Geofact

How Much Groundwater Is There on Earth? There are about 50 million cubic kilometers of groundwater on Earth. That means there is about 20 times more water underground than in all of the rivers and lakes on Earth!

Groundwater

Most of the fresh water that is available for human use cannot be seen—it exists underground. When it rains, some of the water that falls onto the land flows into lakes and streams. But much of the water percolates through the soil and down into the rocks beneath. Water stored beneath the Earth's surface in sediment and rock formations is called **groundwater.**

As water travels beneath the Earth's surface, it eventually reaches a level where the rocks and soil are saturated with water. This level is known as the *water table*. In wet regions, the water table may be at the Earth's surface and a spring of fresh water may flow out onto the ground. But in deserts, the water table may be hundreds of meters beneath the Earth's surface. The water table is actually not as level as its name implies. The water table has peaks and valleys that match the shape of the land above it. Just as surface water flows downhill, groundwater tends to flow slowly from the peaks of the water table to the valleys.

Aquifers An underground formation that contains groundwater is called an **aquifer.** The water table forms the upper boundary of

CASE STUDY

The Ogallala Aquifer: An Underground Treasure

Anyone who has eaten food produced in the United States has probably enjoyed the benefits of the Ogallala Aquifer, one of the largest known aquifers in the world. This enormous underground water system formed from glaciers that melted at the end of the last Ice Age, 12,000 years ago. Today, the Ogallala Aquifer supplies about one-third of all the groundwater used in the United States.

People began to use the Ogallala Aquifer extensively for irrigation in the 1940s. With help from this ancient water source, farmers turned the Great Plains into one of the most productive farming regions in the world. For many years, farmers seemed to enjoy a limitless supply of fresh water. But in recent years, the Ogallala Aquifer has started to show its limits. Water is being withdrawn from the aquifer 10 to 40 times faster than it is being replaced. In some places, the water table has dropped more than 30 m (100 ft) since pumping began.

Humans are not the only living things that depend on the Ogallala Aquifer. In some areas, the aquifer flows onto the surface and creates wetlands, which are a vital habitat for many organisms, especially birds. These wetlands are often the first habitats to disappear when the water table falls.

Many people are working together to try to conserve the Ogallala Aquifer. For example, some farmers have begun to limit irrigation during bird migrations in order to allow surface-water levels

▶ **The Ogallala Aquifer** holds about 4 quadrillion liters of water—enough to cover the United States to a depth of 0.5 m (1.5 ft).

an aquifer. Most aquifers consist of materials such as rock, sand, and gravel that have a lot of spaces where water can accumulate. These aquifers hold water in much the same way that a sponge holds water. Groundwater can also dissolve rock formations, such as those made of limestone, and fill vast caves with water, which creates underground lakes. Aquifers are an important water source for many cities and for agriculture.

Porosity and Permeability How can a rock formation hold millions of gallons of water? Although most rocks appear solid, many kinds of rocks contain small holes, or pore spaces. **Porosity** is the amount of space between the particles that make up a rock. Water in an aquifer is stored in the pore spaces and flows from one pore space to another. The more porous a rock is, the more water it can hold. The ability of rock or soil to allow water to flow through it is called **permeability.** Materials such as gravel that allow the flow of water are *permeable*. Materials such as clay or granite that stop the flow of water are *impermeable*. The most productive aquifers usually form in permeable materials, such as sandstone, limestone, or layers of sand and gravel.

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▶ **Sandhill cranes** are among the many kinds of birds that rely on water from the Ogallala Aquifer.

to rise. Other farmers have adopted water-saving irrigation systems and are planting crops such as wheat or grain sorghum, which require less water than corn or cotton.

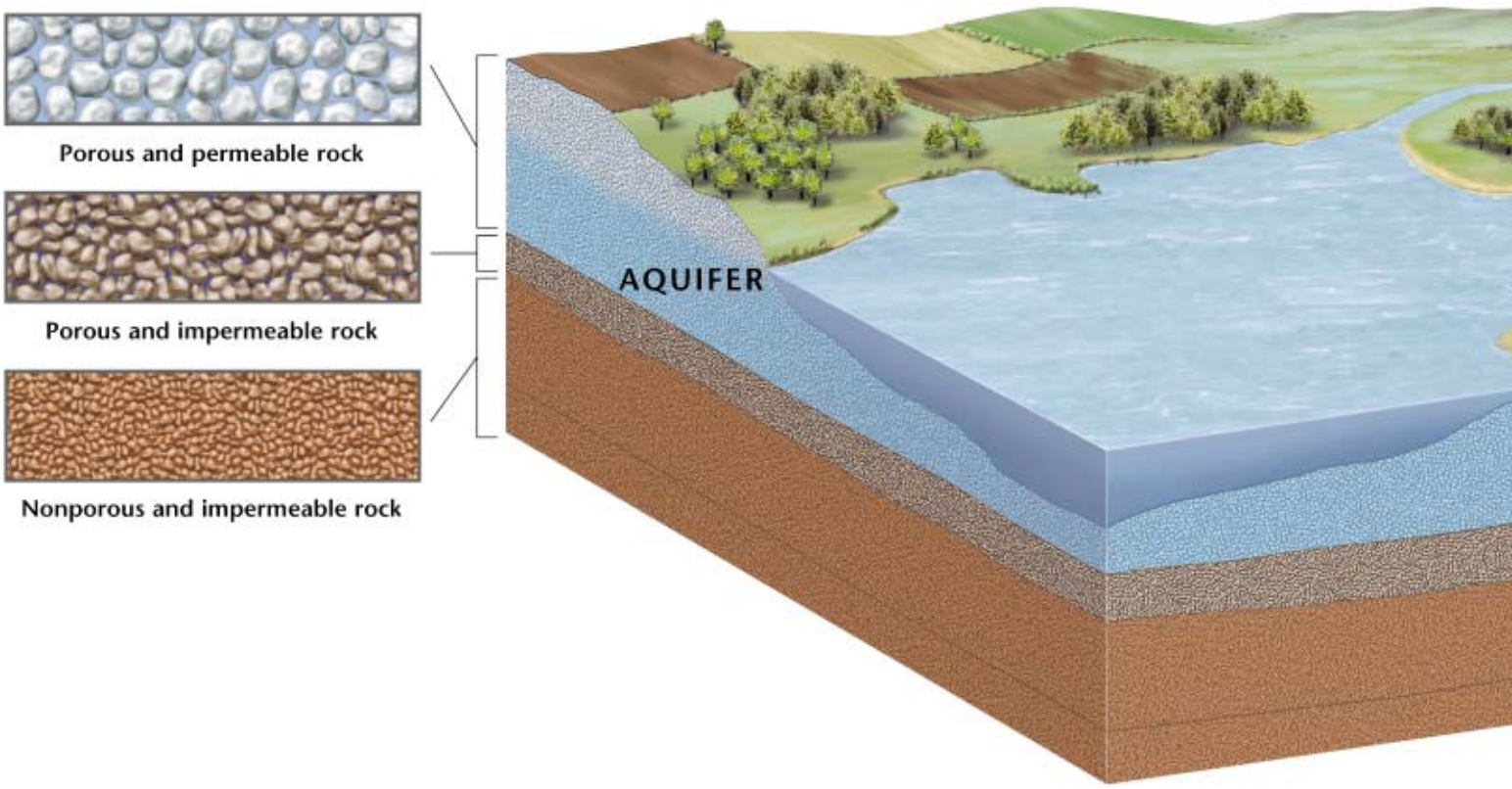
Many farmers and other residents of the Great Plains recognize the value of the Ogallala Aquifer and are fighting to preserve it. They are pressuring politicians to replace policies that encourage wasting water with policies that promote water conservation. These efforts may help save this underground treasure.

CRITICAL THINKING

1. Applying Ideas Most of the water in the Ogallala Aquifer came from glaciers that melted thousands of years ago. What is the aquifer's primary water source today?

2. Expressing Viewpoints Do you think residents of the Great Plains are the only people who have an interest in conserving the Ogallala Aquifer? Write an editorial that expresses your viewpoint.
WRITING SKILLS

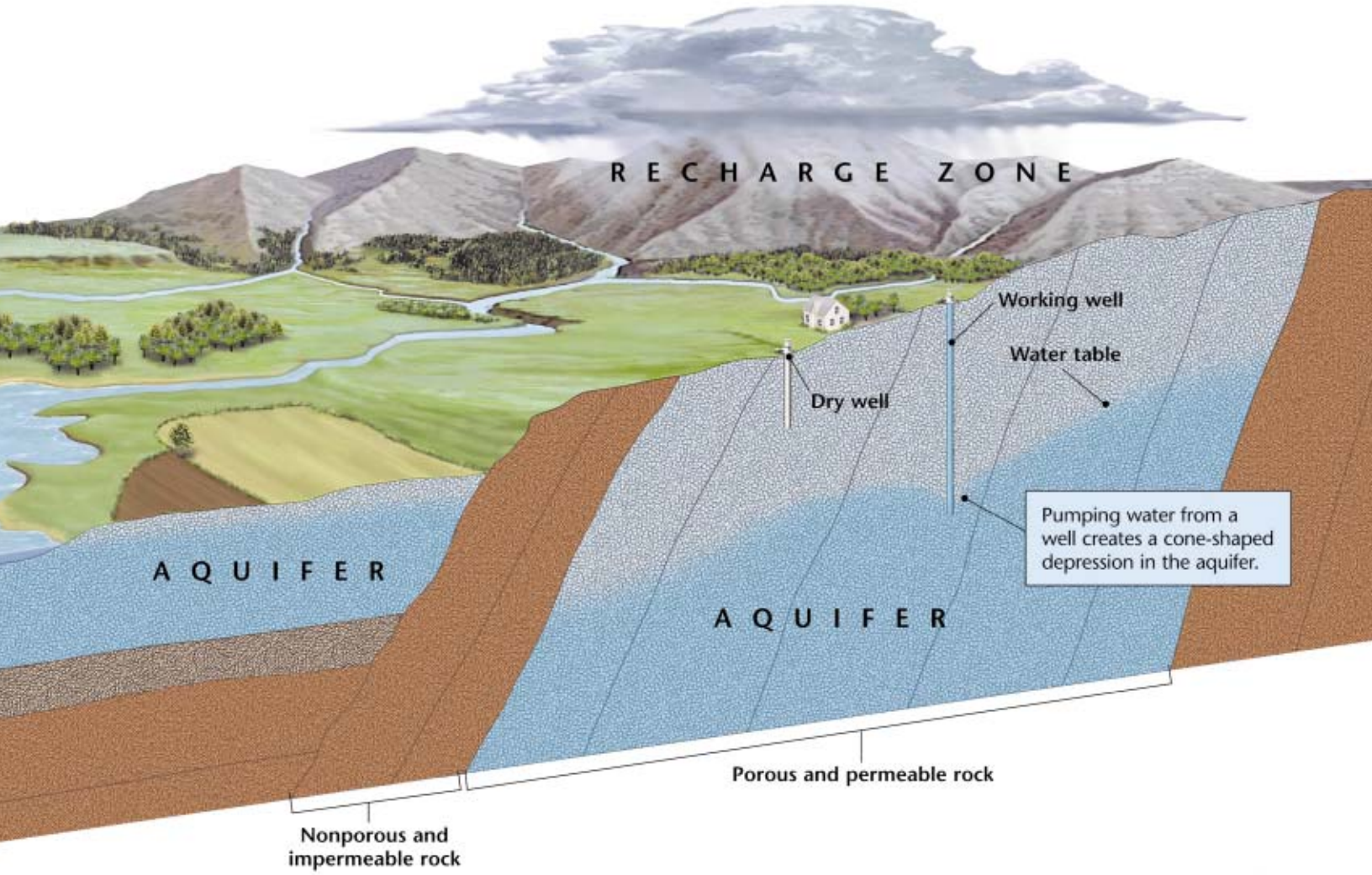
Figure 4 ▶ Groundwater and the Water Table
Aquifers are underground formations that hold water. Impermeable rock can be porous or nonporous, but only permeable rock allows water to pass through it.



The Recharge Zone To reach an aquifer, surface water must travel down through permeable layers of soil and rock. Water cannot reach an aquifer from places where the aquifer is covered by impermeable materials. Notice the permeable layers above the aquifer in **Figure 4.** The area of the Earth's surface where water percolates down into the aquifer is called the **recharge zone.** Recharge zones are environmentally sensitive areas because any pollution in the recharge zone can also enter the aquifer.

The size of an aquifer's recharge zone is affected by the permeability of the surface above the aquifer. Structures such as buildings and parking lots can act as impermeable layers to reduce the amount of water entering an aquifer. Communities should carefully manage recharge zones, because surface water can take a very long time to refill an aquifer. In fact, aquifers can take tens of thousands of years to recharge.

Wells If you go nearly anywhere on Earth and dig a hole deep enough, you will eventually find water. A hole that is dug or drilled to reach groundwater is called a well. For thousands of years, humans have dug wells to reach groundwater. We dig wells because groundwater may be a more reliable source of water



than surface water and because water is filtered and purified as it travels underground. The height of the water table changes seasonally, so wells are drilled to extend below the water table. However, if the water table falls below the bottom of the well during a drought, the well will dry up. In addition, if groundwater is removed faster than it is recharged, the water table may fall below the bottom of a well. To continue supplying water, the well must be drilled deeper.

SECTION 1 Review

1. **Describe** the distribution of water on Earth. Where is most of the fresh water located?
2. **Explain** why fresh water is considered a limited resource.
3. **Explain** why pollution in a watershed poses a potential threat to the river system that flows through it.
4. **Describe** how water travels through rock.

CRITICAL THINKING

5. **Making Comparisons** Read the description of aquifers. How are aquifers like water-filled sponges?
READING SKILLS
6. **Analyzing Relationships** Describe the relationship between groundwater and surface water in a watershed. What human activities in a recharge zone can affect the groundwater?