Geotechnical Engineering–I

BSc Civil Engineering – 4th Semester

Lecture # 26

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by

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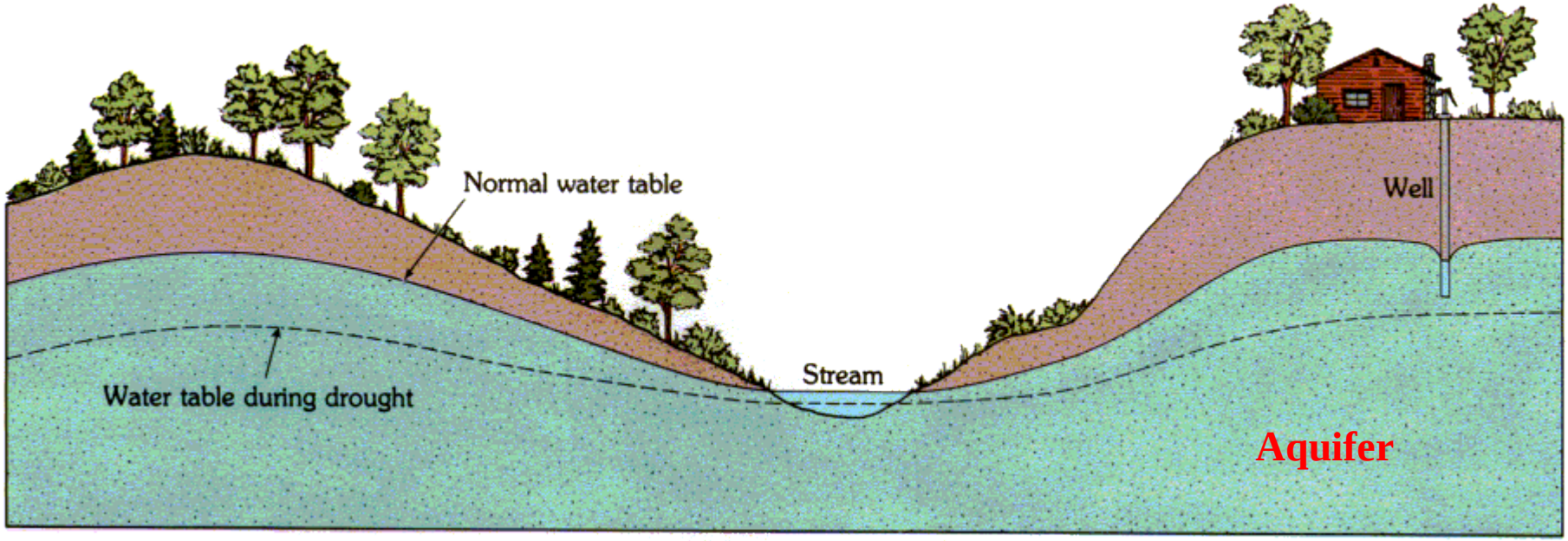
Lecture Handouts: https://groups.google.com/d/forum/geotec-1

Subsurface Flow of Water

Aquifer: Soil or rock forming stratum with sufficient porosity and permeability to store and transmit groundwater.

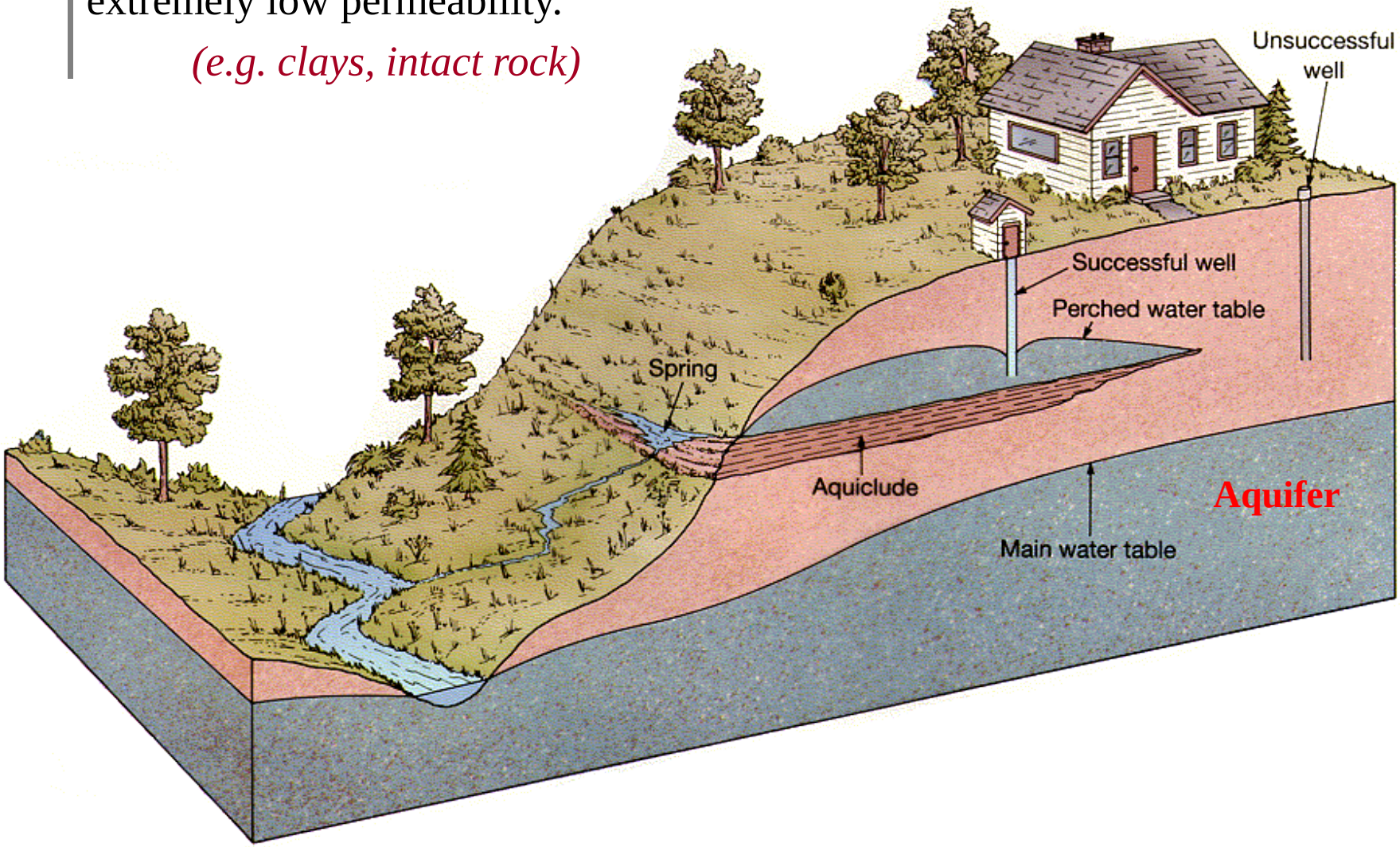
(e.g. sands, gravels, fractured rock)



Subsurface Flow of Water

Aquiclude/ Aquifuge: An impermeable stratum, or a stratum having extremely low permeability.

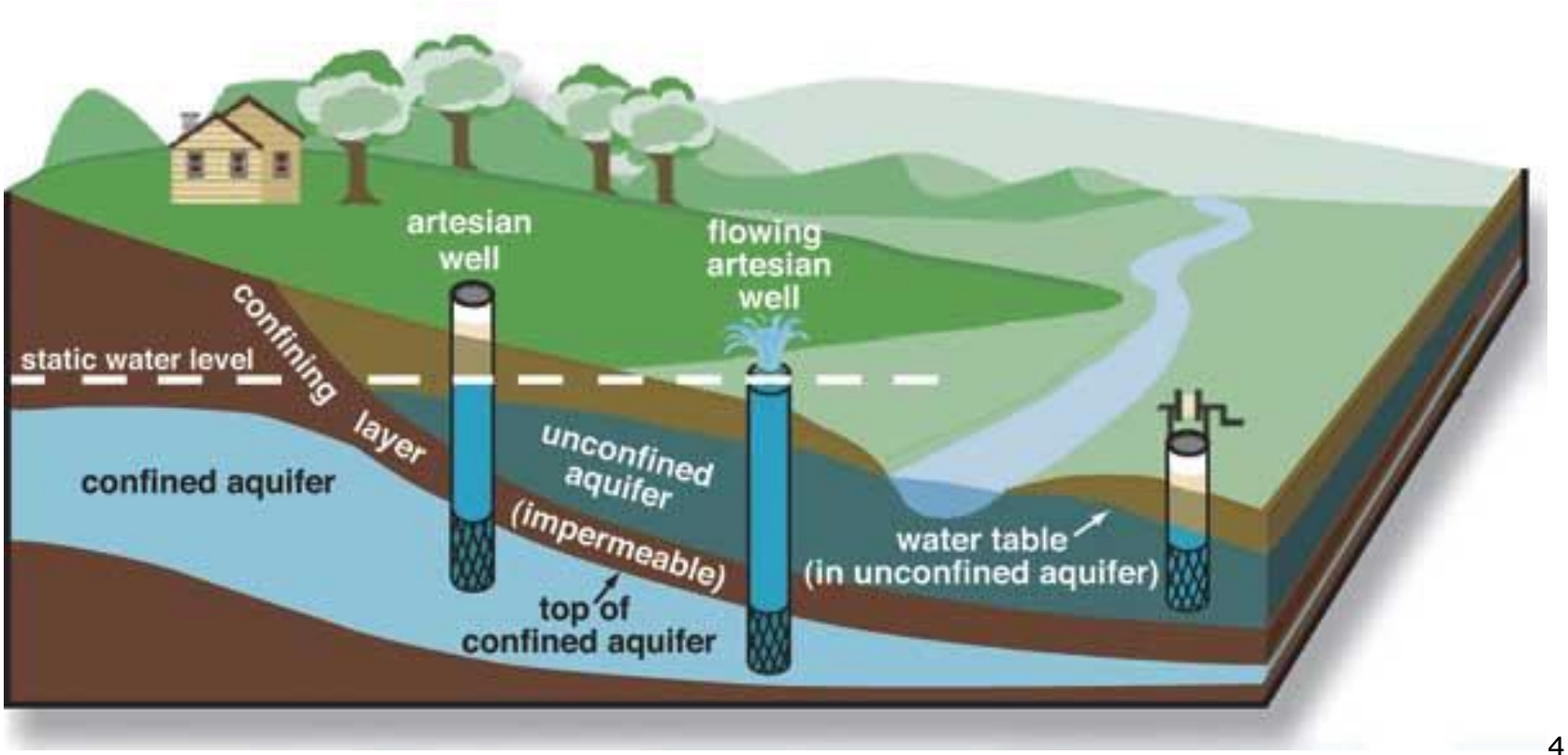
(e.g. clays, intact rock)



Subsurface Flow of Water

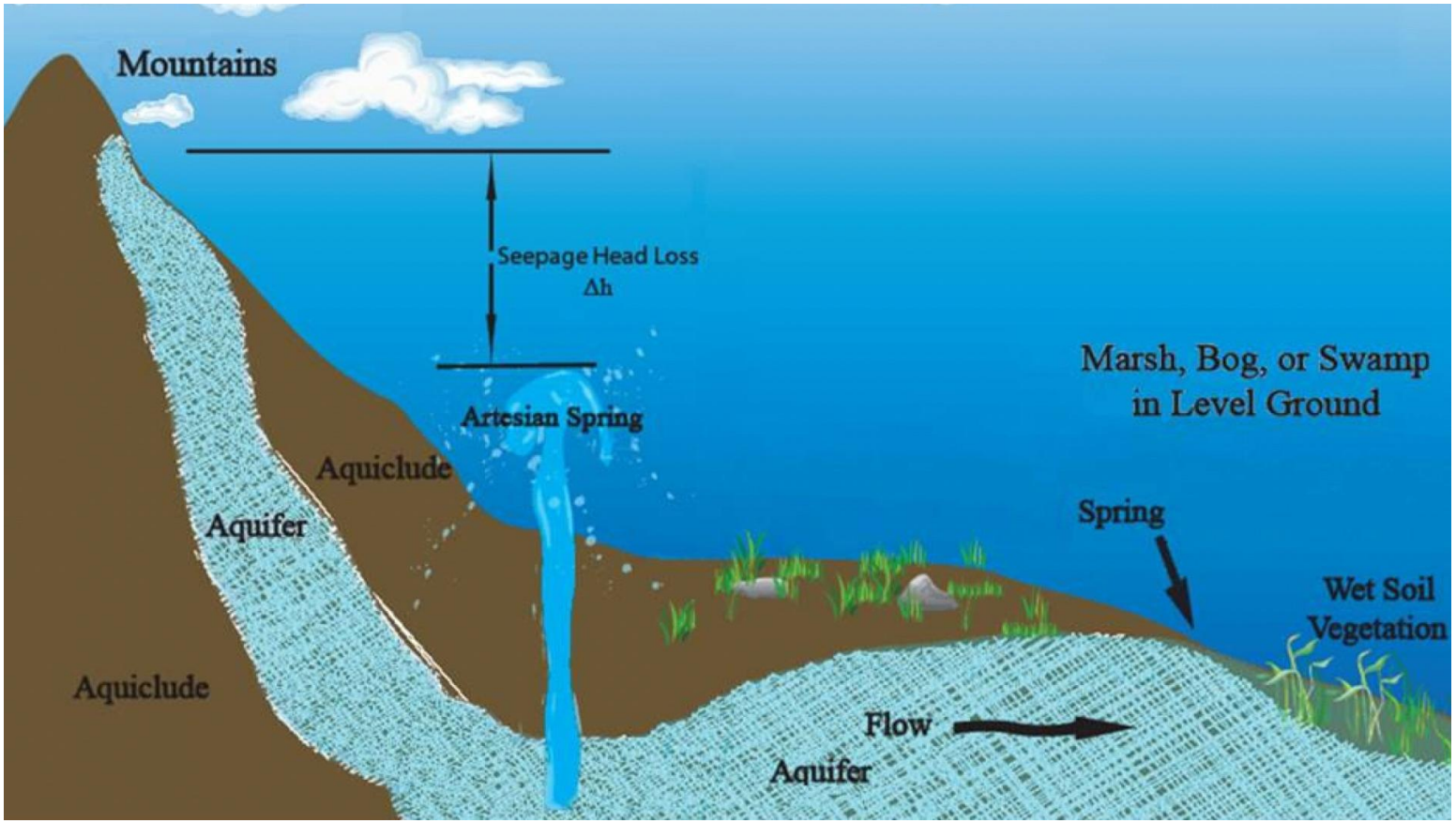
Unconfined Aquifer (water table aquifer) are bound by the water table; i.e., they have no confining rock layers over the top of them.

Confined Aquifer: A water bearing layer confined between less pervious (or impervious) layers.



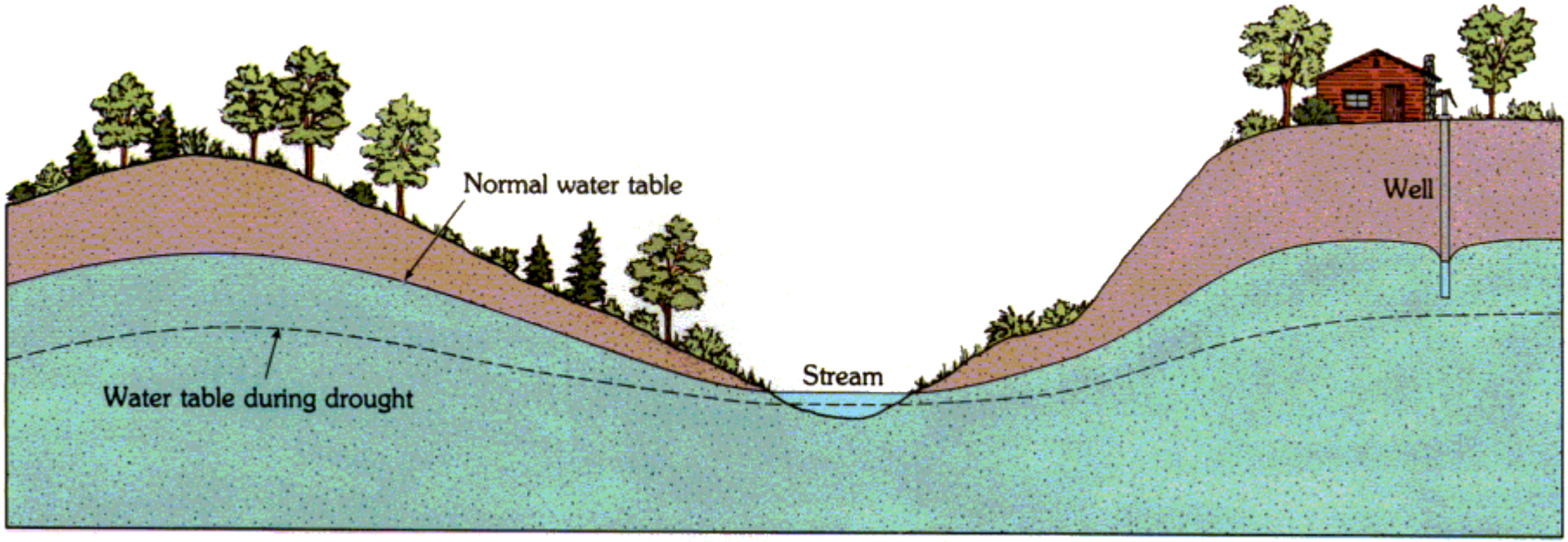
Artesian Flow

- **Artesian springs/wells** are wells that flow under their own pressure.
- These require a sloping permeable layer of rock (Aquifer) with a recharge zone higher than the well.

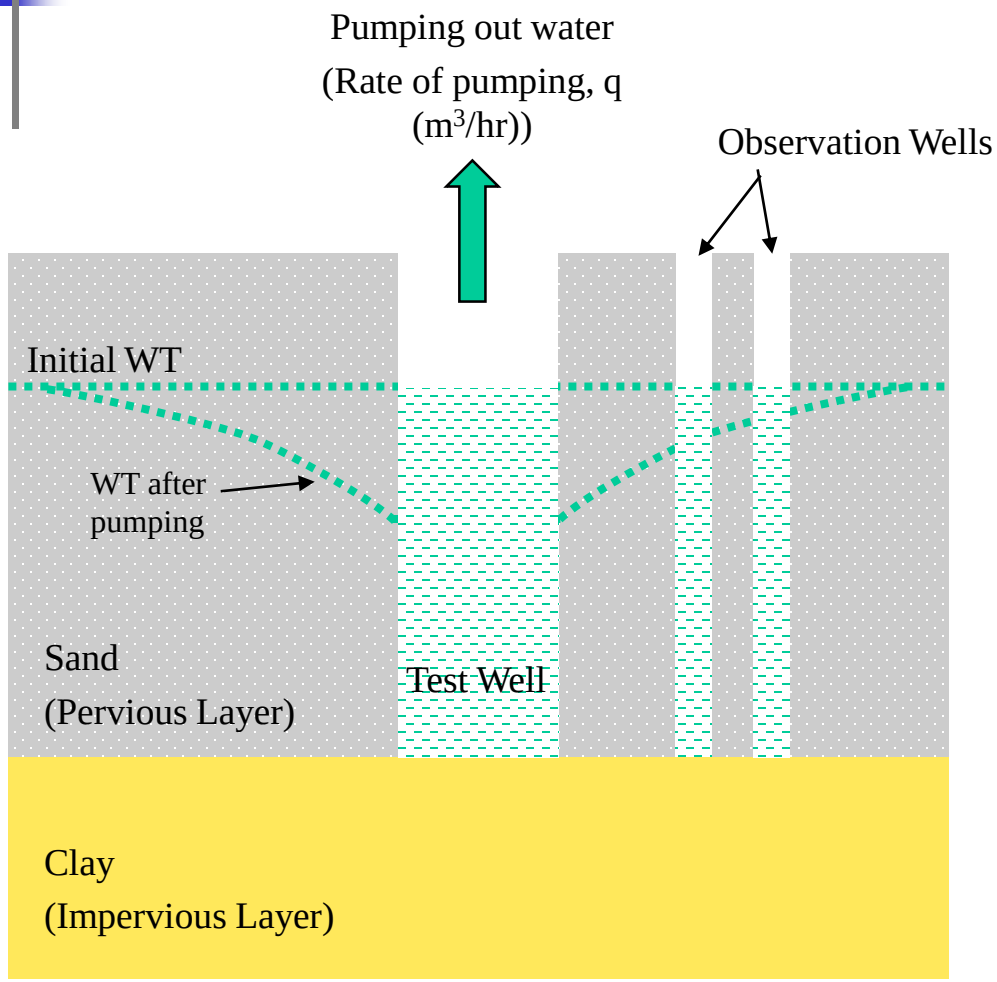


Determination of Hydraulic Conductivity in the Field

1. Pumping wells with observation holes
2. Borehole test
3. Packer test



In-situ Permeability Test using Pumping Wells



- *Steady state:* equilibrium state when the inflow to the well becomes equal to the rate of pumping.
- Water level in the test well + observation wells becomes constant at steady state condition.

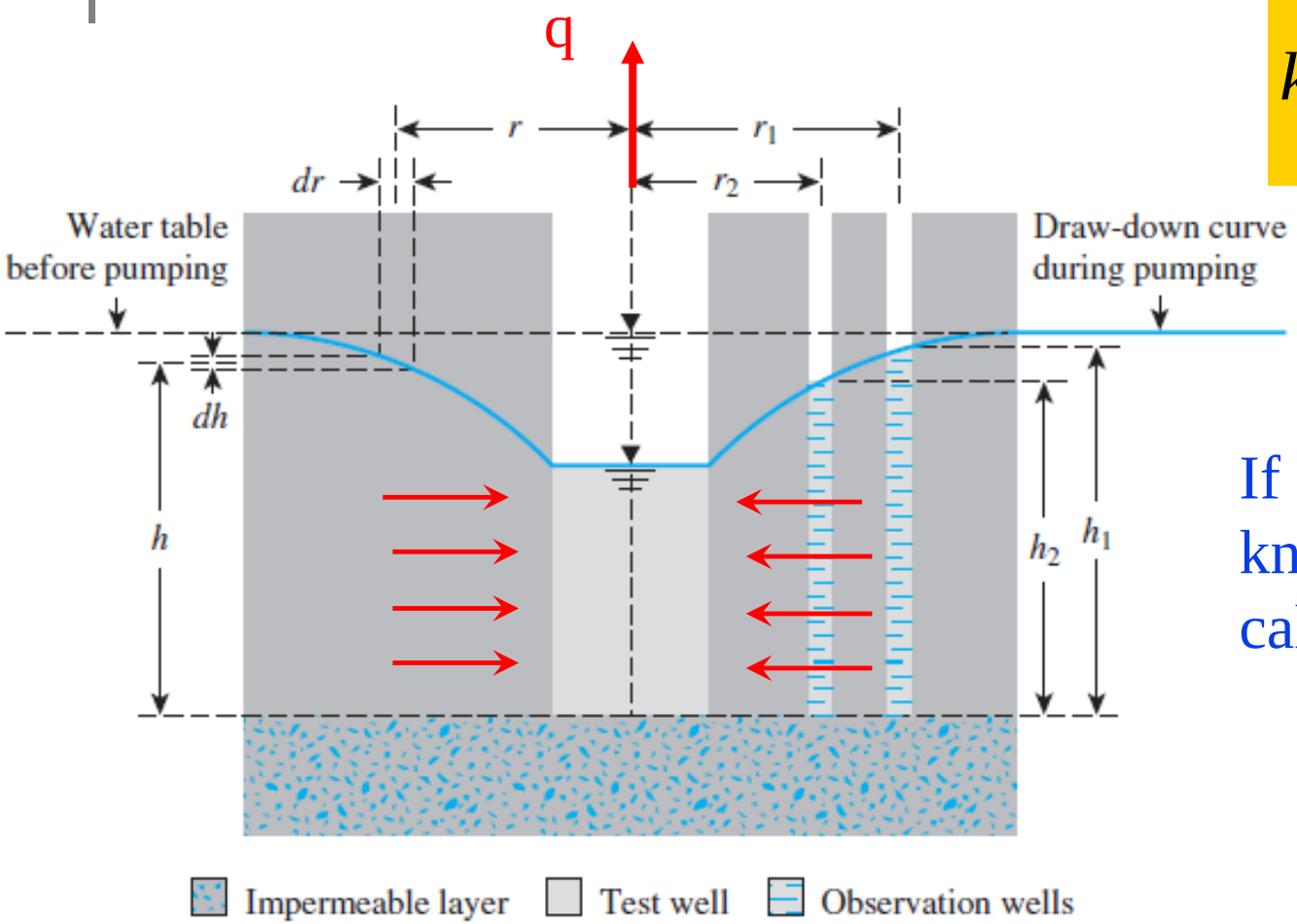
In-situ Permeability Test using Pumping Wells

- Used to determine *hydraulic conductivity (k)* of soil *in-situ*.
- Water is pumped out at a *constant rate* from a *test well* that has a perforated casing.
- Several *observation wells* at various radial distances are made around the test well.
- Continuous *observations of water level* in the test well + observation wells are made after the start of pumping, until a *steady state* is reached.
- The *steady state* is established when the *water level* in the test and observation wells *becomes constant*.

In-situ Permeability Test

Pumping Well in an Unconfined Aquifer

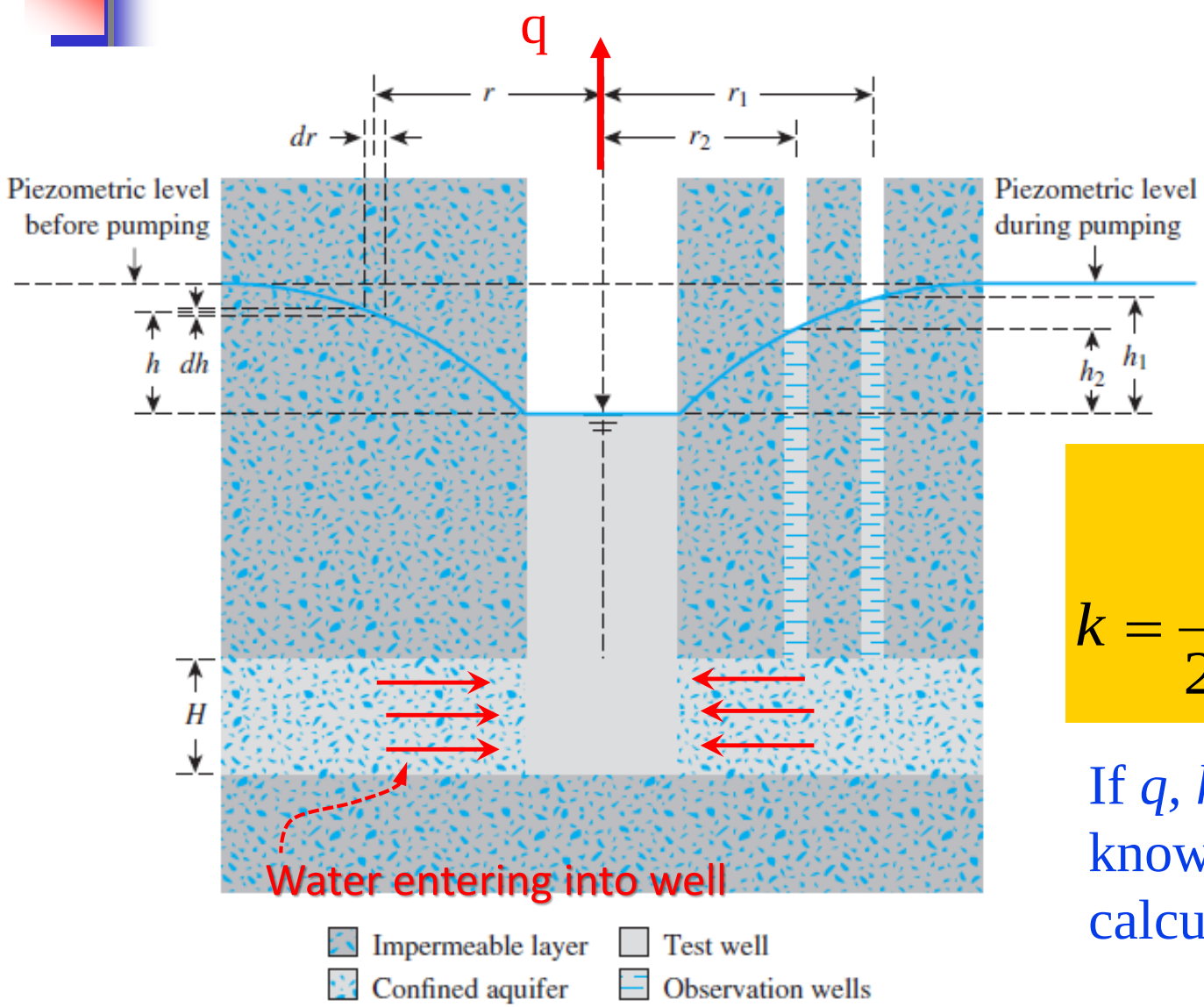
$$k = \frac{q \cdot \ln\left(\frac{r_2}{r_1}\right)}{\pi(h_2^2 - h_1^2)}$$



If q, h_1, h_2, r_1, r_2 are known , k can be calculated

In-situ Permeability Test

Pumping Well in an Confined Aquifer



$$k = \frac{q}{2\pi H} \frac{\ln\left(\frac{r_2}{r_1}\right)}{(h_2 - h_1)}$$

If q, h_1, h_2, r_1, r_2 are known , k can be calculated

Practice Problem #7

A layer of *sand 6m thick* underlies a *5m thick layer of clay* stratum and overlies a bed of shale. A pumping well, sunk to the base of sand yielded *$10x10^{-3}$ m^3/sec* of water under *steady state flow*. *Observation wells* placed at *15m* and *30m* from the well indicated *groundwater levels 3m and 2.5m* below surface level respectively. Determine the permeability of soil.

Practice Problem #8

A field pumping test is carried out to determine average permeability of uniform soil deposit *30m deep*. *Water table* in the deposit is located at a *depth of 2m* below ground surface. *Steady state* is reached under a uniform *pumping rate of 0.02 m^3/sec*. The two *observation wells* located at distances of *20m and 60m* show elevations of *water level* at *2m and 0.5m* below original water table respectively. Determine the value of soil permeability.

CONCLUDED