The Hydrologic Cycle

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To understand how contamination of groundwater and surface water occurs, it is necessary to understand the hydrologic cycle—the endless circulation of water from the ocean, atmosphere and land (see figure on page 2). Then you can understand how contaminants move with it.

The hydrologic cycle begins with evaporation of water over the ocean. The evaporated water condenses to form clouds. These clouds produce **precipitation** in the form of rain, snow, sleet or hail falling on the surface of the earth. As precipitation falls, some of it may turn into water vapor and evaporate directly into the atmosphere from bodies of water and land surfaces. This process is known as **evaporation**. A portion may be intercepted by vegetation. The remainder reaches the ground where it can enter the soil by a process called **infiltration**.

Some of the infiltrating water remains near the soil surface and evaporates into the atmosphere. Another portion is extracted by plant roots and transported to leaves where it is lost to the atmosphere as vapor. This process is called **transpiration**.

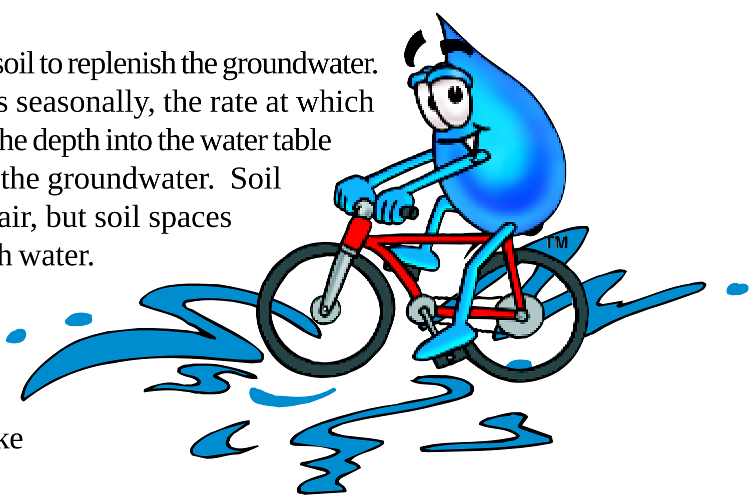
When the precipitation rate exceeds the infiltration rate, excess water builds on the soil surface and moves by overland flow called **surface runoff**. If surface runoff is excessive or concentrated, erosion can occur. **Erosion** is the removal and movement of soil by the action of water or wind. Some of the run-off water reaches streams, rivers, or lakes and continues down to a bay or gulf and back out into the ocean and the cycle begins again.

Still another portion of water that enters the soil can move vertically or laterally out of the plant root zone. Significant lateral movement of water through the soil is called **throughflow** or **interflow**. Downward movement of water through the soil is referred to as **percolation** or **leaching**.

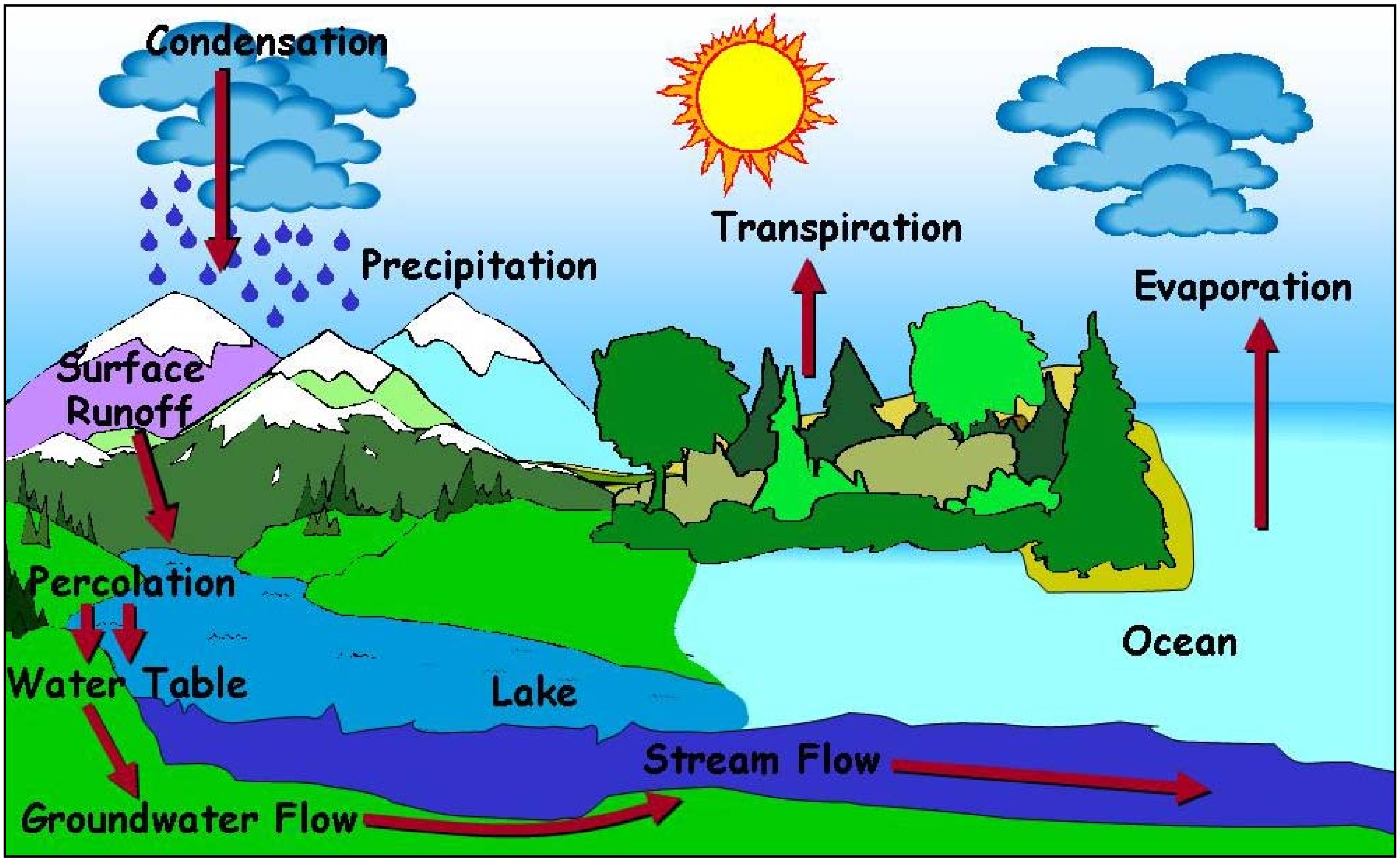
Some of the percolating water eventually makes its way to a saturated zone where all the spaces between rock and soil particles are filled with water. Water filling the spaces between soil and rock particles in the saturated zone is called **groundwater**. The area above the saturated zone is full of air in the spaces between the soil and rock particles is called the **radous zone**. The pleace where the radous zone and groundwater meets is referred to as the **water table**. Groundwater is an important source of water for human consumption, particularly in West Texas.

Groundwater Flow

Recharge is the process in which water percolating through the soil to replenish the groundwater. Because the amount of precipitation and evaporation varies seasonally, the rate at which groundwater is recharged will vary seasonally as well. In turn, the depth into the water table will vary. The **water table** is the upper boundary or top of the groundwater. Soil spaces above the water table are not saturated and contain air, but soil spaces below the water table are completely **saturated** or filled with water.



Water moves within the saturated zone under the influence of gravity from areas where the water table elevation is higher toward areas where the water table elevation is lower. As it moves, groundwater may flow into surface water, such as a lake



or river. In fact, this process, known as **baseflow**, accounts for most of the water that recharges perennial streams, rivers and lakes.

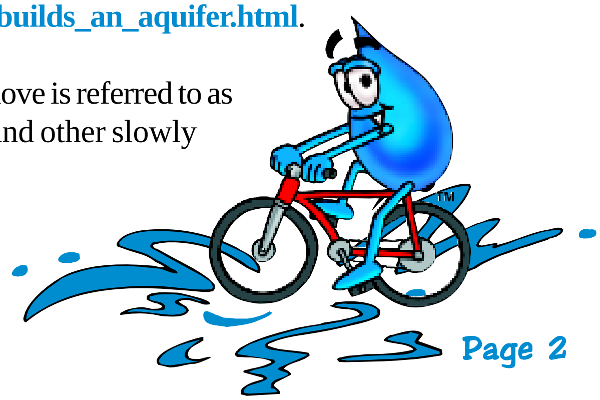
One common misconception, however, is that groundwater moves somewhat rapidly. In reality, groundwater moves much more slowly than water in a river or stream. This is because groundwater must overcome friction to move through small spaces between soil particles and rocks. While water in a stream may move several inches or feet per second, groundwater generally moves much more slowly.

Because groundwater flows slowly, most wells draw on groundwater that lies close to the point where the well is located. This is why activities taking place on land surfaces closest to the well have the greatest impact on water quality. Never store or use household chemicals, pesticides, fertilizers, petroleum and other potential contaminants near water wells.

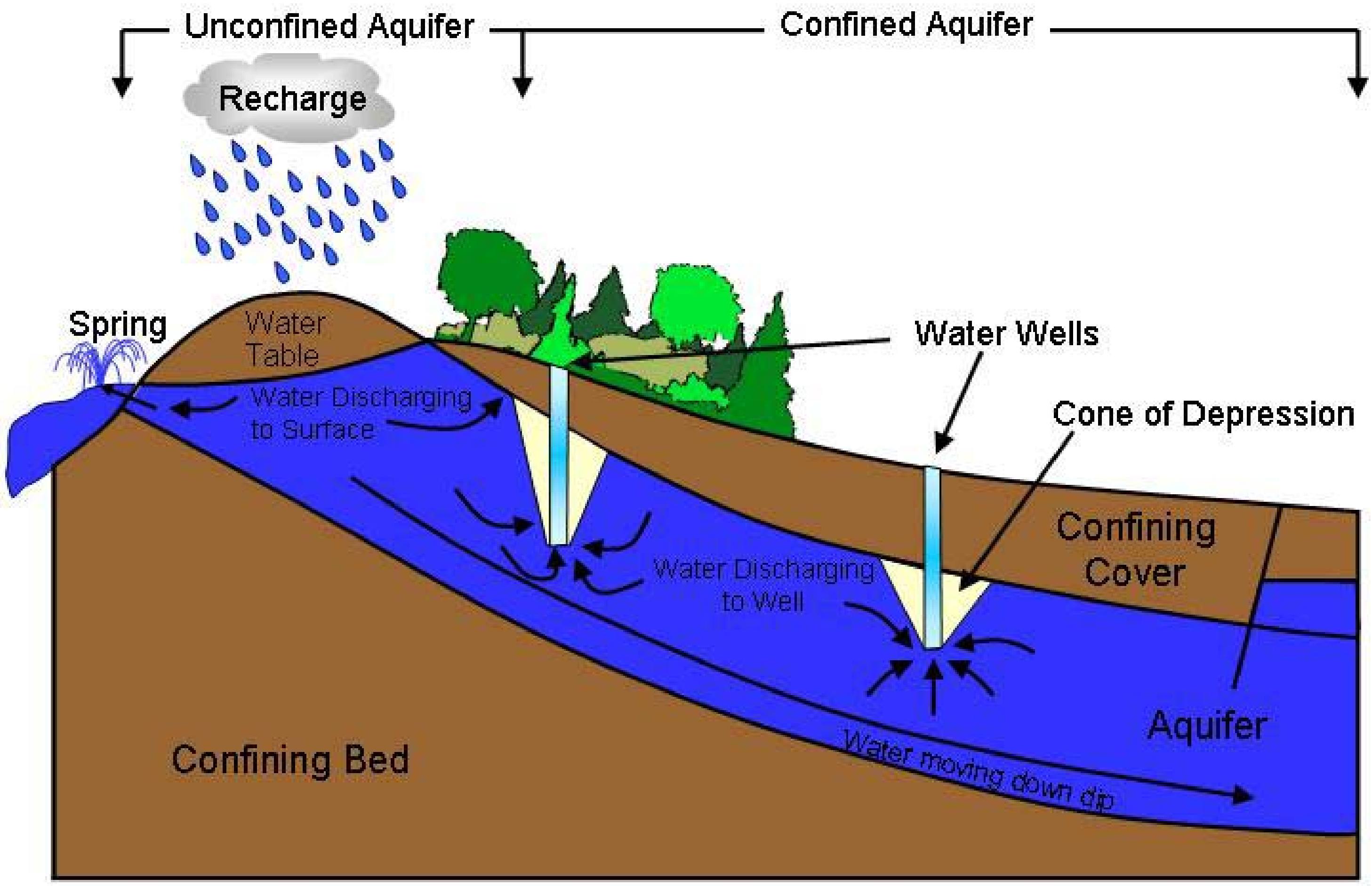
Aquifers and Aquitards

An **aquifer** is defined as permeable, geologic material through which significant quantities of water move. Geologic materials that serve as aquifers include unconsolidated material such as sand and gravel, permeable sedimentary bed rock such as sandstone, limestone and dolomite and fractured crystalline bedrock. To learn how to build your own aquifer model go to **http://www.epa.gov/safewater/kids/grades_k-3_thirstin_builds_an_aquifer.html**.

Geologic material through which significant quantities of water cannot move is referred to as **aquitards**. Clays, shales, dense crystalline and sedimentary bedrock and other slowly permeable materials are common aquitards.



Aquifers and aquitards vary in their occurrence, thickness, continuity and depth. A confined aquifer is bounded on the top and bottom by aquitards. In contrast, unconfined aquifers are overlaid by permeable layers and are generally found close to the land surface.



Groundwater Contamination

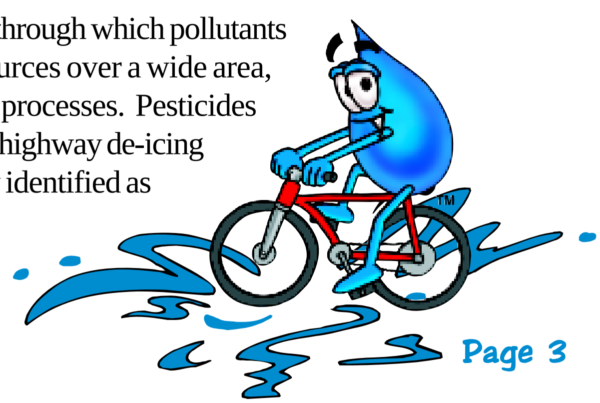
Groundwater becomes contaminated as substances leach downward by percolating water. Some groundwater contamination is the result of human activities on the land surface. Contamination near water wells or from old, abandoned water wells can quickly enter and contaminate groundwater.

An aquifer overlain by an aquitard is less susceptible to contamination than one that is not because contaminated water has difficulty percolating through the aquitard. In addition, deep aquifers are relatively less susceptible to contamination than shallow aquifers because of the distance the contaminant must move in the soil before reaching a deep aquifer.

Point and Nonpoint Source Pollution

Point sources of contamination are identified by a well-defined point of entry through which pollutants reach a body of water, such as municipal and industrial treatment facilities.

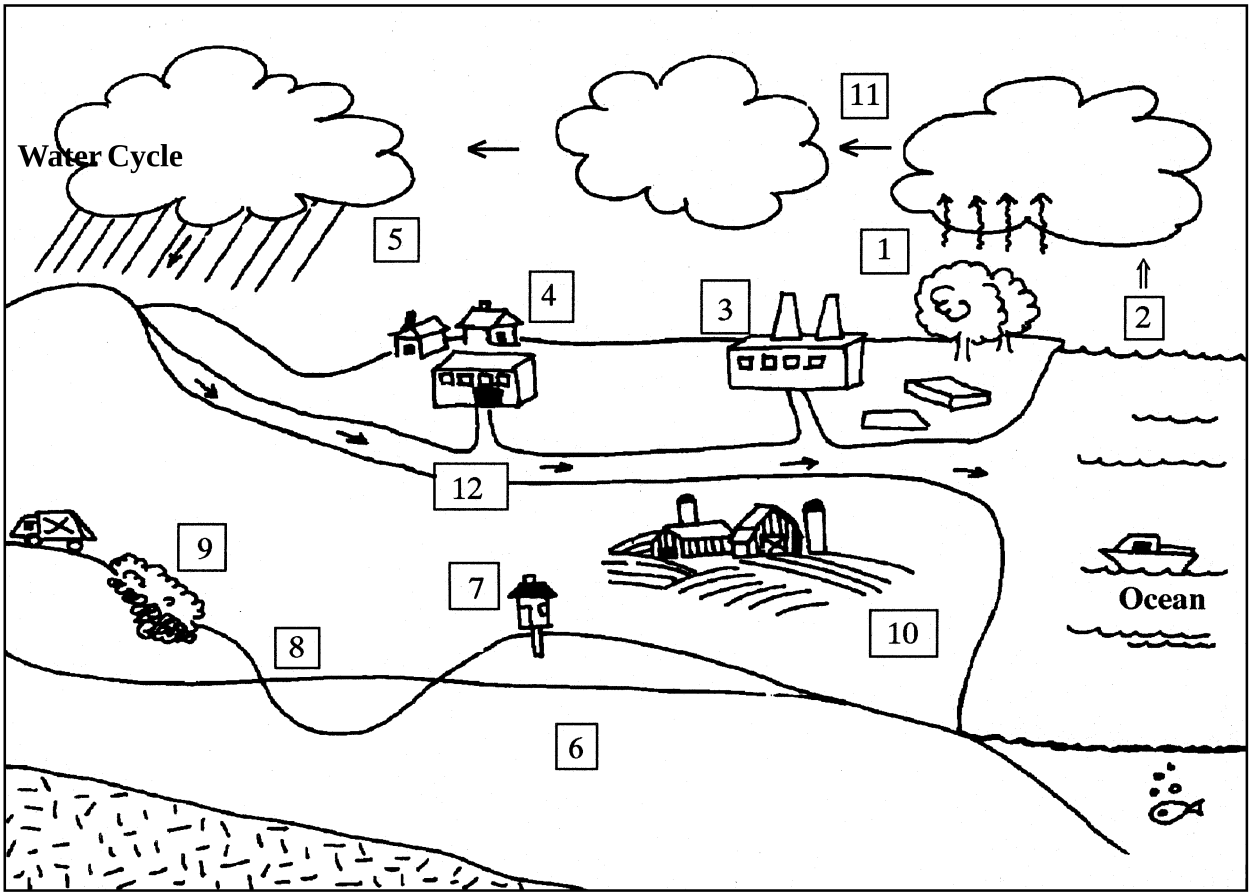
Nonpoint sources of contamination have no easily identified point of entry through which pollutants reach a body of water. Contaminants originate from a wide variety of sources over a wide area, and they enter surface water and groundwater at many locations, by many processes. Pesticides and fertilizers applied to cropland, effluent from septic systems, leaching of highway de-icing salts and products from leaking underground storage tanks, are commonly identified as nonpoint sources of pollution.



Protecting Your Water Supply

You should pay particularly strict attention to the handling and disposal of potential contaminants, such as pesticides, fertilizers, cleaning solvents and motor oil. Mix and handle chemicals as far from the well as possible. At a minimum, always mix and handle chemicals 150 feet downslope from your water well.

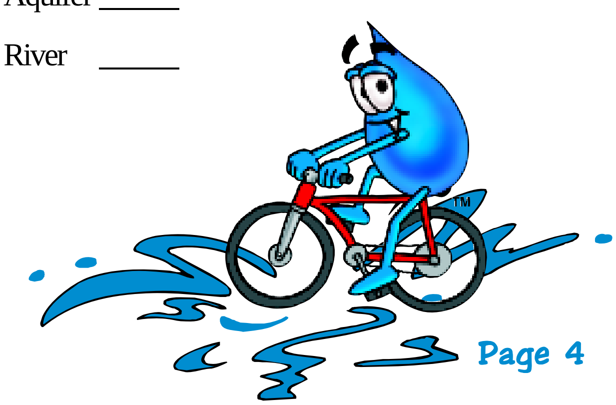
Homeowners should also adopt practices which limit potential groundwater contamination, such as pumping their septic system regularly and disposing of household toxic wastes properly. More information on protecting private water wells can be found at http://soilcrop.tamu.edu or http://tcebookstore.org by accessing the Tex*A*Syst Wellhead Protection publications or by contacting your local Texas Cooperative Extension office.



Match the number with the correct word:

Transpiration	_____	Well	_____	Lake	_____
Evaporation	_____	Landfill	_____	Runoff	_____
Industrial wastewater	_____	Condensation	_____	Aquifer	_____
Municipal wastewater	_____	Precipitation	_____	River	_____

Transpiration 1; Evaporation 2; Industrial wastewater 3; Municipal wastewater 4; Precipitation 5; Aquifer 6; Well 7; Lake 8; Landfill 9; Runoff 10; Condensation 11; River 12



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"Reducing the Risk of Ground Water Contamination by Improving Fertilizer Storage and Handling". Tex*A*Syst Rural Well Water Assessment program. B.L. Harris, D.W. Hoffman and F.J. Mazac, Jr. Texas Cooperative Extension #B-6026.

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