Ground water and well hydraulics

(G306-Seconed semester 2021-2022)

Lecture -5

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For confined aquifer:

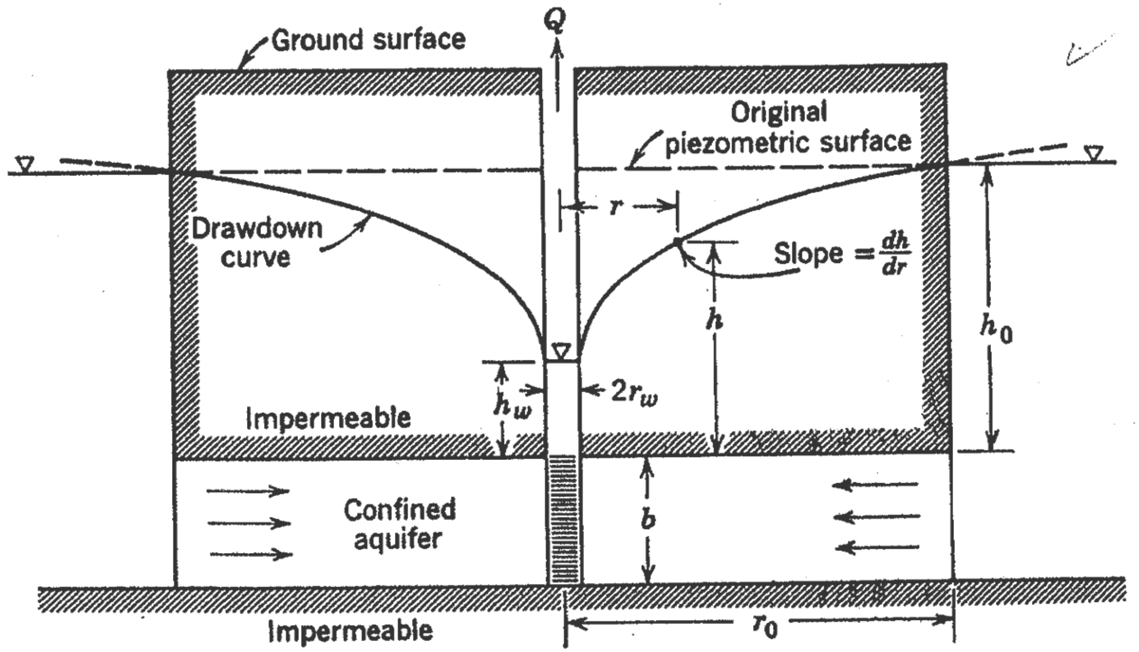

Fig. 4.3. Steady radial flow to a well penetrating a confined aquifer on an island.

When a well is pumped, water is removed from the aquifer surrounding the well and the water table or piezometric surface, depending on the type of aquifer, is lowered. The drawdown at a point is the distance the water level is lowered. The drawdown curve shows the variation of drawdown with distance from the well.

For unconfined aquifer:

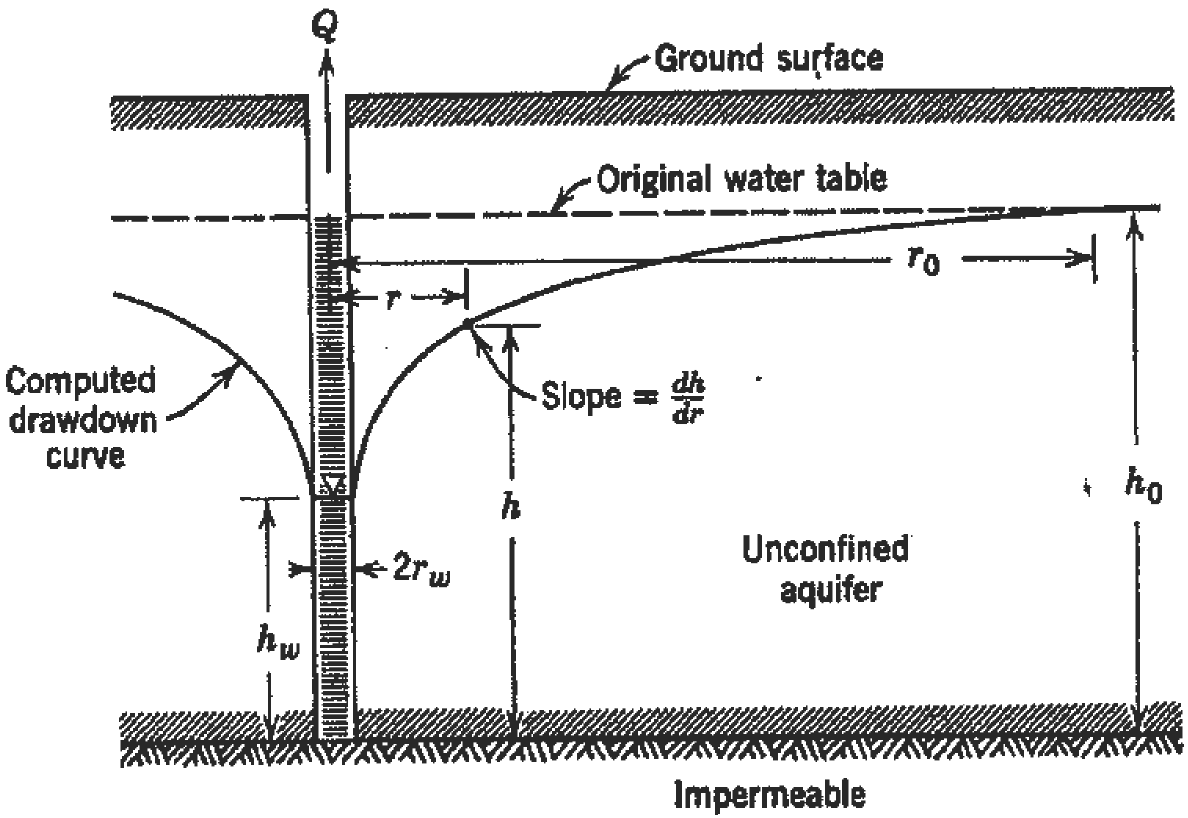

Fig. 4.5. Radial flow to a well penetrating an unconfined aquifer.

Ground water **pumping tests analysis**

Non equilibrium equation for pumping tests

To use this application of test must required a sum of assumptions:

1-The aquifer is homogenous and isotropic.

2-the aquifer is of infinite areal extent.

3-the well penetrates the entire aquifer.

4-the well diameter is infinitesimal.

5-the water removed from storage is discharged instantaneously with decline of heads.

Then average values of S&T are obtained in the vicinity of the pumped well by measuring in one or more observation wells the decline of head with time under the influences of a constant pumping rate.

Unsteady state flow in confined aquifer (Theis,s method)

Theis(1935) was the first to develop a formula for unsteady state flow that introduces the time factor and the storativity. The assumption should be satisfied is:

1-the same assumption above

6-the aquifer is pumped at constant discharge rate

7-the flow to the well is in unsteady state flow .i.e the hydraulic gradient is **not constant** with time.

$$kD = \frac{Q}{4\pi s}\, w(u) \quad \ldots\ldots\ldots 1$$

$$S = 4kD\left(\frac{t}{r^2}\right)u \quad \ldots\ldots\ldots 2$$

Where: w (u), u = Theis well function

Jacob method (cooper and Jacob, 1946)

The Jacob method is based on theis formula s= (Q/4∏kD)w(u), but when he solve this equation he found that ln(u) in the series become so small that they can be neglected .

So for values of u (u<0.01), the drawdown can be approximated by:

$$T = kD\frac{2.3Q}{4\pi\Delta s} \quad \ldots\ldots 1$$

$$S = \frac{2.25Tt_{\circ}}{r^2} \quad \ldots\ldots\ldots 2$$

The following assumptions & conditions should be satisfied :

•The same assumption of theis method

•The values of u are small (u<0.01) to avoided large errors ,i.e. r is small and t is large.

Steady state flow in confined aquifer (Theim's method)

The assumptions & conditions are:

1-the aquifer has infinite areal extent

2-the aquifer is hom., isot., and uniform thickness over the area influenced by the pumping test

3-the aquifer is pumped at constant discharge rate

4-the pumped well penetrates the entire aquifer

5- the flow to the well is in steady state (the hydraulic gradient is constant with time)

6-the aquifer is confined

The well discharge can be expressed as:

$$Q = \frac{2\pi kD(h_2 - h_1)}{\ln (r_2/r_1)} = \frac{2\pi kD(h_2 - h_1)}{2.30 \log (r_2/r_1)}$$

r_2, r_1 = the respective distance of the piezometers from the well in m

h_2, h_1 = the respective steady state elevations of the water levels in the piezometers in m