briny waters from underlying layers of consolidated rock. An example of this can be found east of Salina in the Smoky River Valley. Water from the Hutchinson Salt Formation moves upward into the alluvial waters found in the river valley. The Smoky River is not used for irrigation purposes because of this inflow of high salinity water.

[**NOTE:** The aquifers listed above are the only major ones found east of a line from Concordia to Wichita (Highway 81 and I-135). Much of eastern Kansas is not served by a principal aquifer.]

f. **GREAT PLAINS** This aquifer is located in north central Kansas starting at the northern border in Washington and Republic counties and continuing southward through Cloud, Ottawa, Lincoln, and Ellsworth counties. It then meanders westward through Barton, Rush, Ness, Hodgeman, and Finney counties. This aquifer is deeper in many locations than those found in eastern Kansas. Water quality is acceptable in areas where the aquifer is relatively shallow but decreases in quality as the depth of the aquifer increases.

g. **HIGH PLAINS (OGALLALA)** This aquifer, which covers the western third of the state reaches from west Texas to South Dakota. It is one of the largest aquifers in terms of quantity of water found in the world. The saturation depth (depth of water) in this aquifer varies from 0 to 1200 feet. This aquifer supplies water for rural and public use as well as for industry and major cities, although the majority of water removed from this aquifer is utilized for agricultural irrigation use.

By comparing records of well depth over a period of years, it is possible to determine whether the aquifers of the state are being depleted. Aquifers which have major withdraws (many large wells for irrigation, industrial, or municipal use) have shown a drop of water level in the last

30 to 40 years. Aquifers will show a faster depletion rate during times of low precipitation and may even show a water level increase in times of high precipitation. If an aquifer shows continual depletion, its use may be restricted or even stopped completely.

CONDITION OF THE OGALLALA

Since the Ogallala aquifer is so large, and so heavily used, its condition is of major concern for many agriculturalists and others. Data collected from 1950 to 1990 in the Ogallala aquifer region show that the water level drop varied depending on the locations of the wells. In areas where irrigation is the greatest, the potential for aquifer depletion is the greatest.

If the Ogallala were to be depleted to the level where irrigation would have to stop, there would be a major impact on the economies of the areas it serves. Not only would farmers be greatly limited in the types of crops they could grow, but many major industries would be affected as well. The cattle feeding industry has located in the areas of this aquifer because of the plentiful sources of feed grains. Likewise the beef packing industry has developed into a major employer in the region. A loss of water for irrigation would nearly eliminate these industries and the jobs they create. It is important to note that irrigation will not pump the Ogallala dry. As the water level in a well drops, it becomes more expensive to pump water from that well due to the increased amount of energy required to lift the water to the surface. The loss of profit from raising irrigated crops would stop pumping long before the aquifer was pumped dry. An example of this can be seen in west Texas, where the water table dropped enough that it was no longer profitable to pump water for crop irrigation. This entire region has returned to dry land cropping.

The regions of the Ogallala aquifer have undergone many changes in their water usage practices during the past 15 years in an attempt to reach a zero depletion rate. For example, cities have encouraged homeowners to cut water usage by implementing “xeriscaping.” This involves landscaping homes and buildings with plant materials that are adapted to the area or are low water use plants. Utilization of these plant materials, along with water conserving measures such as mulch and drip irrigation methods all will reduce the water demand for landscape care in the communities.

The greatest water user from the Ogallala is agriculture. The irrigation industry has been implementing many innovations in the past years to obtain maximum crop growth on the least amount of water. Conversion to low pressure central pivot irrigation systems, with nozzles that apply water directly at the crop level, cuts the evaporation of water a great deal. In furrow irrigation systems, they are utilizing solar panels which control irrigation valves. These valves apply water to a field in surges which greatly reduces the amount of water it takes to water an entire field. Different tillage practices which reduce the evaporation of water from the field surface also decrease the need for irrigation water. Catching runoff water in tailwater pits and reapplying this water to the field in another practice also reduces the need to pump groundwater.