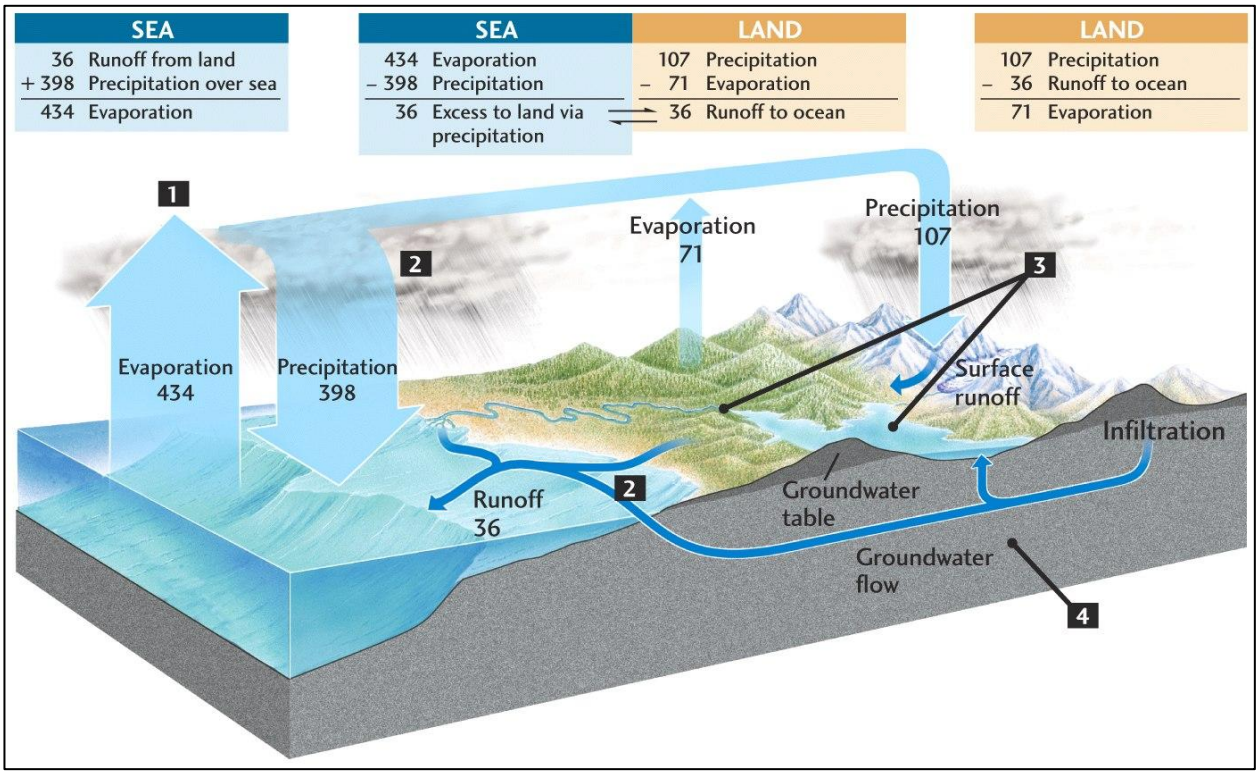
Hydrologic Cycle

The cyclical movement of water from the ocean to the atmosphere by evaporation, to the surface through precipitation, to *streams* through *runoff* and *groundwater*, and back to the ocean.

Precipitation = rain + snow

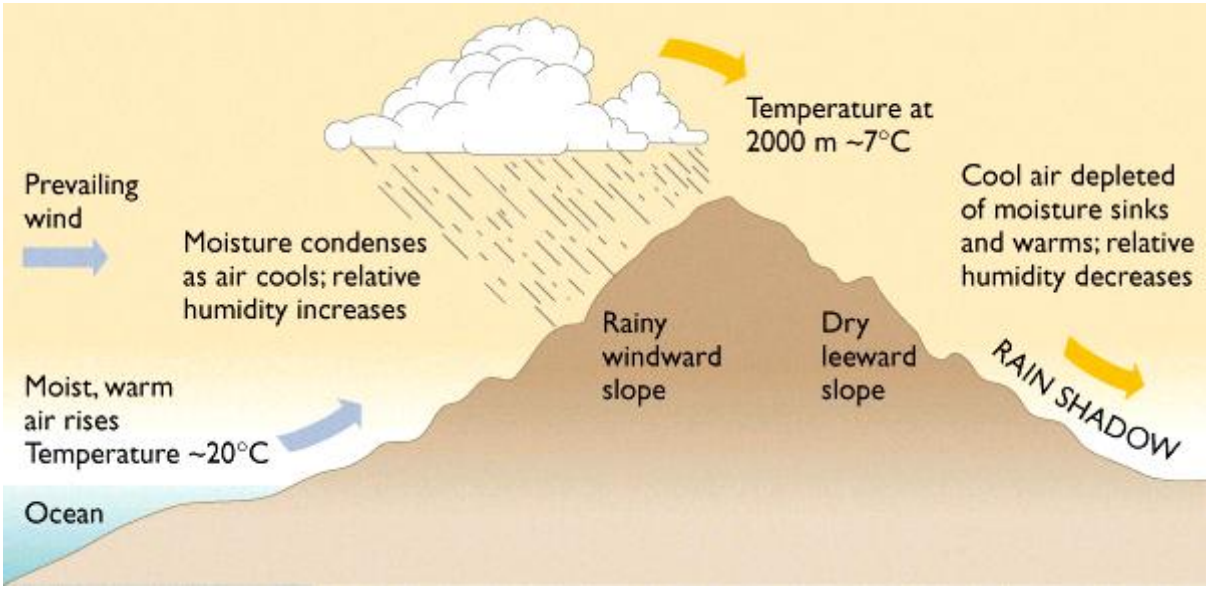
Transpiration = the release of water vapor from plants

- The ***hydrologic cycle*** models the movement of water from one reservoir to another (means and amount).
- Knowing flux and reservoir size, a *residence time* can be calculated - the time that a water molecule spends in each reservoir.



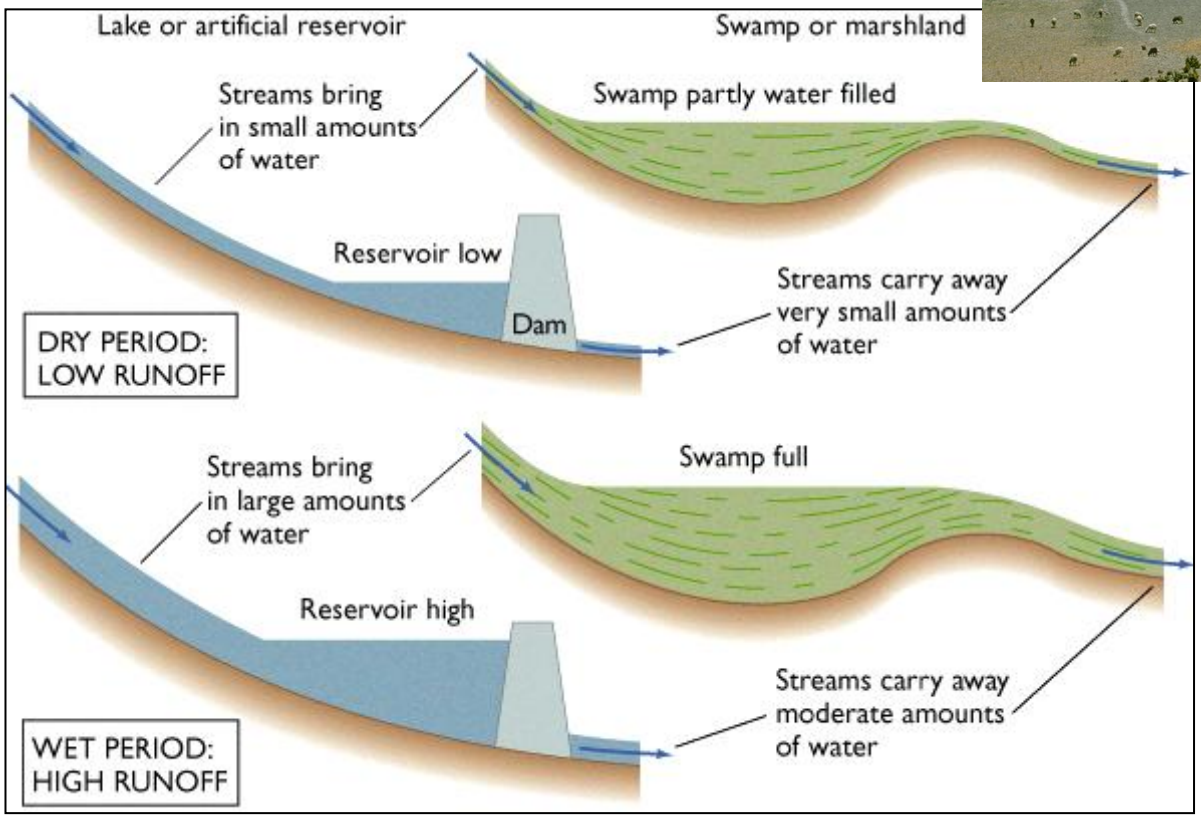
Rain Shadow:

Cool air depleted of moisture sinks and warms; relative humidity decreases.



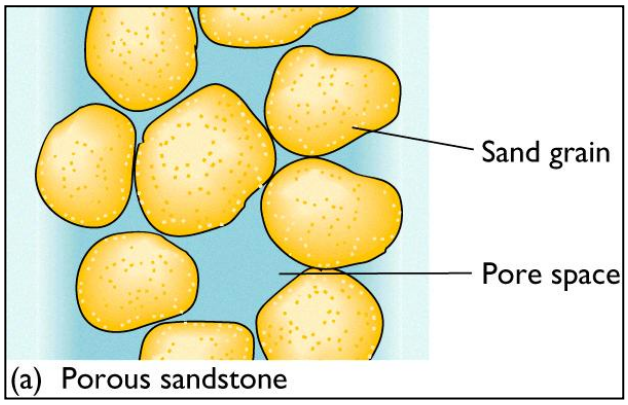
Surface Storage:

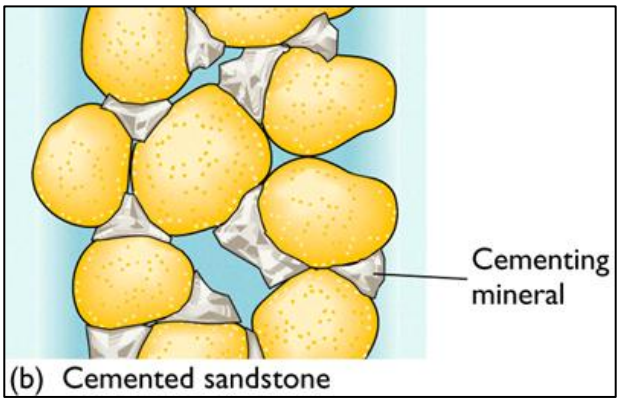
- Surface runoff collects in wetlands and lakes
- These features smooth out the large changes in runoff after storms.
- These features are usually a direct reflection of the ***water table***…(groundwater)

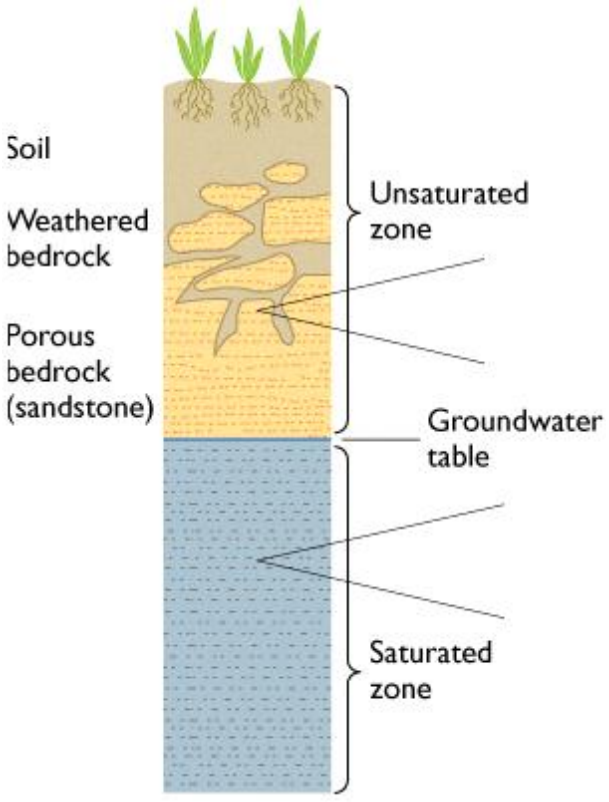


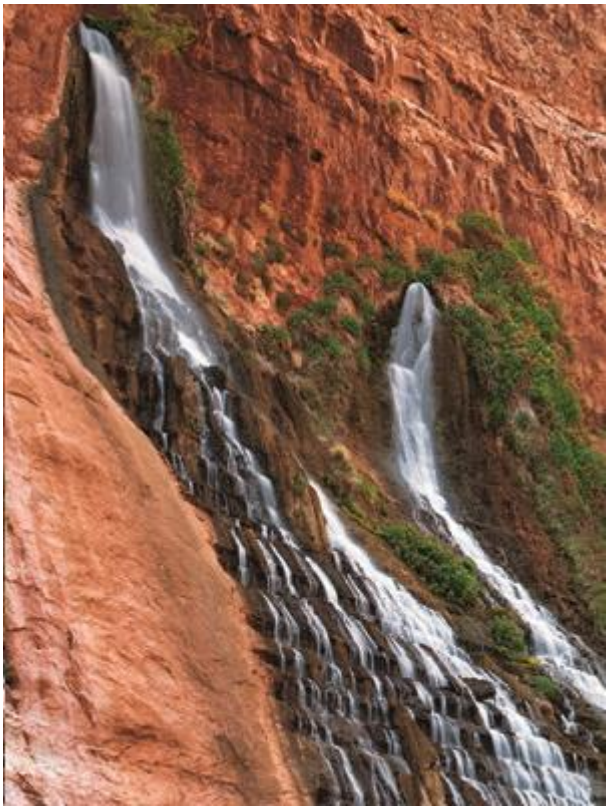
Groundwater:

- Ground water: *That part of the subsurface water that is in the zone of saturation*.
- Ground water occupies the pore spaces between minerals or rock fragments:
  - Highly porous rounded sand grains hold more water
  - Low porosity cemented sandstone holds much less water.



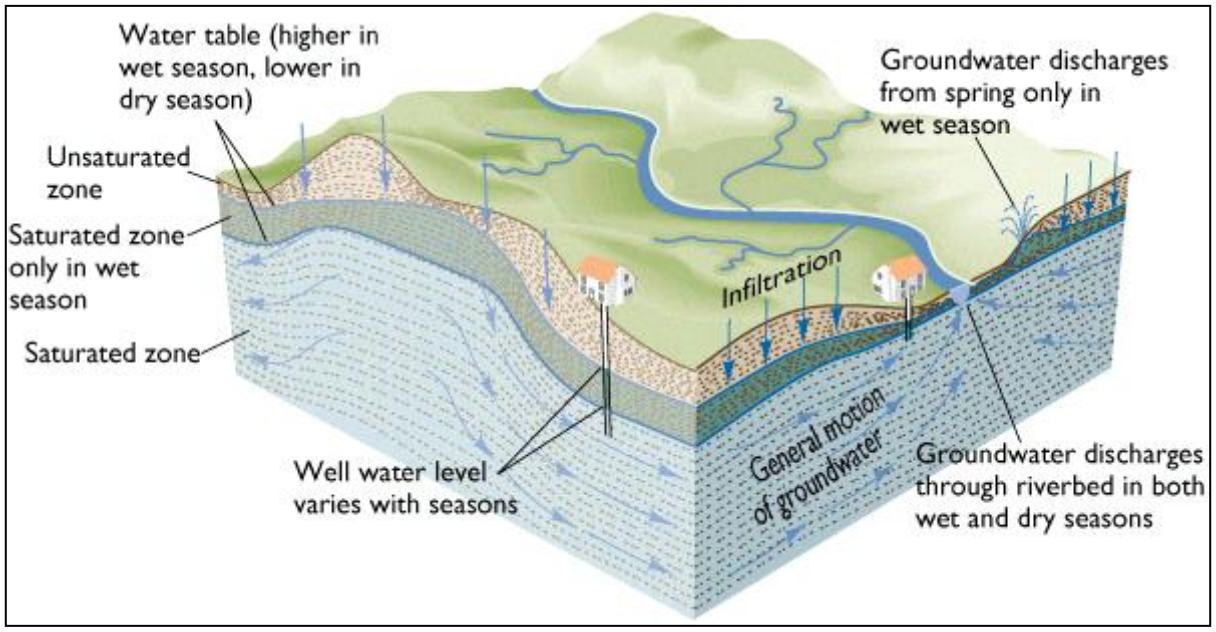






Groundwater relative to surface:

- Groundwater discharged form spring only in wet season.
- Groundwater discharged through riverbed in both wet and dry seasons.
- Groundwater discharged by infiltration (e.g. from rainfall, snow, …. etc)



Porosity and Permeability:

- **Porosity**: The total volume of empty space (pore space) in rock or soil, usually expressed as a percentage.

  P = Volume of pore spaces / Total volume of rock x 100

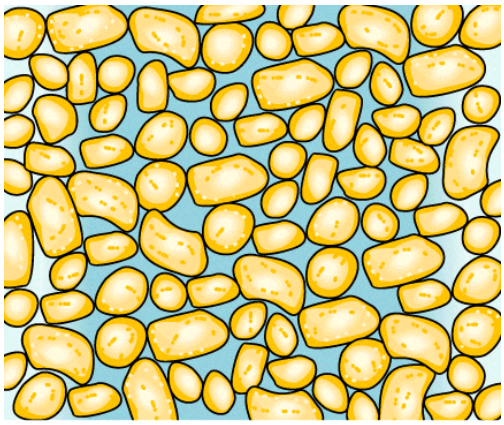
- **Permeability:** The degree to which a material allows fluids to pass through it via an interconnected network of pores and cracks, usually expressed as cm/sec, meter/hours.

Porosity defines the amount of water a volume of rock can hold:

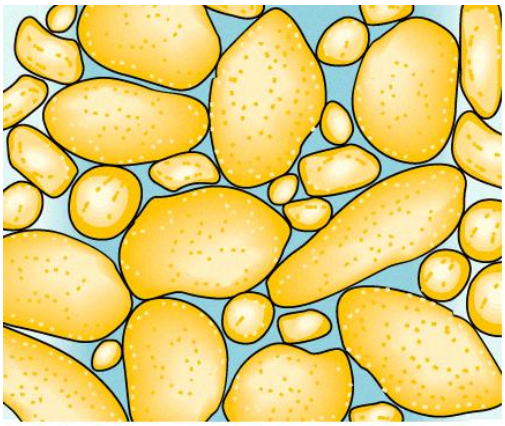
- Porosity increases with increased sorting, and depends on packing.
- Porosity is ***independent*** of grain size
- Porosity can vary from 1- 60%

Permeability defines the resistance to the movement of a fluid, and is controlled by the pore size and connectivity:

- Permeability decreases with decreasing grain size, porosity, and sorting.
- Permeability can very over many orders of magnitude.



(c) Fine-grained sandstone



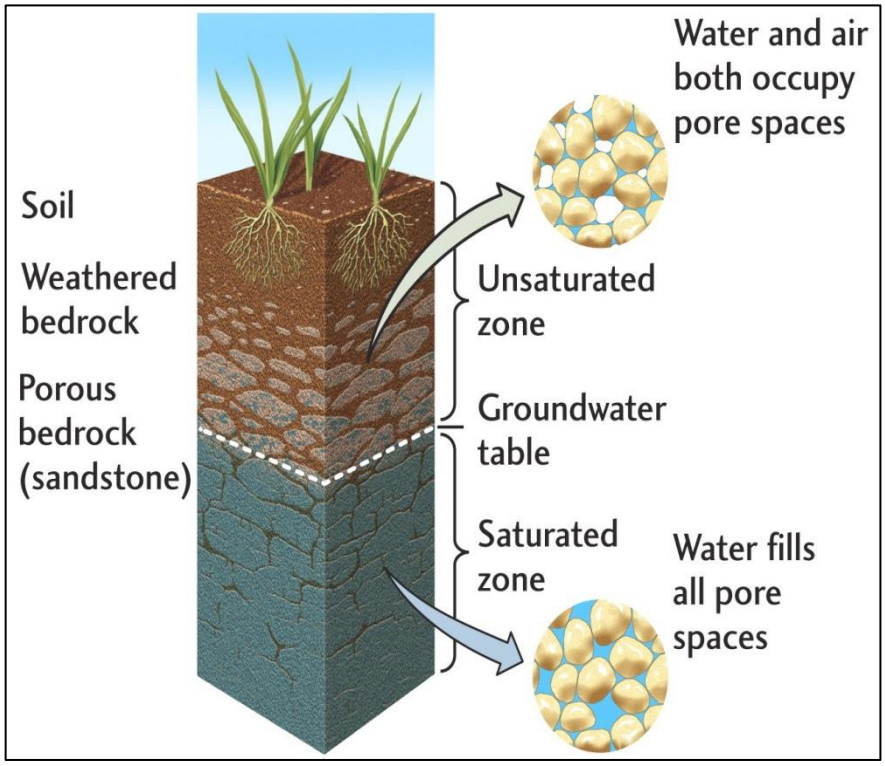
(d) Sandstone with irregular shapes

The Water Table:

The water table defines the boundary between the *saturated zone* (phreatic zone) and the *unsaturated zone* (vadose zone).

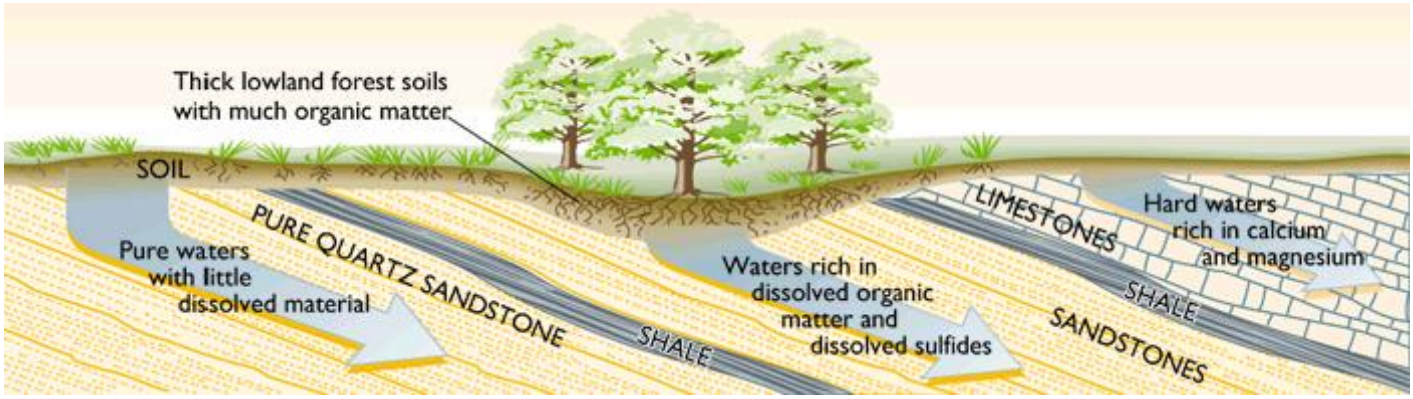
Operationally defined as the level to which the water will rise in an open hole

Absolutely defined as the point where the pressure *head* of the water is equal to the atmospheric pressure…



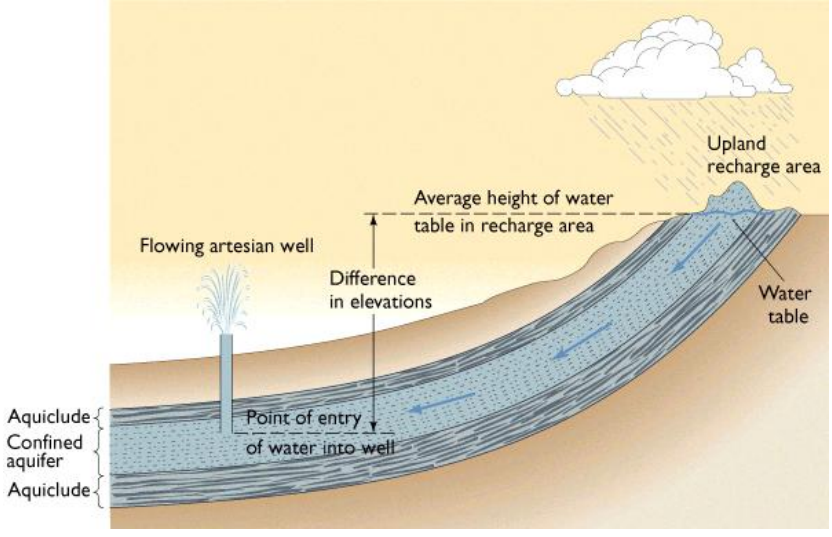
Aquifers:

- **Aquifer**: A body of rock that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells and springs.
- **Aquiclude**: A body of rock that will absorb water slowly but will not transmit it fast enough to supply a well or spring.
- **Aquitard**: A confining bed that retards but does not prevent the flow of water to or from an aquifer.
- **Recharge**: Gain of water from precipitation or by leakage from streams:
- **Discharge**: Loss of water by evapotranspiration, springs, or wells.

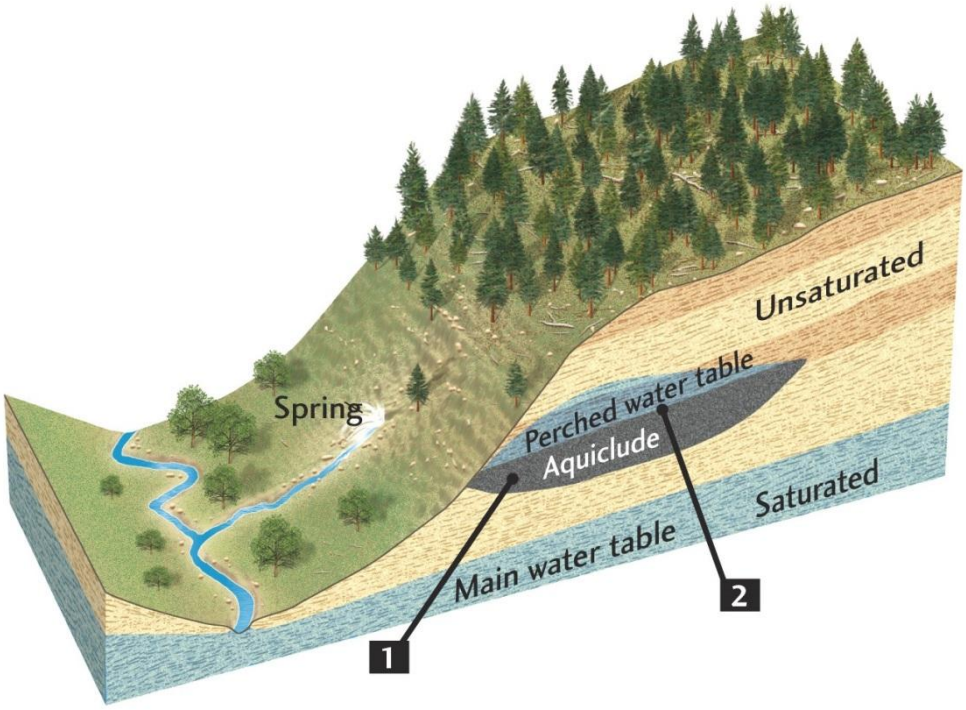


Type of Aquifer:

- ***Unconfined Aquifers*** have an upper boundary defined by the *water table*.
- ***Confined aquifer*** (Artesian): The upper boundary is a confining layer (Aquitard)
  - The water level (*head)* in a well penetrating confined aquifer rises above the level of the confining layer.
  - The surface defined by the water level is the *piezometric (or potentiometric) surface*, and is *not* the water table
  - Some are also *flowing* artesian wells.



- ***Perched Aquifer***: A zone of saturation with an upper water table boundary and a lower confining layer, underlain by another unsaturated zone.



Drawdown:

The lowering of the water table in an unconfined aquifer (potentiometric surface in a confined aquifer) caused by pumping ground water from wells.