

Introduction to Groundwater

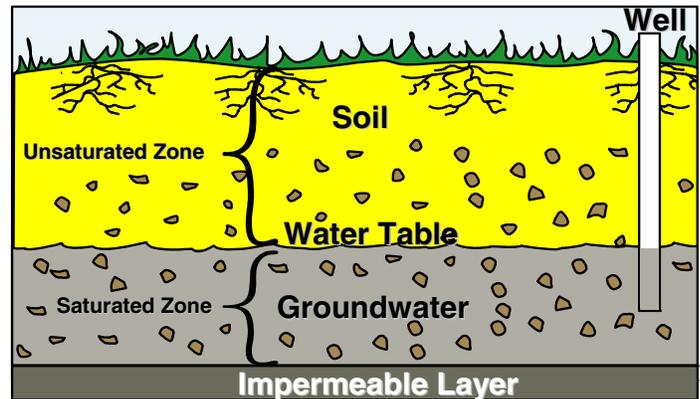
What Is Groundwater?

Groundwater cleanup is very important in Alaska because many communities and individuals get their drinking water from wells. Groundwater is water stored under the surface of the ground in the tiny pore spaces between rock, sand, soil, and gravel. It occurs in two “zones”: an upper, unsaturated zone where most of the pore spaces are filled with air, and a deeper, saturated zone in which all the pore spaces are filled with water. To picture this, think of filling a cup with gravel. Then add enough water to half fill the cup. The top of the water layer represents the water table. Below it, where the gravel is covered with water, is the saturated zone. Above it, where there is just gravel, would be the unsaturated zone. The bottom of the cup forms a barrier to the water continuing to move downward. This barrier can occur in nature as bedrock, clay, or permafrost and is called an aquitard. The water table may be a few feet or many hundreds of feet below ground surface. In some areas of Alaska there is no groundwater at all. In permafrost areas, the ground is saturated with water, but remains frozen all year.

How well loosely arranged rock (such as sand and gravel) holds water depends on the size and shape of the rock particles. Layers of loosely arranged particles of uniform size (such as sand) tend to hold more water than layers of rock with materials of different sizes. This is because smaller rock materials can settle in the spaces between larger rocks, decreasing the space available to hold water.

How Does Groundwater Move?

Several things happen to precipitation that falls on the land surface. Some of the water flows



overland across into streams, lakes, or the ocean. If the surface soil is porous, some water seeps into the ground by a process called infiltration. Water seeping into the soil clings to soil particles, and may be drawn into the rootlets of growing plants. After the plant uses the water, it is released as vapor into the atmosphere. Excess soil moisture is pulled downward by gravity. At some depth, either shallower or deeper depending on the location, the pores in soil or rocks become saturated with water. The top of the saturated zone is called the water table. Below the water table is groundwater.

Groundwater generally flows downhill, just as surface water does. However, “downhill” for groundwater is determined by the slope of the barrier below it, not the ground above it. The slope of the underground barrier often is in the same direction as the ground above it, but that is not always the case.

The speed at which groundwater flows also is determined by the permeability of the soil or rock in the saturated zone. If the saturated zone consists of less permeable material (such as clay), water flows through it more slowly. Groundwater can move as quickly as several feet per day, and as slowly as a foot per century.

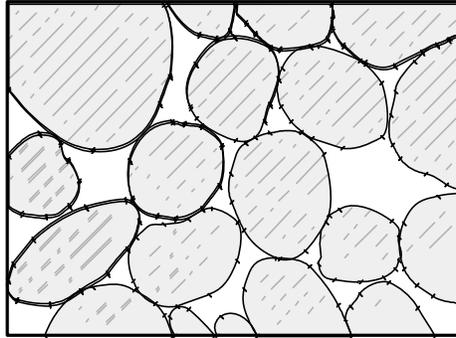
What Is an Aquifer?

An aquifer is an area that contains enough groundwater to be pumped to the surface and used for drinking water, irrigation, industry, or other uses. An aquifer may be a few feet or several thousand feet thick, and less than a square mile or hundreds of thousands of square miles in area.

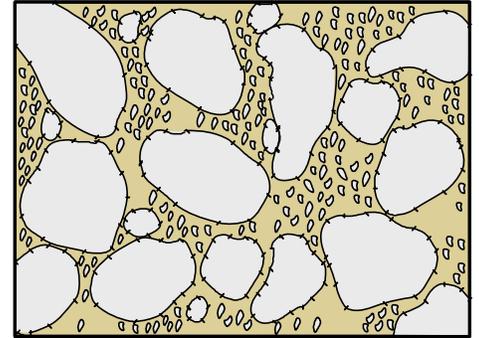
The amount of water an aquifer can produce depends on the volume of the soil and rock in the saturated zone, the size and number of the pores and fractures that can fill with water, and the permeability of the soil or rock. Water-filled porosity is a measurement of the amount of water a material can store, and permeability is a measure of how well the water can move through the material. Material such as silt or clay has high water-filled porosity (it can store a lot of water) but low permeability (the water does not flow through it easily). Bedrock usually has low water-filled porosity (it can only store water in cracks, if at all) and low permeability (water can only flow through cracks that interconnect).

Recharge areas are where the aquifer takes in water, and discharge areas are where groundwater flows to the land surface. Water moves from areas of recharge, often at higher elevations, to areas of discharge, often at lower elevations, through the saturated zone. Aquifers receive water from rain or snowmelt that filters down through the unsaturated zone. They also can receive water from surface waters such as lakes and streams. Where the water table meets the surface of the ground, water from the aquifer can appear at the land surface as a seep or spring.

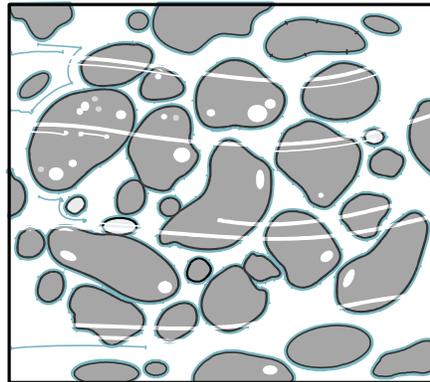
An aquitard is a confining geologic layer that slows, but does not prevent, the flow of water to or from an adjacent aquifer. An aquitard does not readily provide water to wells or springs, but may store groundwater and also transmit it slowly from one aquifer to another. Most geologic layers are classified as either aquifers or aquitards.



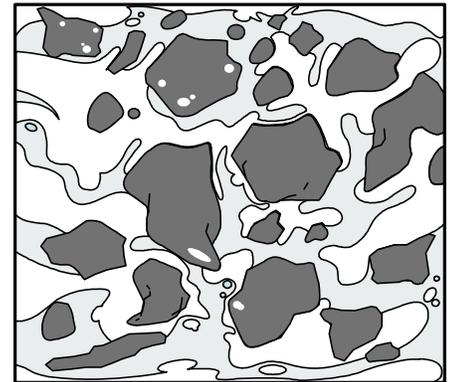
High Porosity



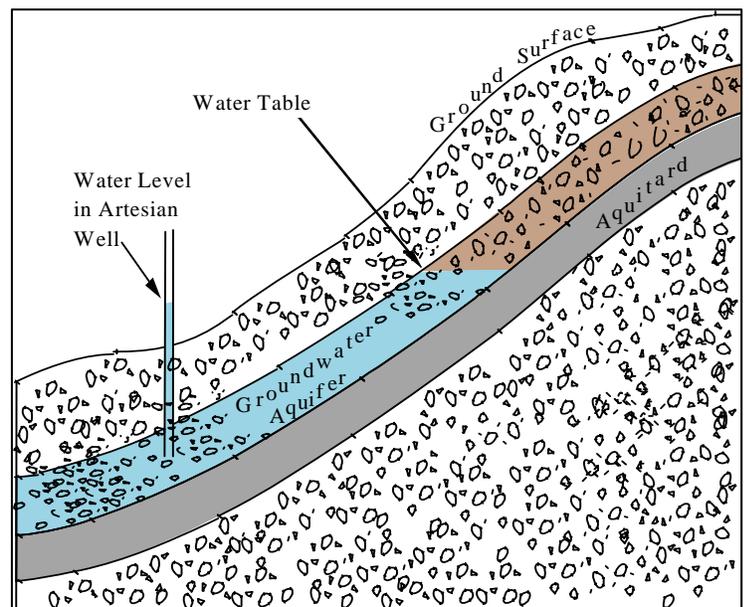
Low Porosity



High Permeability



Low Permeability



How Does Groundwater Become Contaminated?

Groundwater can be contaminated in many ways. If surface water that recharges the aquifer is contaminated, the groundwater will also become contaminated. This can, in turn, affect the quality of surface water at discharge areas. Groundwater can also be contaminated by liquid hazardous substances (or solids that can dissolve in water) that filter through the soil into groundwater, by salt water moving in from the ocean, or by minerals that are naturally present in the area.

Glossary

aquifer - saturated zone containing sufficient groundwater that the water can be pumped out.

aquitard - material that retards or restricts the flow of groundwater.

permafrost - An important term specific to Alaska is permafrost. Permafrost is saturated soil that has remained below 32° F (the freezing point of water) for at least two years. On the North Slope, permafrost can be 1,200 to 2,000 feet thick, and only the top 6 to 18 inches ever thaws! Permafrost can act as an impermeable layer, like bedrock, but it can also be affected by chemical contaminants. These contaminants can cause increased melting of the permafrost similar to when you put salt on the ice in your driveway in the winter.

permeability - a measure of how well a material allows fluid to flow through it.

porosity - the percentage of empty (void) space in earth material such as soil or rock.

water table - the top of the saturated zone.

saturated zone - the area below the water table where all the pore spaces are filled with water.

unsaturated zone - the area above the water table where most of the pore spaces are filled with air.

Reference List

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