BULLETIN NO. 1 JULY 1988

What is GROUNDWATER?

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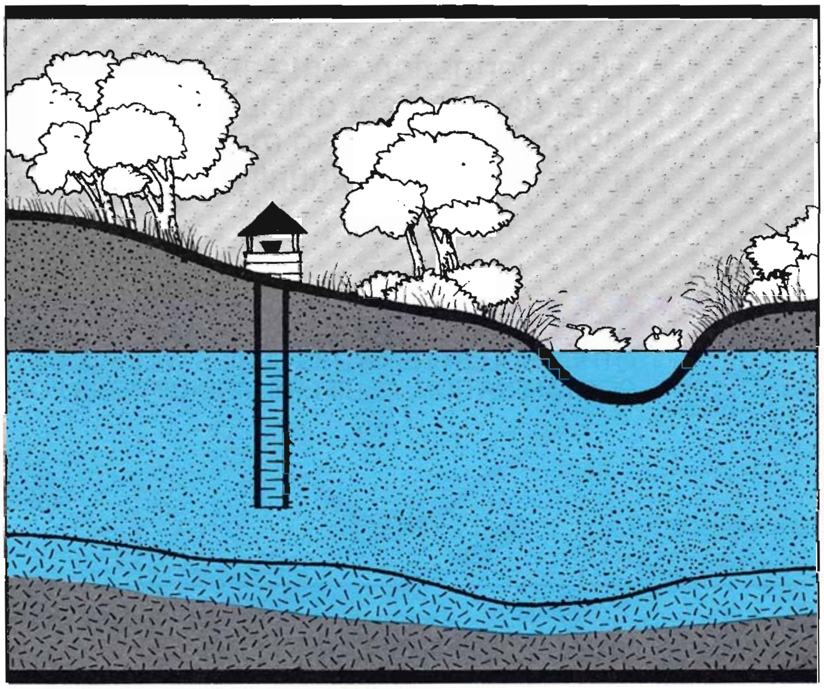


Learn to "talk groundwater"!

How does groundwater get there?

Where does it go?

PURPOSE OF THIS BULLETIN

The land surface was traditionally considered to be sufficient to protect the quality of underlying groundwater. It is now recognized that natural soil processes that change contaminants into harmless substances are often overwhelmed by waste products from human activities.

Groundwater protection programs require an understanding of the groundwater resource. The purpose of this bulletin is to help the reader become more knowledgeable about groundwater and the terminology commonly used to describe it. A pictorial approach is used to enable the reader to quickly grasp basic groundwater terms and concepts.

The information contained in this bulletin should help local government officials and citizens become informed and able to make decisions on how to protect and manage community groundwater resources.

OTHER BULLETINS IN THIS SERIES WILL FOCUS ON GROUNDWATER CONTAMINATION, AQUIFERS, AND OPTIONS FOR LOCAL ACTION.

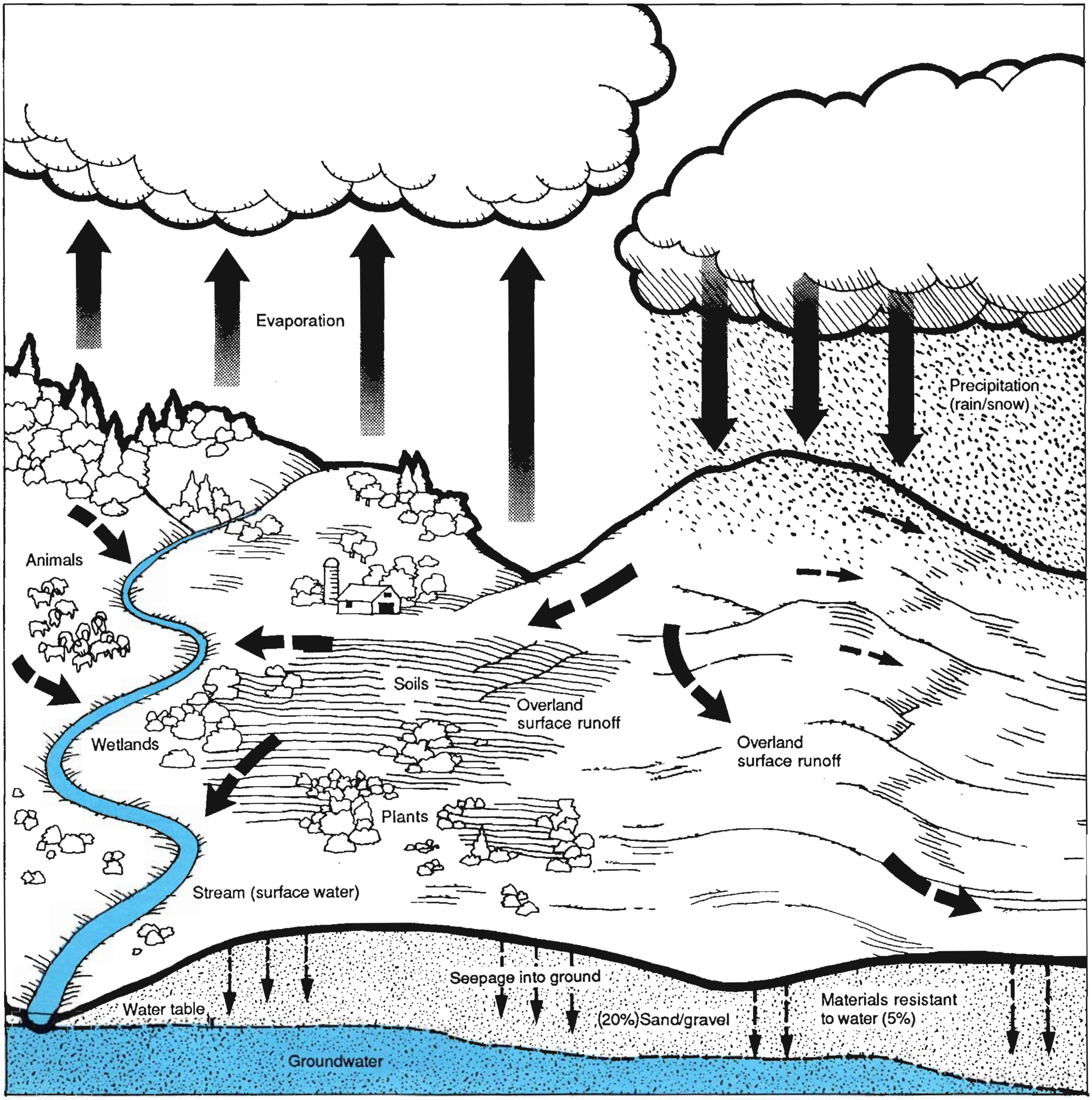
ACKNOWLEDGEMENT

This bulletin was funded by the New York State Water Resources Institute, a unit of the Center for Environmental Research, Cornell University, and the State of New York Temporary State Commission on Tug Hill, Watertown, NY. **Clifford Scherer**, Department of Communications, Cornell University, served as faculty consultant. The bulletin was designed and illustrated by **Lito Manto**.

Many individuals contributed to the bulletin by their reviews and critical comments. These include members of the New York State Water Resources Institute staff and the Tug Hill Commission staff; Todd Miller, U.S. Geological Survey; Cornell Cooperative Extension agents in the four counties included in the Tug Hill Commission's jurisdiction; and representatives of the user public who generously gave their time to provide reaction to preliminary drafts of the bulletin.

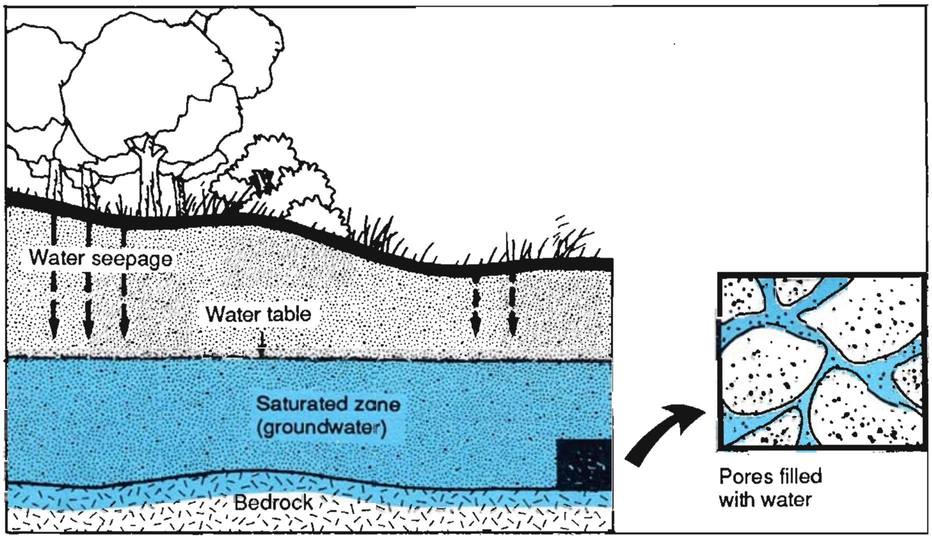
WHERE GROUNDWATER COMES FROM

Groundwater begins with rain and snowmelt that seeps into the ground. The amount of water that seeps into the ground varies widely from place to place according to the type of land surface that is present. In porous surface material that water readily seeps through, such as sand or gravel, **about 20%** of the rain and snowmelt may seep into the ground. In less porous surface material, where seepage is much slower, **perhaps 5%** will seep into the ground. The remainder of the rain and snowmelt runs off the land surface into streams or returns to the clouds by evaporation. Ground seepage is also strongly influenced by the season of the year. Evaporation is greater during the warm months, including evaporation through plant leaves, known as transpiration. During the cold months, the ground surface may be frozen, hindering water seepage, and evaporation is less.



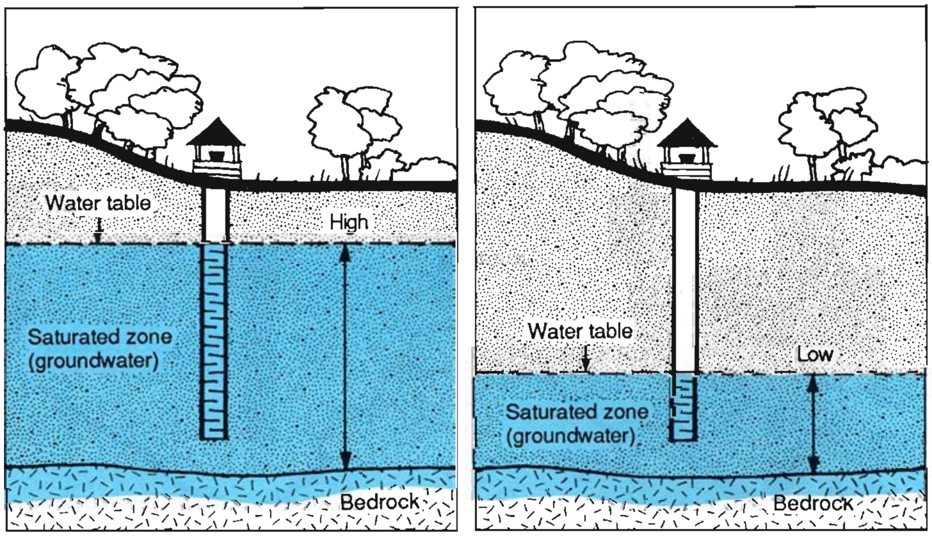
THE SATURATED ZONE

Rain and snowmelt that seeps into the ground continues downward under the force of gravity until it reaches a depth where water fills all of the openings (pores) in the soil or rock. This is called the **saturated zone.** The saturated zone typically includes numerous water-filled crevices in the upper layer of bedrock. Deeper bedrock layers may have few or no crevices where water can penetrate.



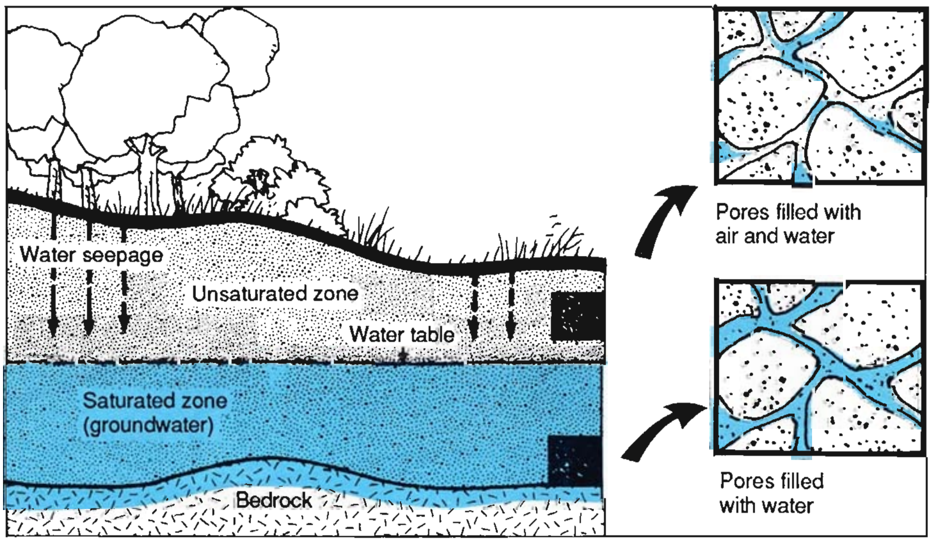
THE WATER TABLE

The top of the saturated zone is called the **water table.** The water table rises and falls according to the season of the year and the amount of rain and snowmelt that occurs. It is typically higher in early Spring and lower in late Summer. Heavy rainfall or drought conditions may cause changes in the typical pattern, however.



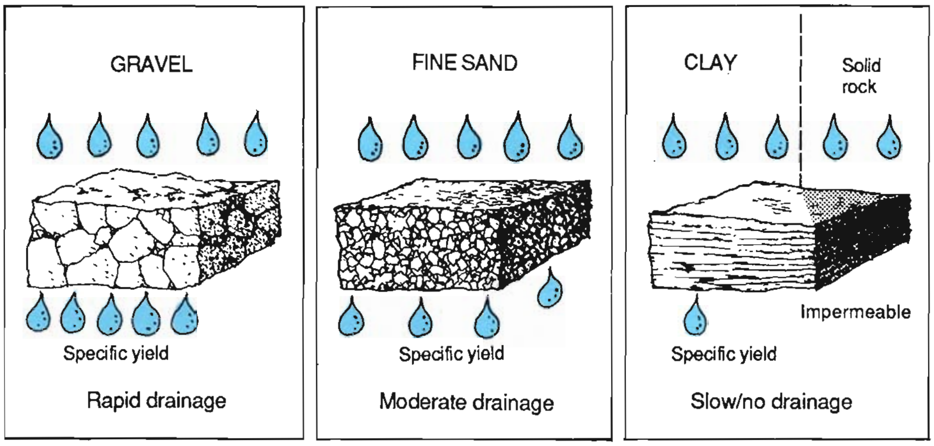
THE UNSATURATED ZONE

A zone is usually present between the water table and the land surface where the openings, or pores, in the soil are only partially filled with water. This is the **unsaturated zone.** Water seeps downward through it to the water table below. Plant roots can capture the moisture passing through this zone, but it cannot provide water for wells.



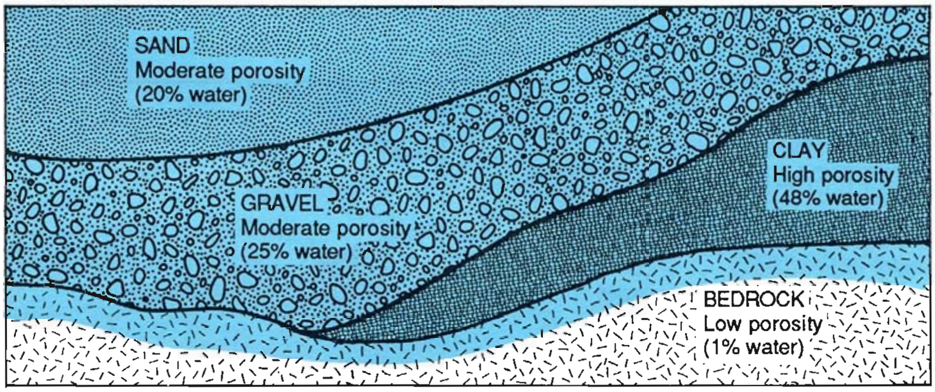
PERMEABILITY

Permeability is a measure of how fast water will flow through connected openings in soil or rock. **Impermeability** refers to soil or rock that does not allow water to pass through it. The **specific yield** is the actual amount of water that will drain out of saturated soil or rock by gravity flow. It does not drain out completely because some water forms a film that clings to soil and rock. Permeability is critical for water supply purposes; if water contained in soil or rock will not drain out, it is not available to water wells. (See Porosity.)



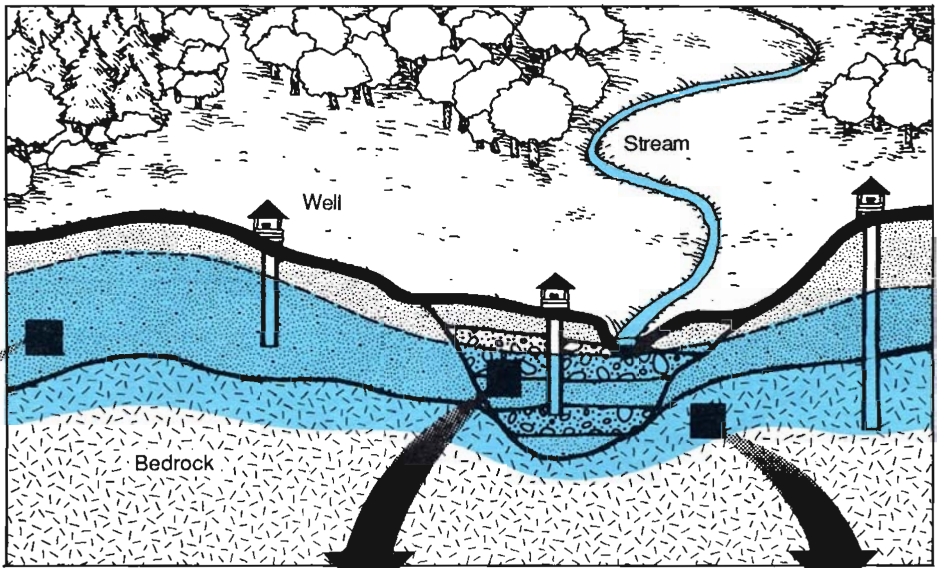
POROSITY

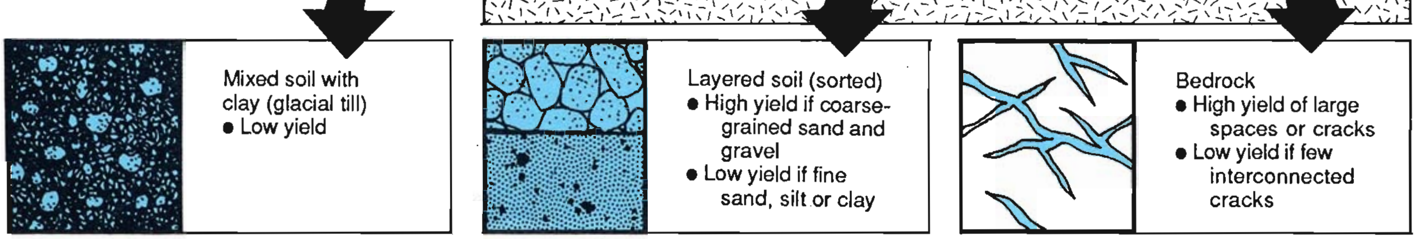
The capacity of soil or rock to hold water is called **porosity**. Saturated sand contains about 20% water; gravel, 25%; and clay, 48%. Saturated bedrock with few crevices commonly contains less than 1% water. Clay is not a good water source despite its high water content, or porosity, because the extremely small size of the openings between microscopic clay particles creates friction that effectively halts water movement. Saturated clay is virtually impermeable.



AQUIFERS

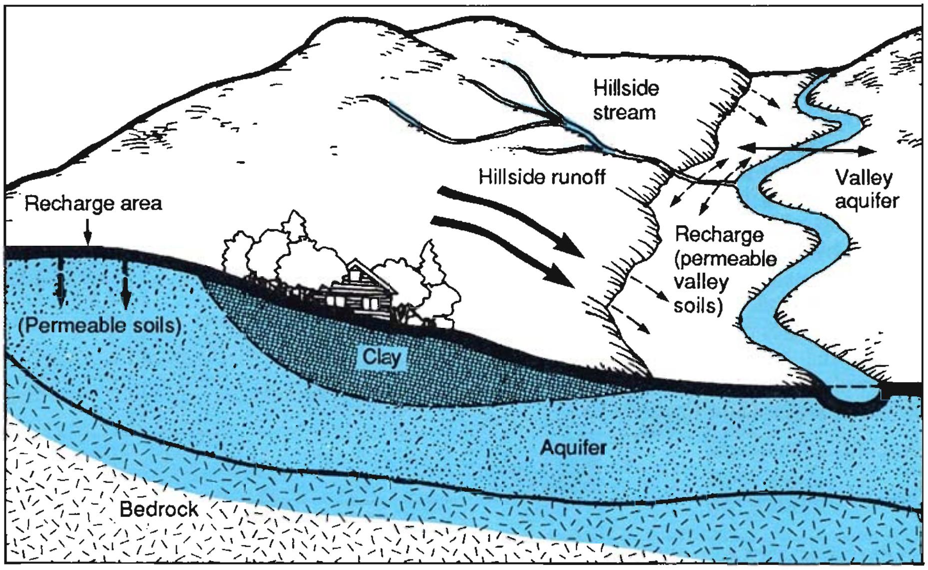
A water-bearing soil or rock formation that is capable of yielding useable amounts of water is called an **aquifer.** Mixed clay, sand, gravel, and fine particles that were deposited by continental glaciers (glacial till) yield low amounts of water. Materials sorted into distinct layers will yield high amounts of water from coarse-grained sand and gravel, but low amounts from fine-grained sand, silt or clay. Bedrock aquifers will yield substantial amounts of water if there are large openings or cracks, but small amounts if there are few openings in the rock.





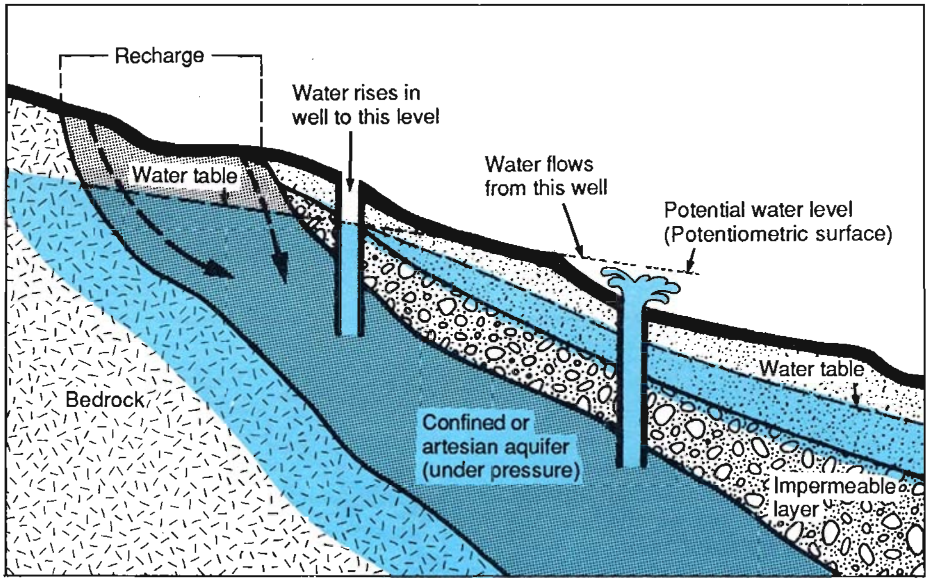
RECHARGE

Water seeping into an aquifer is known as **recharge**. This takes place intermittently during and immediately following periods of rain and snow-melt. Recharge occurs where permeable soil or rock allows water to readily seep into the ground. These areas are known as **recharge areas.** Permeable soil or rock formations where recharge occurs may occupy only a very small area or extend over many square miles. Valley aquifers may also receive recharge from hillside runoff or streams that flow down from hillsides in addition to the rain and snow that falls directly onto the land surface overlying the aquifer.



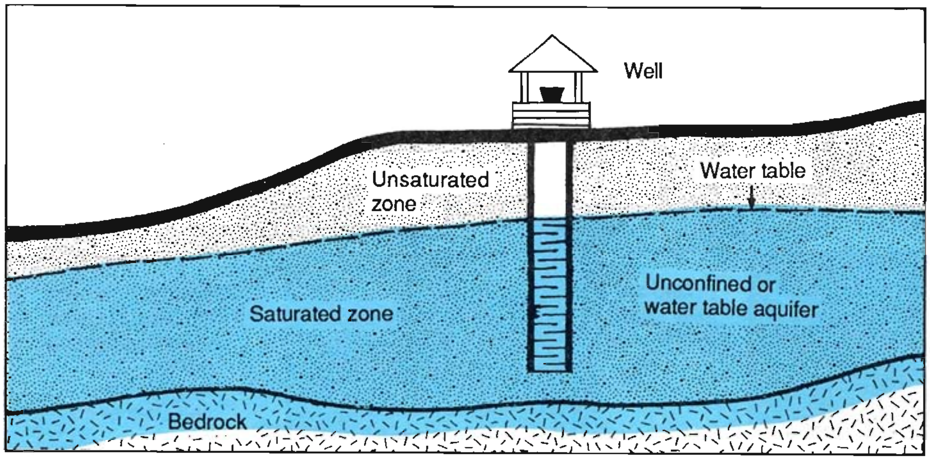
CONFINED OR ARTESIAN AQUIFER

Groundwater that becomes trapped under impermeable soil or rock may be under pressure. This is called a **confined** or **artesian aquifer**. A well that pierces a confined aquifer is known as an **artesian well**. Water pressure in the confined aquifer will cause water in the well to rise above the aquifer level. The maximum level that the water in the well will rise to is known as the **potentiometric surface,** or potential water level. If this is higher than the top of the well, the well will overflow.



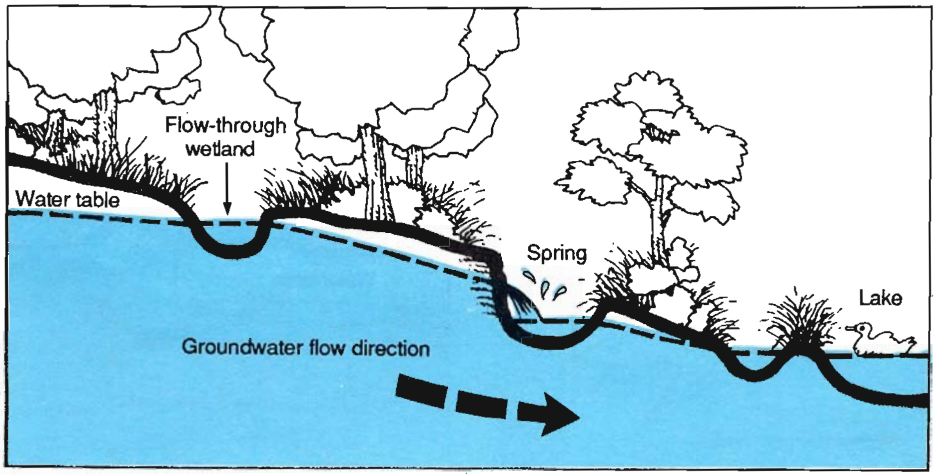
UNCONFINED OR WATER TABLE AQUIFER

Aquifers that are not confined under pressure are called **unconfined** or **water table aquifers**. The water level in a well is the same as the water table outside the well.



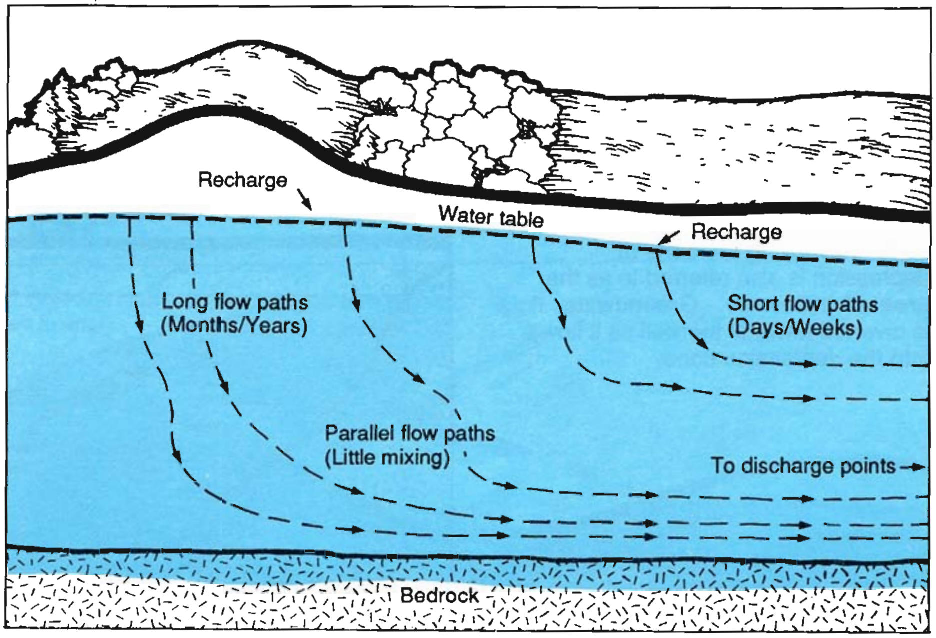
GROUNDWATER DISCHARGE POINTS

Groundwater enters the ground in recharge areas and leaves the ground at **discharge points.** Discharge is continuous, as long as sufficient water is present above the discharge point. Discharge points typically occur as seepage into wet-lands, lakes and streams. Springs are visible discharge points at the land surface. If the water table is close to the land surface during the growing season, large amounts of groundwater may be withdrawn by plant transpiration.



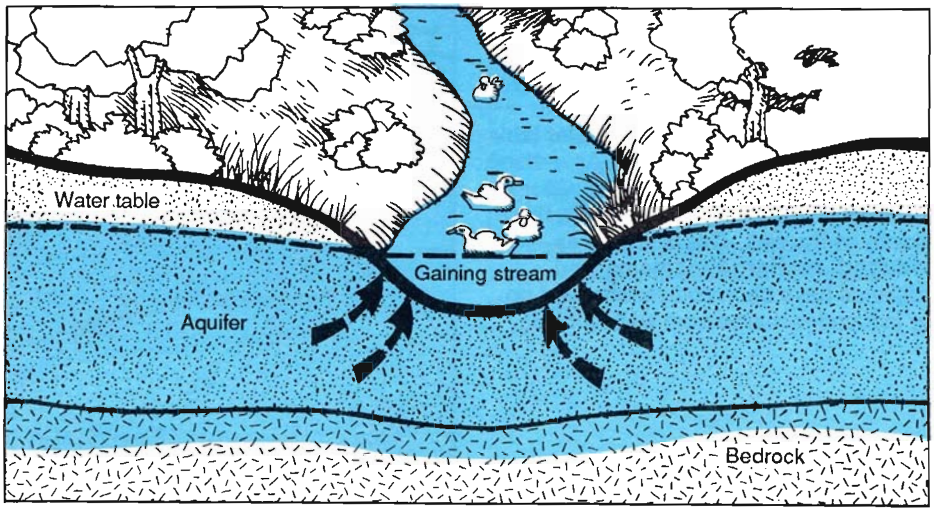
GROUNDWATER FLOW RATES

Groundwater moves very slowly from recharge areas to discharge points. **Flow rates** in aquifers are typically measured in feet per day. Flow rates are much faster where large rock openings or crevices exist (often in limestone) and in loose soil, such as coarse gravel. It may take years, decades, or even centuries for groundwater to move long distances through some aquifers. However, ground-water may take only a few days or weeks to move for a short distance through loose soil. Groundwater typically moves in **parallel paths** (i.e., layers) with little mixing, due to the slow movement of groundwater, which does not create sufficient turbulence to cause mixing to occur. This becomes an important factor in the location and movement of contaminants that enter the groundwater.



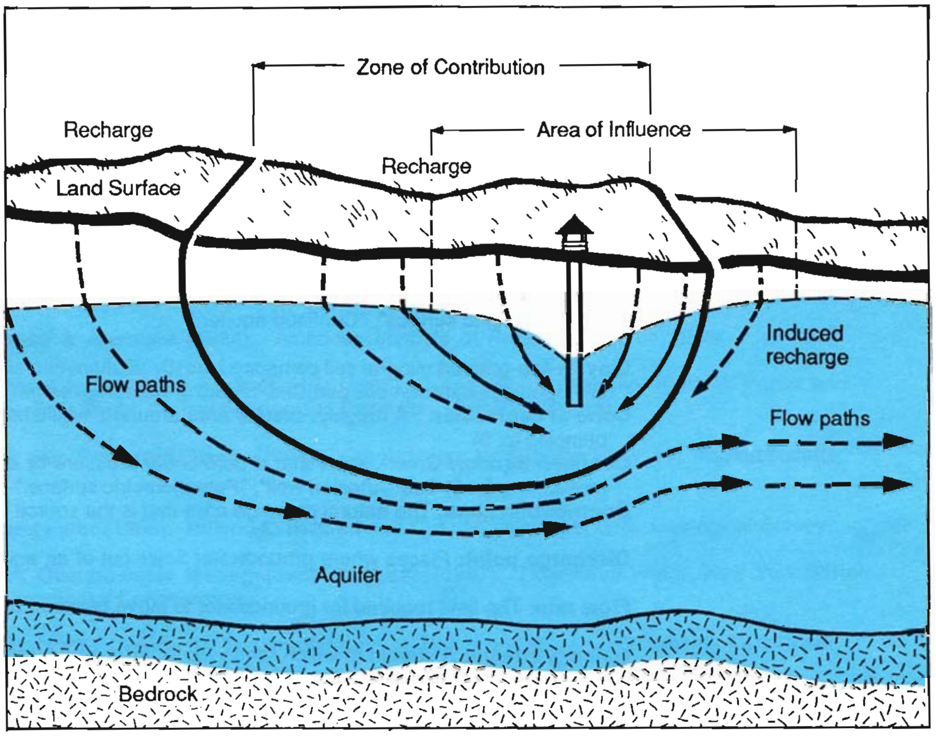
GAINING STREAMS

Streams that receive groundwater discharges are **gaining streams**. The level of water in the stream is at the water table level for the adjacent aquifer. This is also true for lakes and wetlands that receive groundwater discharges. More than half of the total flow of some streams during dry periods may be from groundwater discharge.



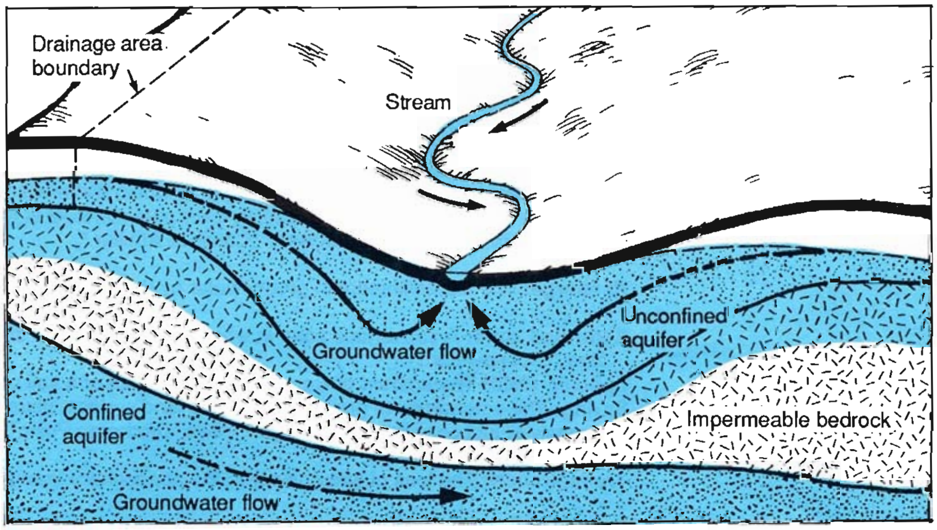
WELL CONTRIBUTION ZONE

A groundwater recharge area that is the source of water for a well is known as the **contribution zone** or **catchment area.** This may include only a portion of a larger aquifer recharge area. The area of influence due to well pumping, that overlies the cone of depression, may extend beyond the contribution zone. Induced recharge from well pumping causes groundwater to flow towards the well that would not normally contribute water to the well.



GROUNDWATER DRAINAGE AREA

Groundwater in unconfined aquifers, that do not have impermeable soil or rock layers between the aquifer and the land surface, usually flows into the same stream drainage basin where it is located. Confined or artesian aquifers, which exist at greater depth, may be part of a regional groundwater flow system that may not correspond with the surface drainage.



GROUNDWATER MYTHS

MYTH: There are vast underground lakes and rivers.
REALITY: Although these do exist in caverns, principally in limestone bedrock, they are rare. Most groundwater seeps slowly through the ground.

MYTH: Groundwater is separate from streams, lakes and wetlands.
REALITY: Groundwater is part of the drainage system that maintains the supply of water in streams, lakes and wetlands.

GLOSSARY

Aquifers: Any water-bearing soil or rock formation that is capable of yielding sufficient water for human use. (p.5)
Area of influence: The land surface overlying the cone of depression created by well pumping. (p. 8)
Artesian aquifer: See "Confined aquifer".
Artesian well: A well that penetrates an aquifer containing water under pressure. Water in the well will rise above the water level in the aquifer; if the water pressure is great enough, the well will overflow. (p. 6) See "Potentiometric surface", "Confined aquifer."

Clay: A fine-grained mineral soil composed mostly of aluminum silicate. Water is held by surface tension in the tiny openings between soil particles, reducing water movement to a barely detectable rate. (p. 5)
Cone of depression : A roughly circular area around a well where the groundwater level is lowered by pumping (p. 9)
Confined aquifer: Groundwater that is held under pressure by overlying soil or rock layers that restrict water movement. (p. 6) See "Artesian well", "Potentiometric surface."
Contribution zone: The natural drainage area that is the source of water for a well. (p. 9) See "Recharge. "

Discharge point: Places where groundwater flows out of an aquifer. (p. 7.)

Flow rate: The time required for groundwater to move between points. (p. 7)

Gaining stream: A stream in which groundwater discharges contribute significantly to the streamflow volume. (p. 8)
Glacial till: A mixture of clay, sand, gravel, boulders and sediment deposited by melting glacial ice, intermingled in any proportion; usually resistant to groundwater movement. (p. 5)
Groundwater: Water in a subsurface, water-saturated layer of soil or rock. (p. 4) See "Saturated Zone."

Impermeable: Water movement is severely restricted. (p. 5)
Induced recharge: Infiltration of surface water from a stream or body of water into an adjacent aquifer, caused when the cone of depression created by well pumping intersects the stream or water body. (p. 9)

Losing stream: A stream that is losing water by infiltration to the groundwater system. (p. 8)

Parallel flow paths: Layers of groundwater flow that do not mix with other flow layers because groundwater movement is too slow to create sufficient turbulence to cause mixing to occur. (p. 7)
Permeability: The capacity for water movement through soil or rock. ((p. 5)
Porosity: The capacity of soil or rock to hold water. (p. 5)
Potentiometric surface: The potential level to which water will rise above the water level in an aquifer in a well than penetrates a confined aquifer; if the potential level is higher than the land surface, the well will overflow. (p. 6) See "Artesian well," "Confined Aquifer."

Recharge: The replenishment of groundwater by infiltration or seepage from precipitation or surface runoff. (p. 6)

Saturated zone: A subsurface zone in which all openings in a soil or rock formation are filled with water. (p. 4) See "Groundwater."
Specific yield: The amount of water that will drain out of a soil or rock formation by gravity flow. (p. 5)
Spring: The emergence of groundwater at the land surface, usually at a clearly defined point; it may flow strongly or just ooze or seep out. (p. 7) See "Discharge Point."

Transpiration: The loss of water vapor to the atmosphere from plants through pores in the leaf surface. (p. 3)

Unconfined aquifer: An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well. (p. 6)
Unsaturated zone: A soil or rock zone above the water table, extending to the land surface, in which the pore spaces are only partially filled with water. (p. 4) See "Water Table."

Valley aquifers: Aquifers located in flat-bottomed valleys, usually with a stream running through them. (p. 6)

Water table aquifer: See "Unconfined aquifer," "Water table."
Water table: The top of the saturated zone. (p. 4) See "Saturated Zone."
Well catchment: See "Contribution Zone."

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