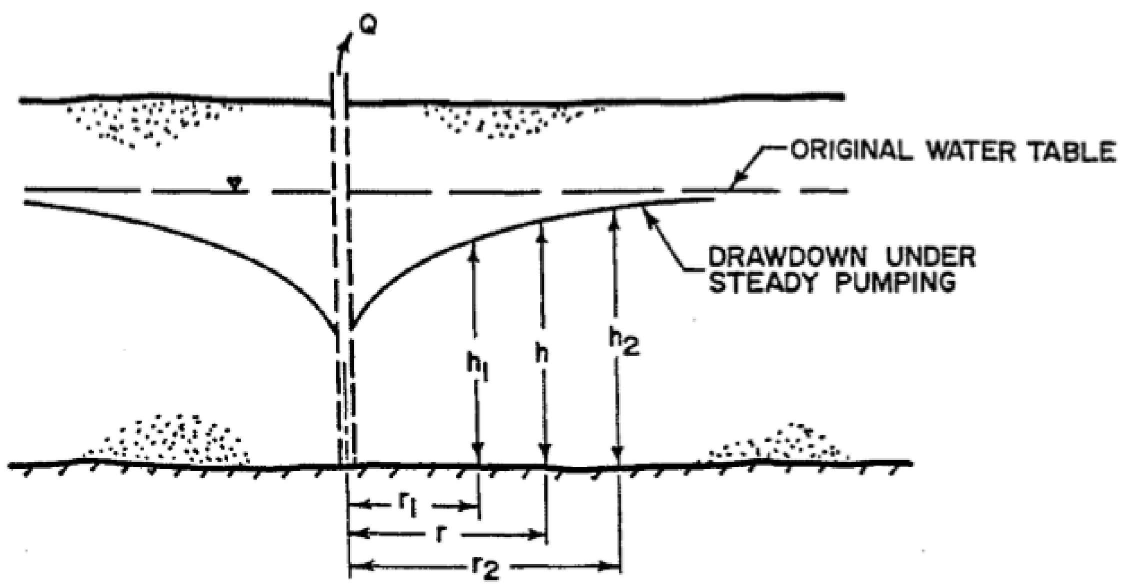
**Field Determination of Permeability**

One of the many methods of determining k in the field is by means of a pump out test. This test can be used in a situation which is represented in below figure. A horizontal stratum of previous soil containing a water table overlies an impervious stratum. A well is sunk to the bottom of the pervious material and water is pumped from the well at a constant rate Q until steady state conditions are reached. Observation wells at radial distances $r_1$ and $r_2$ permit measurement of the heights $h_1$ and $h_2$ respectively.




**FIELD PUMP OUT TEST**

At a radial distance r the cylindrically shaped area across which discharge occurs towards the well is

$$A = 2\,\pi\,r\,h$$

and the hydraulic gradient at this radial distance may be approximated by:

$$i = dh/dr$$

Applying Darcy's law:

$$Q = k\,i\,A$$

$$= k\frac{dh}{dr}\,2\pi\,r\,h$$

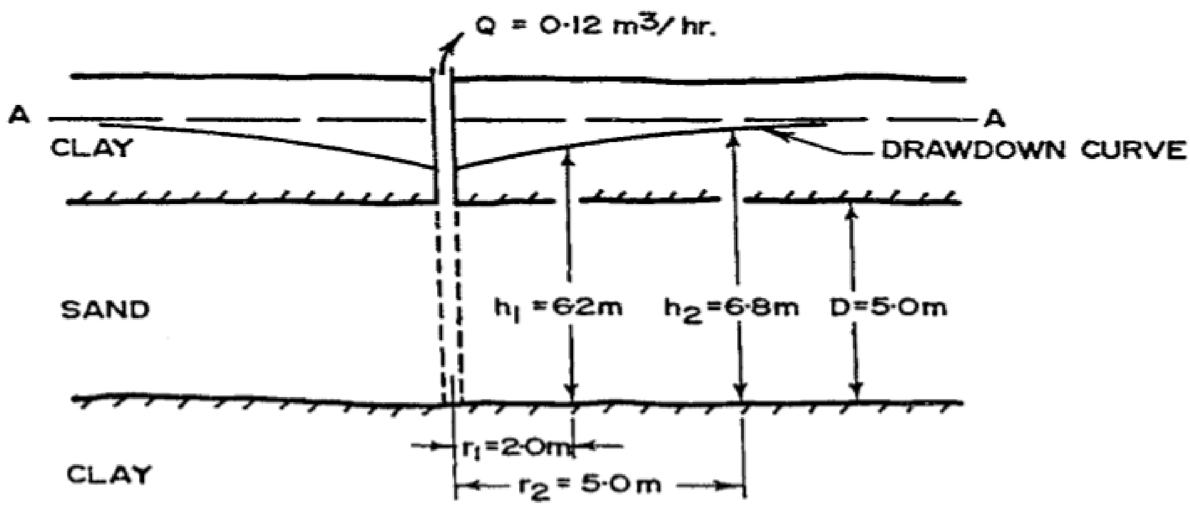
$$\therefore \int_{r_1}^{r_2}\frac{dr}{r} = \frac{2\pi\,k}{Q}\int_{h_1}^{h_2} hdh$$

$$\ln_e\left(\frac{r_2}{r_1}\right) = \frac{\pi\,k\,(h_2{}^2 - h_1{}^2)}{Q}$$

$$\therefore k = \frac{2.3\,Q\,\log_{10}(r_2/r_1)}{\pi\,(h_2{}^2 - h_1{}^2)}$$

The below figure represents a confined sand stratum located between two relatively impermeable clay strata. The piezometric surface (the level to which water would rise in a standpipe or piezometric tube placed in the sand stratum) is indicated by line AA. A pump out test with constant discharge is performed with a fully penetrating well. Observations of drawdown (steady state conditions) at two observation wells are shown in the figure. Determine the coefficient of permeability for the sand stratum, assuming it is homogeneous and istotropic.

Equation below cannot be used in this case since it was derived for an "unconfined" aquifer, whereas the figure below represents a "confined" aquifer. Consequently, the appropriate equation will need to be derived.




**Pump Out Test in a Confined Aquifer**

Applying Darcy's law:

$$\mathbf{Q} = \mathbf{k\,i\,A}$$

$$= k\frac{dh}{dr}\;.\;2\pi r\,D$$

$$\therefore \int_{r_1}^{r_2}\frac{dr}{r} = \frac{2\pi\,k\,D}{Q}\int_{h_1}^{h_2} dh$$

$$\ln_e\left(\frac{r_2}{r_1}\right) = \frac{2\pi k\,D}{Q}\;(h_2 - h_1)$$

$$\therefore k = \frac{2.3\,Q}{2\pi D}\;\frac{\log_{10}(r_2/r_1)}{(h_2 - h_1)}$$

Substituting the values in the above figure into equation (5.17)

$$\therefore k = \frac{2.3\,Q}{2\pi D}\;\frac{\log_{10}(r_2/r_1)}{(h_2 - h_1)}$$

$$k = \frac{2.3 \times 0.12}{2\pi \times 5.0}\;\frac{\log_{10}{(2.5)}}{(6.8 - 6.2)}$$

$$= 5.8 \times 10^{-3}\ \text{m/hr}$$

$$= 1.6 \times 10^{-6}\ \text{m/sec}$$