GROUND WATER HYDROLOGY

GROUND WATER

- Groundwater is water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations.
- The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table

SUB SURFACE WATER

- Water in a soil mantle is called as sub surface water.
- Water beneath the surface can essentially be divided into two zones
  - the unsaturated zone (also known as the "zone of aeration") which includes soil water zone,
  - The zone of saturation which includes ground water.

- Sometimes, especially during times of high rainfall, these pore spaces are filled with water.
- The water table divides the zone of aeration from the zone of saturation.
- In the saturation zone, all the pores of soil are filled with water.
- In the aeration zone, soil pores are partially saturated with water.

- The aeration zone has 3 sub-zones.

    i) Soil water zone

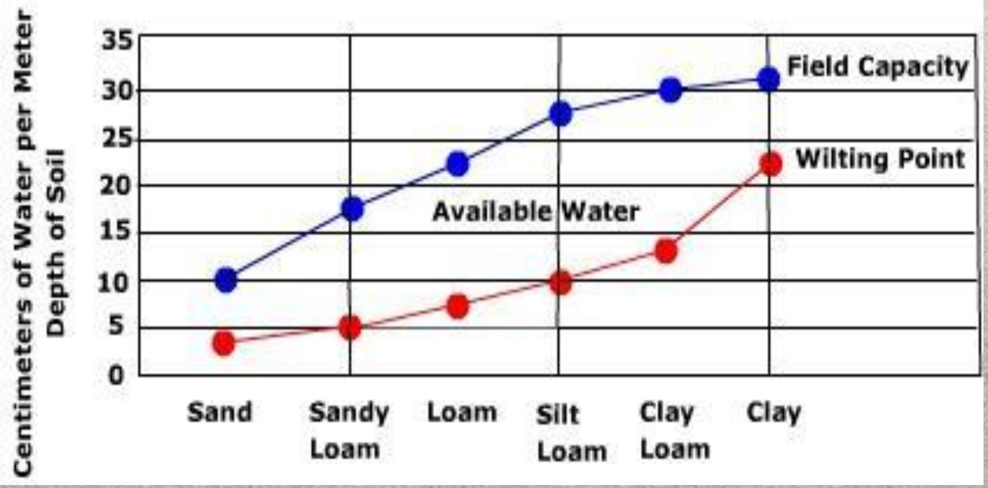
    ii) Intermediate zone

    Iii) Capillary fringe

SOIL WATER ZONE:

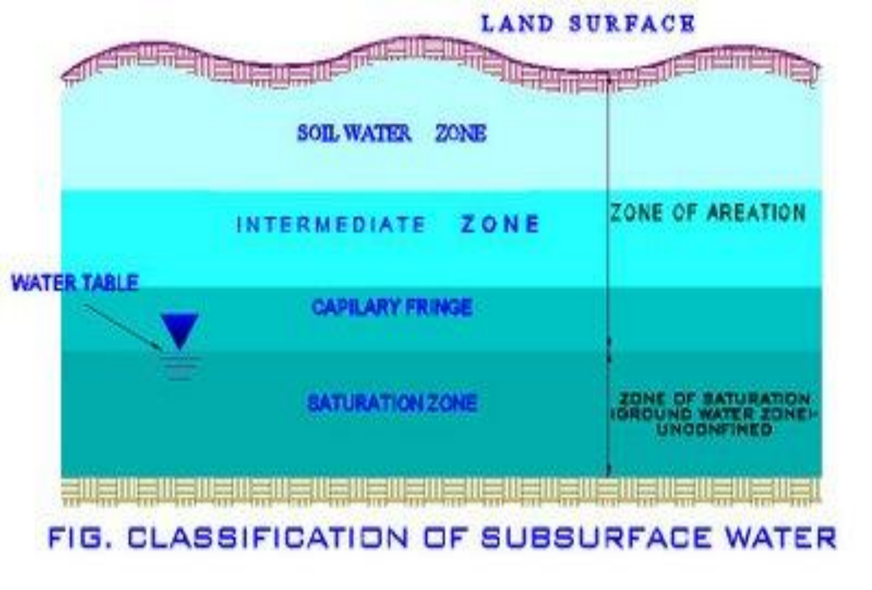
- Soil water is held in the pore spaces between particles of soil.
- Soil water is the water that is immediately available to plants.
- This water can be removed by air drying or by plant absorption, but cannot be removed by gravity.

- Plants extract this water through their roots until the soil capillary force (force holding water to the particle) is equal to the extractive force of the plant root.
- At this point the plant cannot pull water from the plant-rooting zone and it wilts (called the wilting point).
- The amount of water held in the soil after excess water has drained is called the field capacity of the soil.



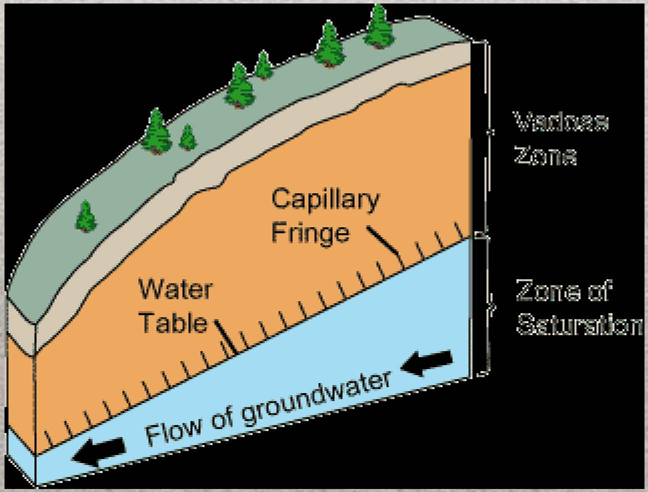
INTERMEDIATE ZONE:

- This is the layer that is available next to the soil water zone.
- It lies in between the soil water zone and the capillary zone.



CAPILLARY ZONE:

- The capillary fringe is the subsurface layer in which groundwater seeps up from a water table by capillary action to fill pores.
- Pores at the base of the capillary fringe are filled with water due to tension saturation.



- This saturated portion of the capillary fringe is less than total capillary rise because of the presence of a mix in pore size.
- If pore size is small and relatively uniform, it is possible that soils can be completely saturated with water for several feet above the water table.
- Alternately, the saturated portion will extend only a few inches above the water table when pore size is large.

- Saturated zone is classified into 4 categories.

  i) Aquifer

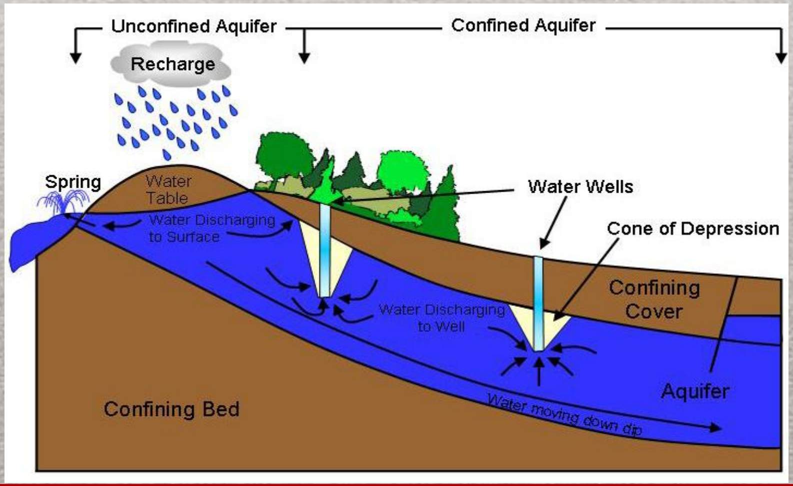
  ii) Aquiclude

  iii) Aquifuge

  iv) Aquitard

AQUIFER

- An aquifer is a layer of porous substrate that contains and transmits groundwater.
- An aquifer is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well.
- Aquifers may occur at various depths.



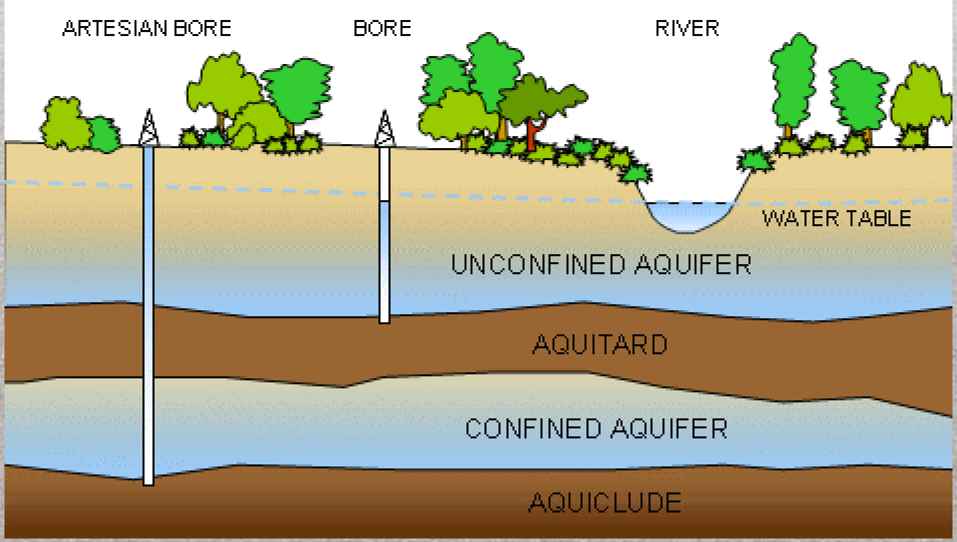
TYPES OF AQUIFER

UNCONFINED AQUIFER:

- Unconfined aquifers are sometimes also called water table or phreatic aquifers, because their upper boundary is the water table
- When water can flow directly between the surface and the saturated zone of an aquifer, the aquifer is unconfined.
- The deeper parts of unconfined aquifers are usually more saturated since gravity causes water to flow downward.

CONFINED AQUIFER:

- A water-bearing subsurface stratum that is bounded above and below by formations of impermeable, or relatively impermeable soil or rock.
- Also know as an artesian aquifer.



PROPERTIES OF THE AQUIFER

i) Porosity

ii) Specific yield

iii) Specific retention

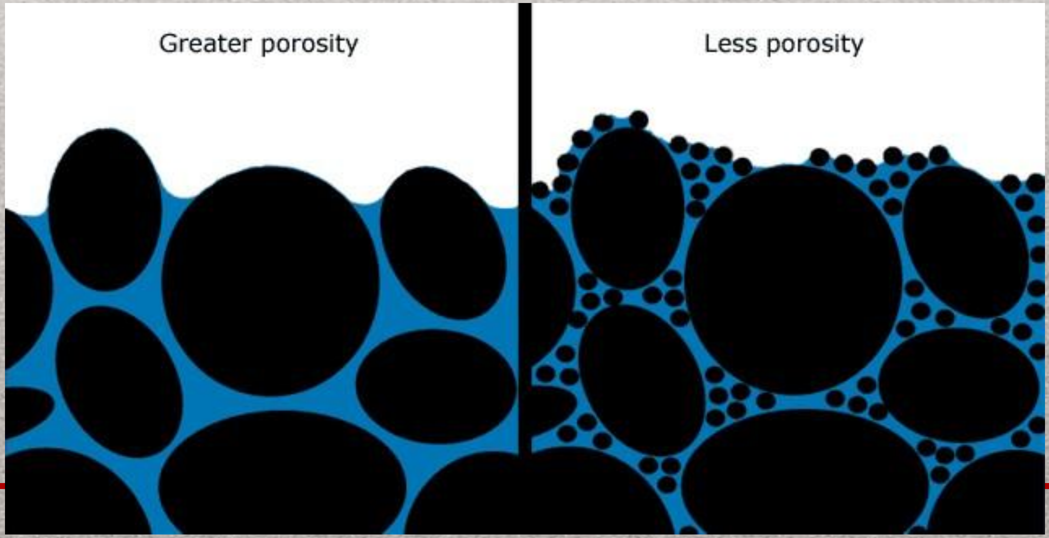
iv) Storage by efficiency (field capacity)

v) Permeability

vi) Transmissibility

POROSITY:

- Porosity or void fraction is a measure of the void (i.e., "empty") spaces in a material, and is a fraction of the volume of voids over the total volume, between 0–1, or as a percentage between 0–100%.
- Porosity of surface soil typically decreases as particle size increases.



SPECIFIC YIELD

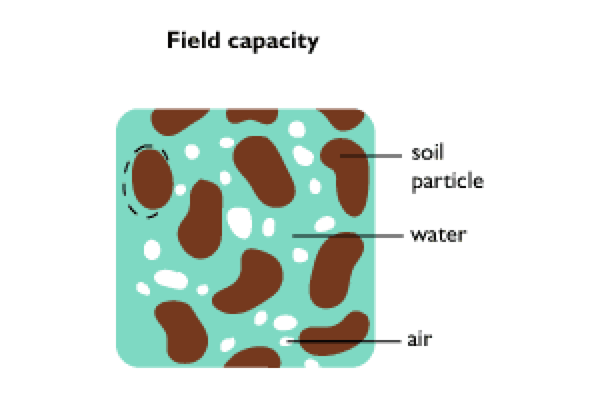
- The quantity of water which a unit volume of aquifer, after being saturated, will yield by gravity; it is expressed either as a ratio or as a percentage of the volume of the aquifer; specific yield is a measure of the water available to wells.

FIELD CAPACITY:

- Field capacity is the amount of soil moisture or water content held in soil after excess water has drained away .
- The physical definition of field capacity is the bulk water content retained in soil

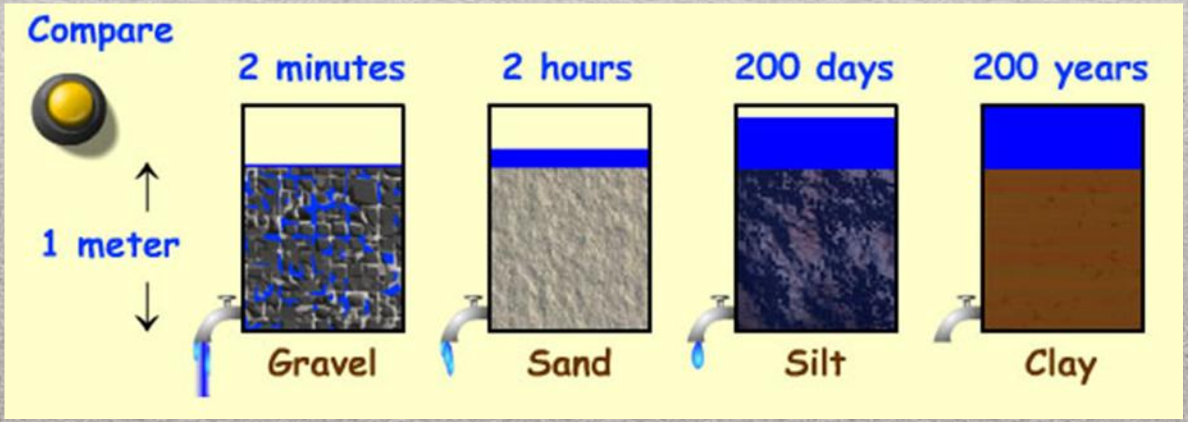
SPECIFIC RETNTION:

- The ration of the volume of water that a given body of rock or soil will hold against the pull of gravity to the volume of the body itself. It is usually expressed as a percentage



PERMEABILITY

- Just as the porosity of a soil affects how much water it can hold, it also affects how quickly water can flow through the soil.
- The ability of water to flow through a soil is referred to as the soil's permeability.

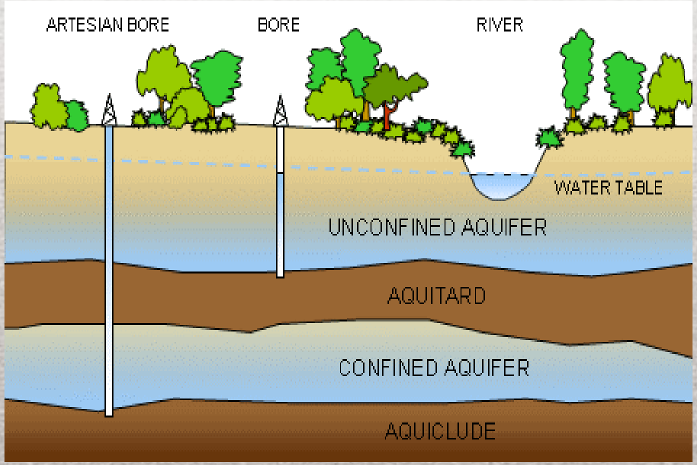


TRANSMISSIBILITY

- A measure of the ratio of the response amplitude of the system in steady-state forced vibration to the excitation amplitude; the ratio may be in forces, displacements, velocities, or accelerations.
- The transmissibility of an unconfined aquifer depends upon the depth of the GWT.

AQUICLUDE

- It is a solid, impermeable area underlying or overlying an aquifer. If the impermeable area overlies the aquifer pressure could cause it to become a confined aquifer.
- A solid, impermeable area underlying or overlying an aquifer.
- It can absorb water but cannot transmit it in significant amount.



AQUIFUGE:

- An impermeable body of rock which contains no interconnected openings or interstices and therefore neither absorbs nor transmits water.

AQUITARD:

- A bed of low permeability adjacent to an aquifer; may serve as a storage unit for groundwater, although it does not yield water readily.

DARCY'S LAW

- Darcy's law is a simple proportional relationship between the instantaneous discharge rate through a porous medium, the viscosity of the fluid and the pressure drop over a given distance.
- Darcy's law is only valid for slow, viscous flow;

$$Q=Tiw$$

i= hydraulic gradient

w= width of the aquifer

T= co.eff of transmissibility of the aquifer

- Typically any flow with a Reynolds number less than one is clearly laminar, and it would be valid to apply Darcy's

$$Re=(\rho Vd)/\mu$$

- where ρ is the density of water (units of mass per volume)
- v is the specific discharge (not the pore velocity — with units of length per time)
- d30 is a representative grain diameter for the porous media (often taken as the 30% passing size from a grain size analysis using sieves - with units of length)
- μ is the viscosity of the fluid.

DUPUIT'S ASSUMPTIONS

- i) stabilized drawdown- i.e., the pumping has been continued for a sufficiently long time at a constant rate, so that the equilibrium stage of steady flow conditions have been reached.
- ii) The aquifer is homogeneous, isotropic, of infinite areal extent and of constant thinkness i.e., constant permeability.
- iii) complete penetration of the well (with complete screening of the aquifer thickness) with 100% well efficiency.
- iv) Flow lines are radial and horizontal and the flow is laminar i.e.,Darcy's law is applicable.
- v) The well is infinitely small with neglible storge and all the pumped water comes from the aquifer.

PUMPING TEST

- The water level in the well is depressed to an amount equal to the safe working head for the sub- soil.
- The water level is kept constant by making the pumping rate equal to the percolation into the well.
- The quantity of water pumped in a known time gives an idea of the probable yield of the wel of the given diameter.
- This test may be carried out in an existing open well.
- Rate of seepage into the well = (volume of water pumped out – volume of stored in the well)/ time of pumping