SITE DEWATERING

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Source:

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Dewatering Systems

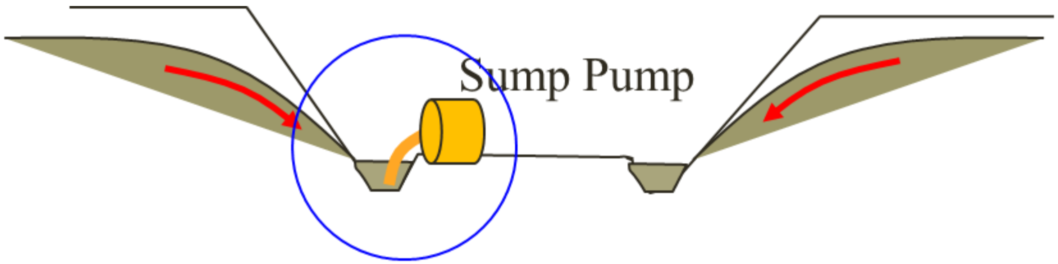
1. **Sumps, Trenches, and Pumps**

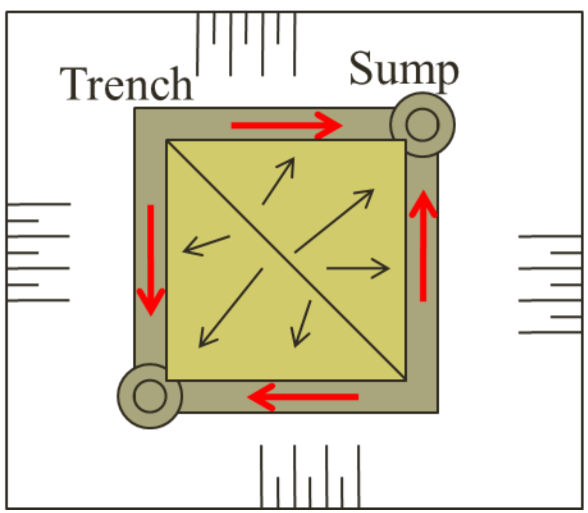
2. **Well Point Systems**

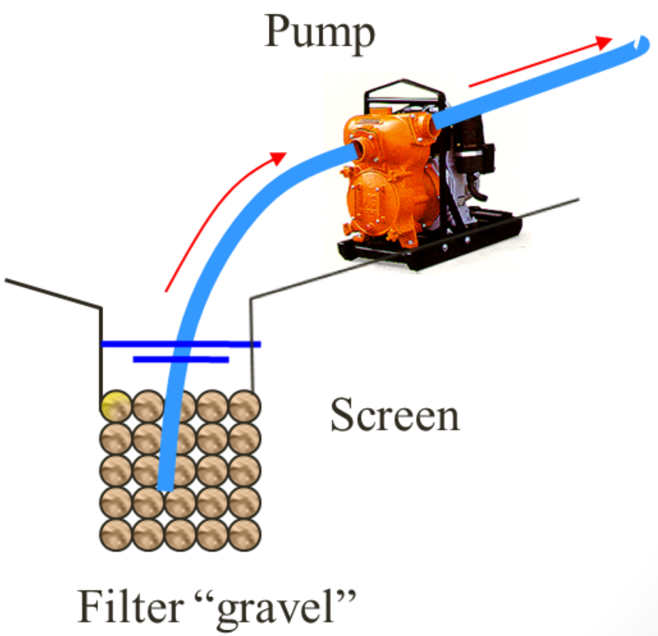
3. **Deep Well Systems**

Sumps, Trenches, and Pumps

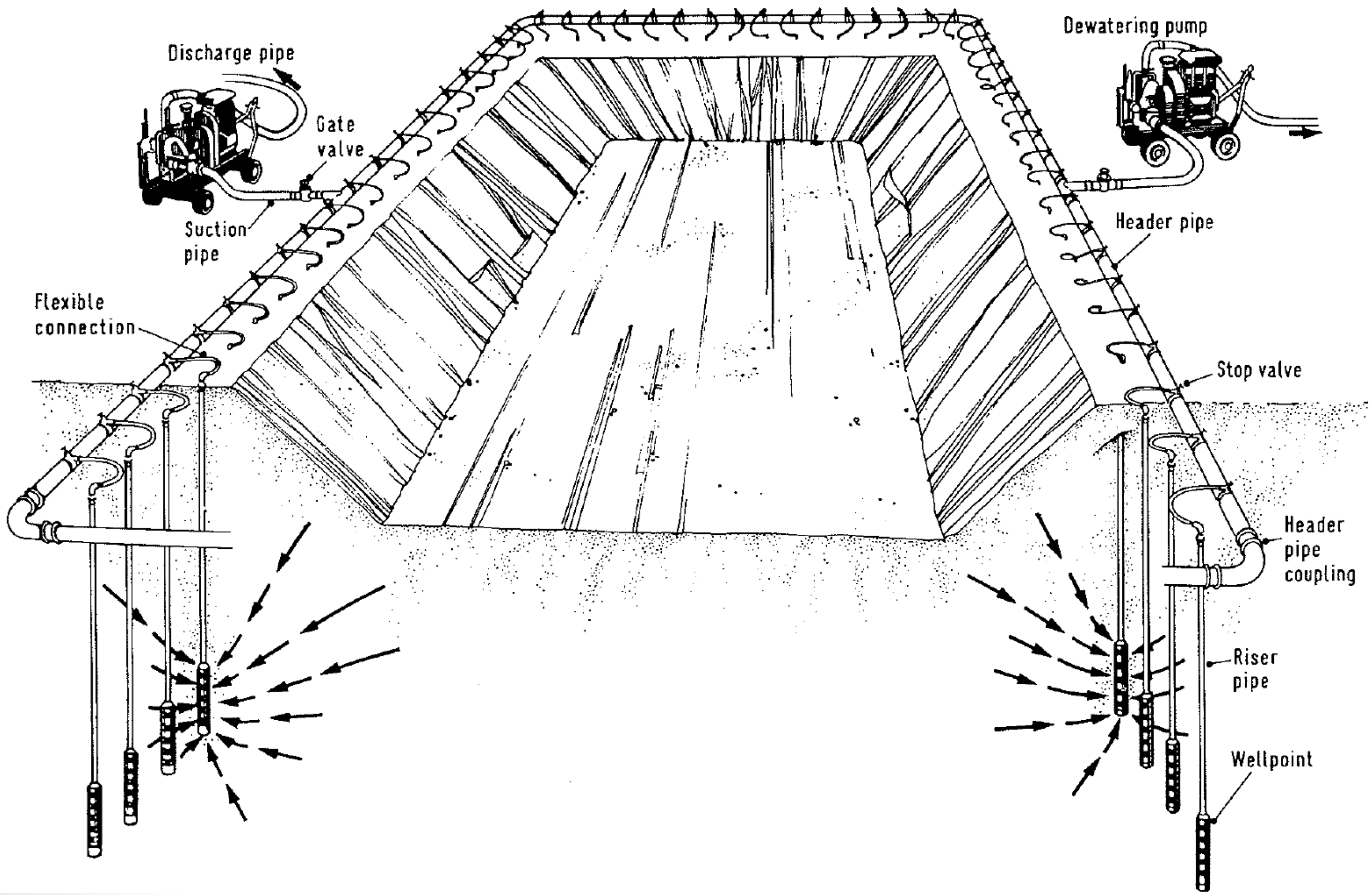
طلمبات خنادق بالوعات







Single Stage Well Point System



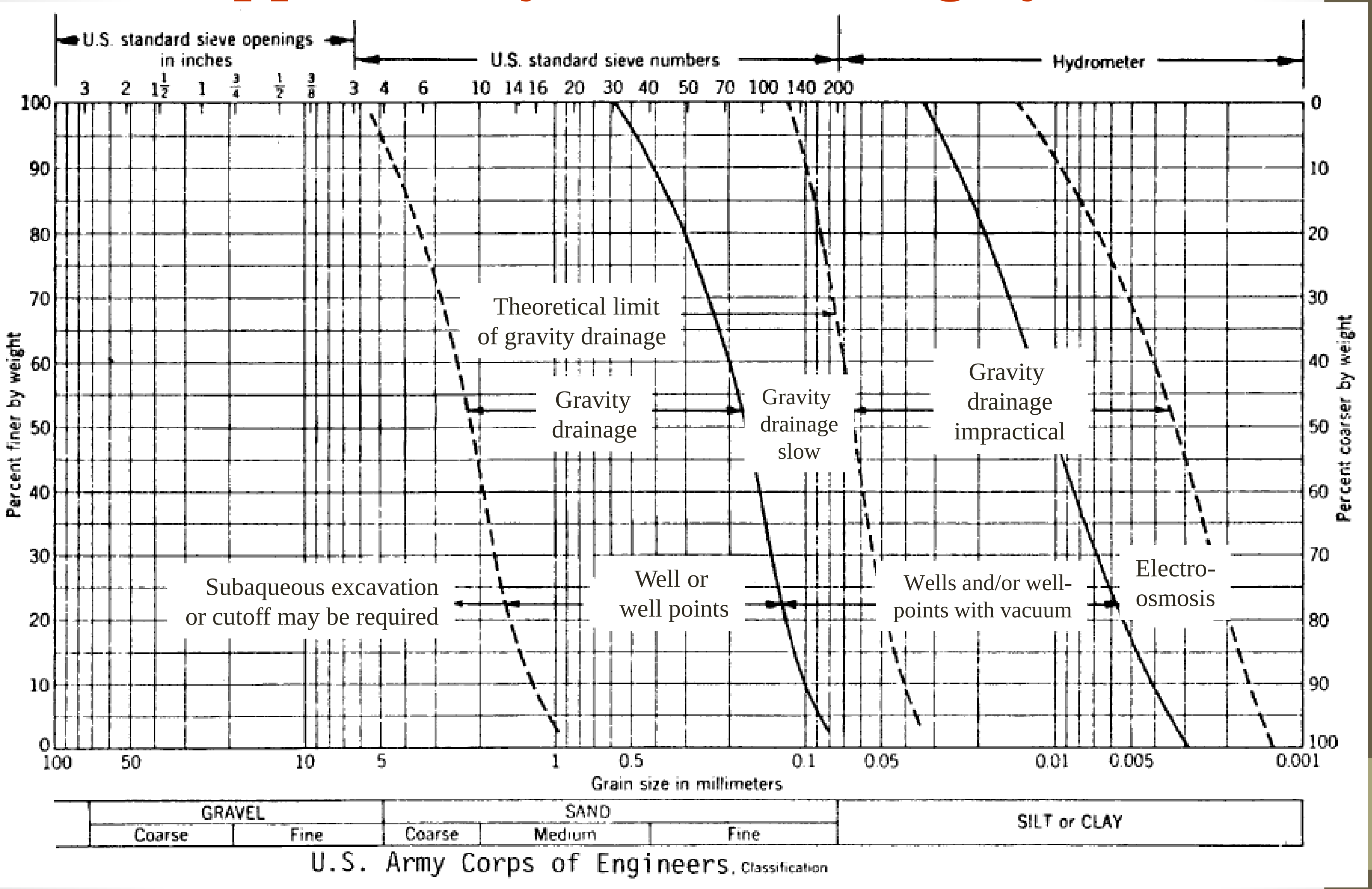
Design Input Parameters

- Most important input parameters for selecting and designing a dewatering system:

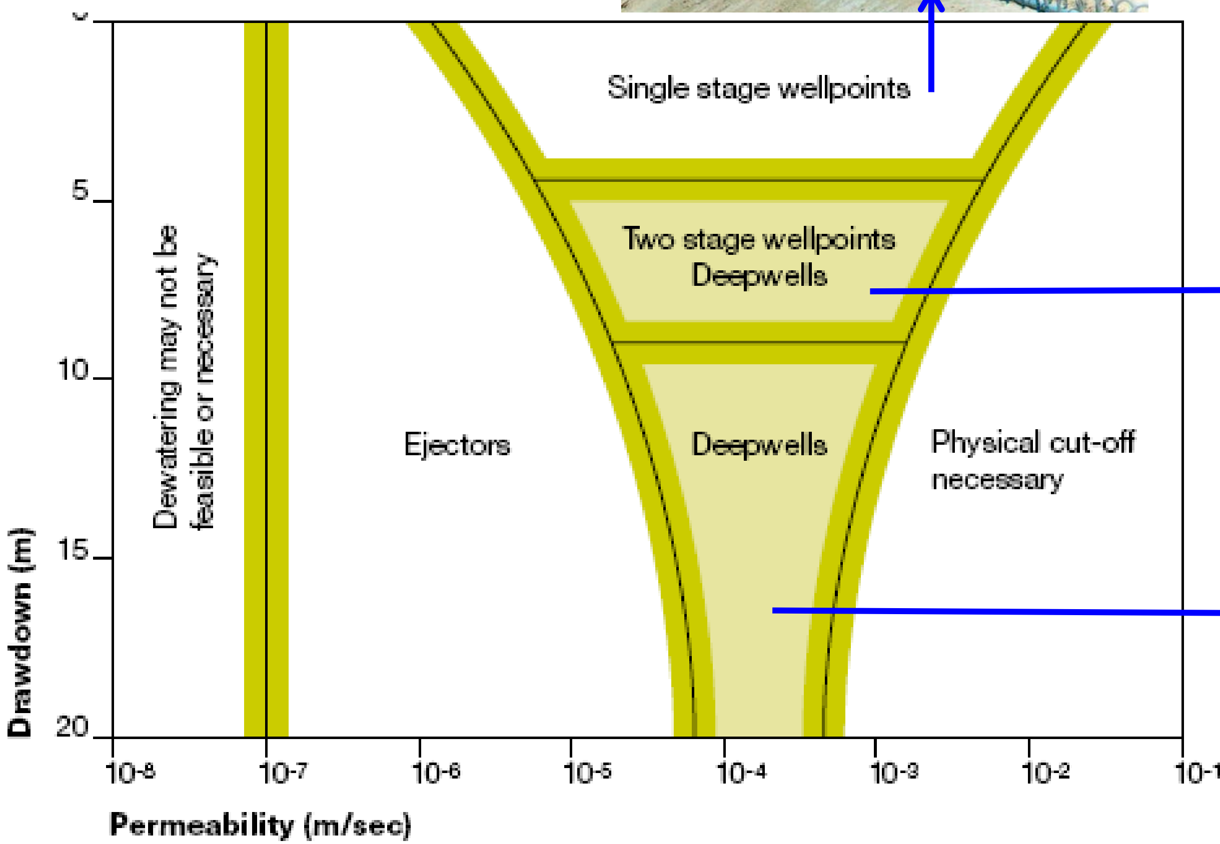
  - the height of the groundwater above the base of the excavation

  - the permeability of the ground surrounding the excavation

Applicability of Dewatering Systems



Summary


Single stage wellpoints
Two stage wellpoints
Deepwells
Dewatering may not be feasible or necessary
Ejectors
Deepwells
Physical cut-off necessary
Drawdown (m)
5
10
15
20
10-8
10-7
10-6
10-5
10-4
10-3
10-2
10-1
Permeability (m/sec)

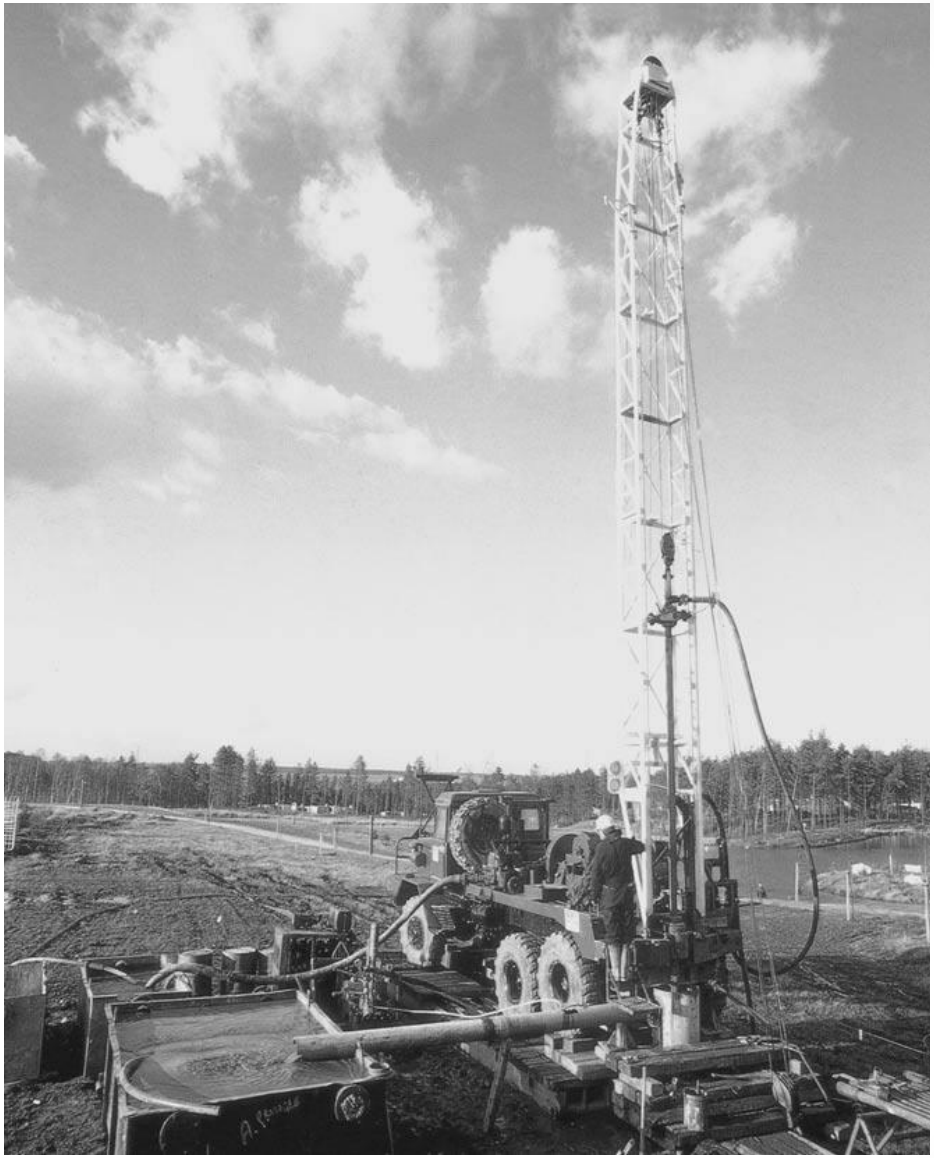
3- DEEP WELLS

DEEP WELLS

- Pumps are placed at the bottom of the wells and the water is discharged through a pipe connected to the pump and run up through the well hole to a suitable discharge point
- They are more powerful than well points, require a wider spacing and fewer well holes
- Used alone or in combination of well points

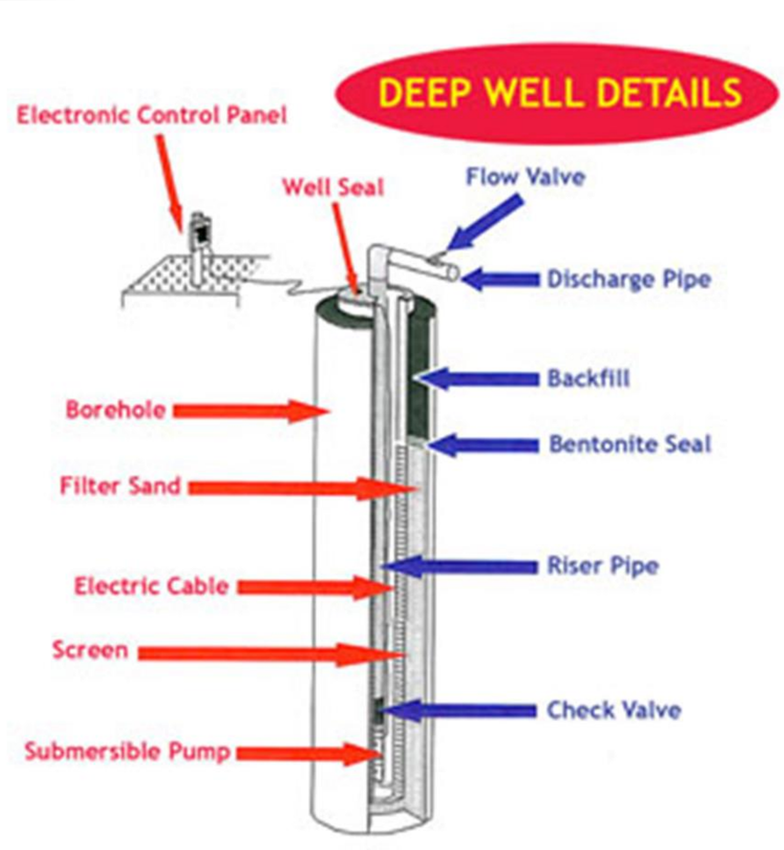
Constructing deep wells

Drilling of well boreholes



Constructing deep wells

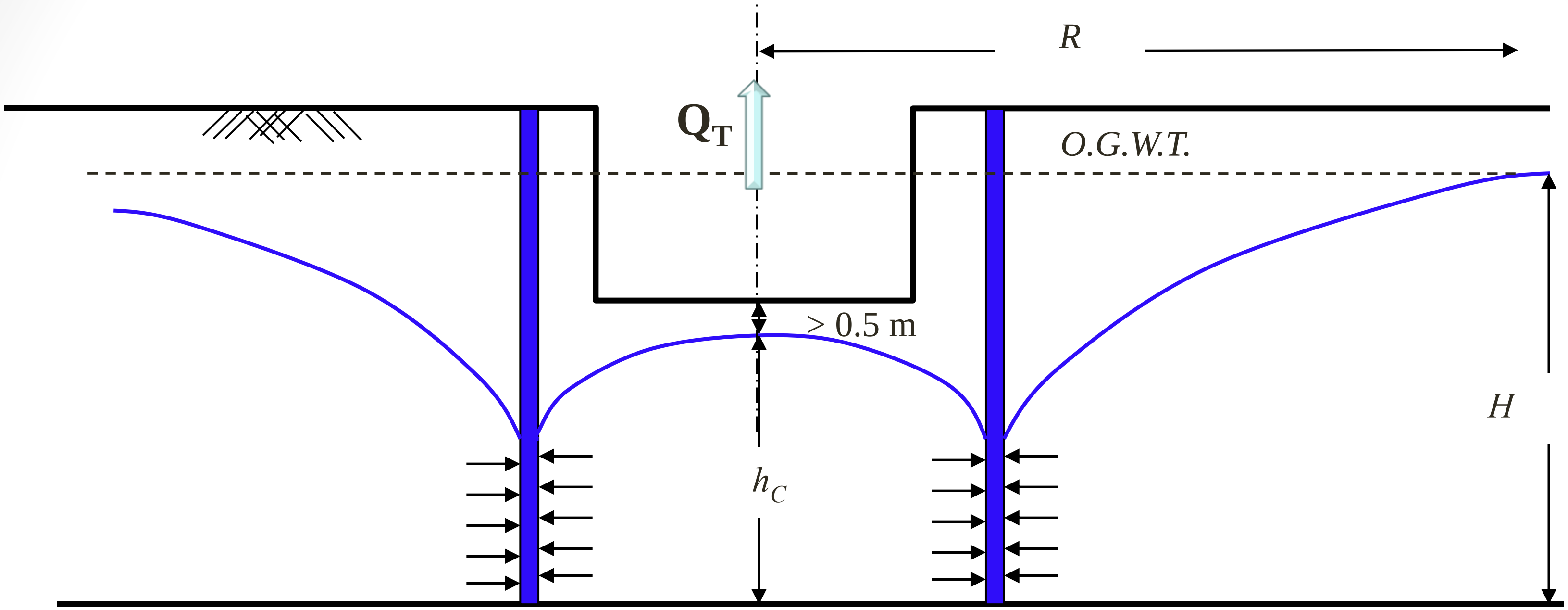
Lowering borehole electro-submersible pump and riser into well



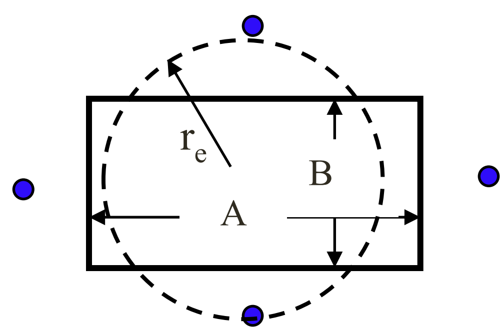
SUBMERSIBLE

Different sizes to fit specific needs.

Analysis And Design Of Deep Wells With Submersible Pumps



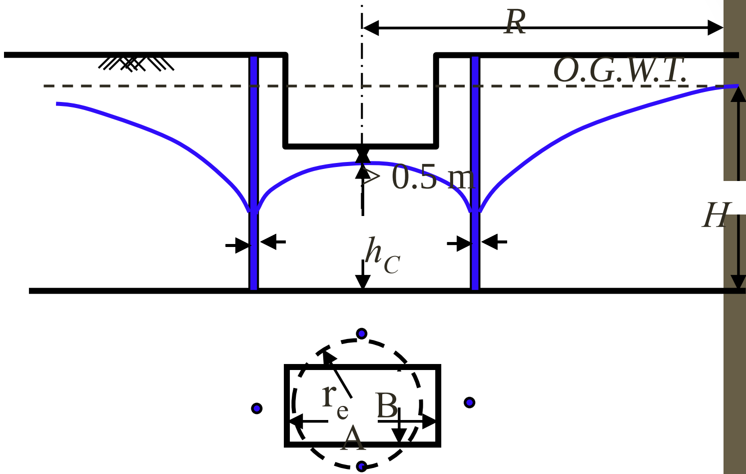
$$k = \frac{Q}{\pi} \frac{\ln(r_2 / r_1)}{h_2^2 - h_1^2}$$



Submersible Pump

<u>STEP ONE</u> Approximate the system as a single large well with a radius (r_e) [*Circular source*]

$$r_e = \sqrt{\frac{A \times B}{\pi}}$$



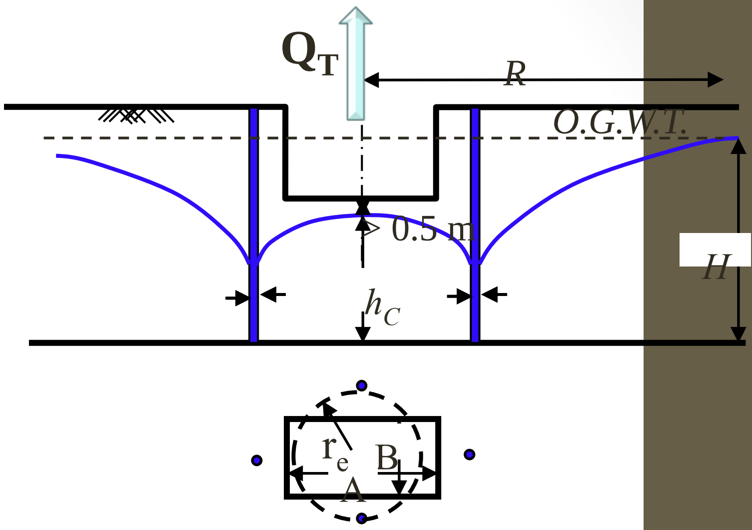
- **Compute the radius of influence of the well (R).**

$$R = 3000\left(H - h_c\right)\sqrt{K}$$

$(H - h_c)$ = drawdown at well location [m]

K = permeability coefficient [m/sec]

<u>STEP TWO</u> Determine the total discharge of the dewatered area (Q_T)



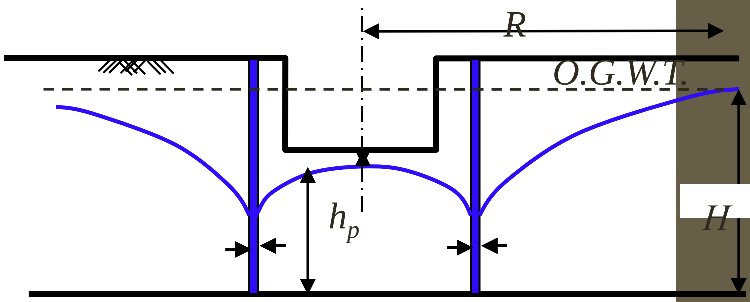
$$Q_T = \frac{\pi K \left(H^2 - h_c^2 \right)}{\ln \frac{R}{r_e}}$$

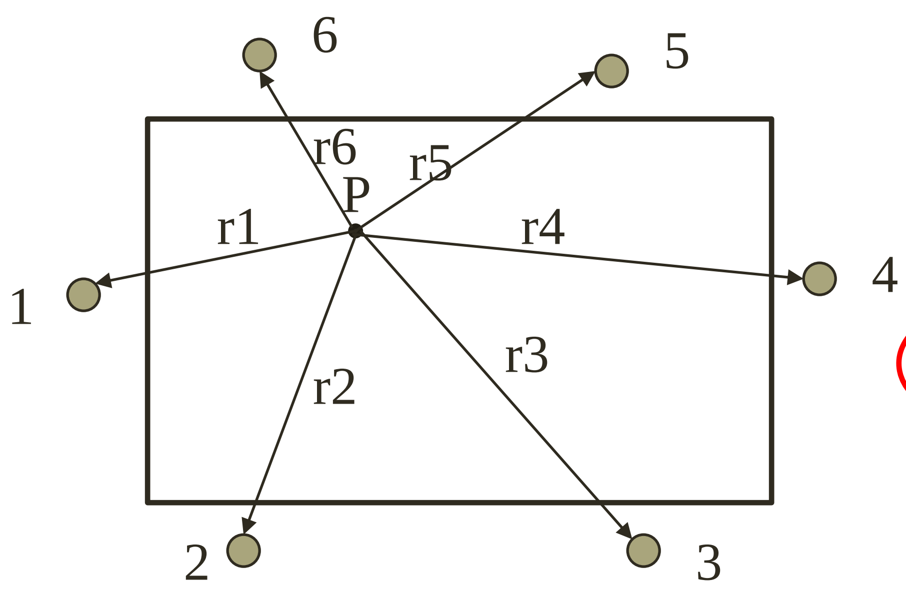
- **<u>STEP THREE</u> Determine the required number of wells and arrange the wells around the excavation top.**

$$N_p = \frac{Q_T}{Q_{pump}}$$

<u>STEP FOUR</u> Check Head at Several Points.

$$H^2 - h_p^2 = \frac{1}{\pi K} \sum_{1}^{N_p} q_{wi} \ln \frac{R}{r_i}$$

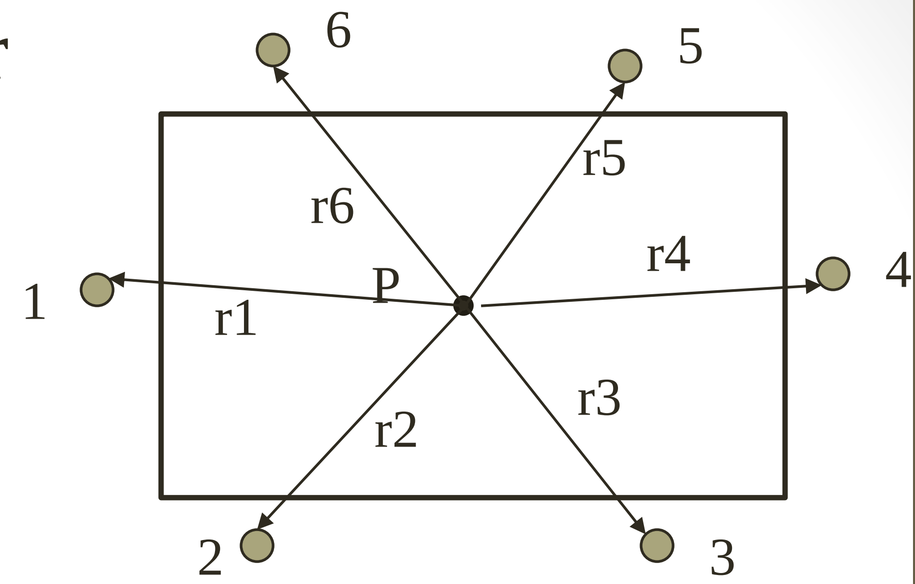




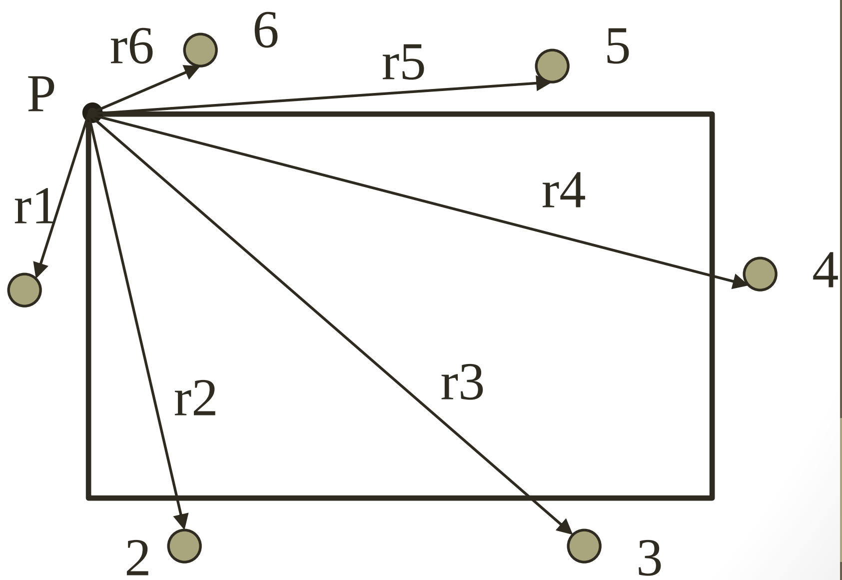
At any point, if $h_p > h_c$

→ increase number of pumps

Check head at Center



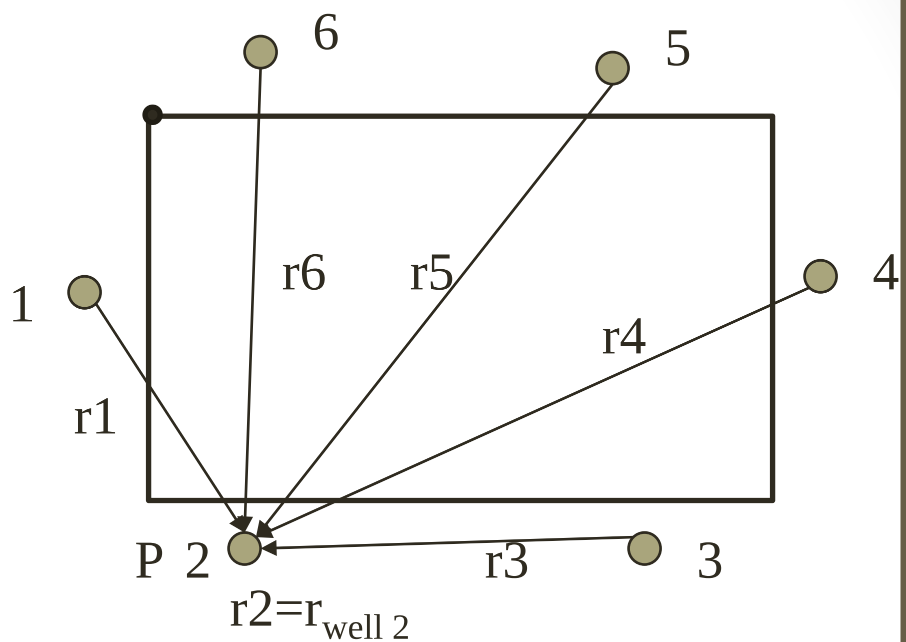
Check head at corner



At any point, if $h_p > h_c$

→ increase number of pumps

Check head at well location



At any well location, if

$$h_p < 6m$$

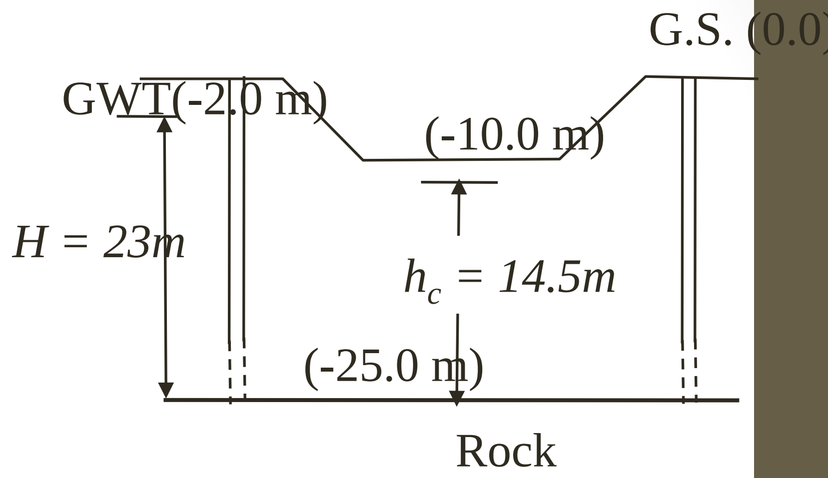
→ increase number of pumps,

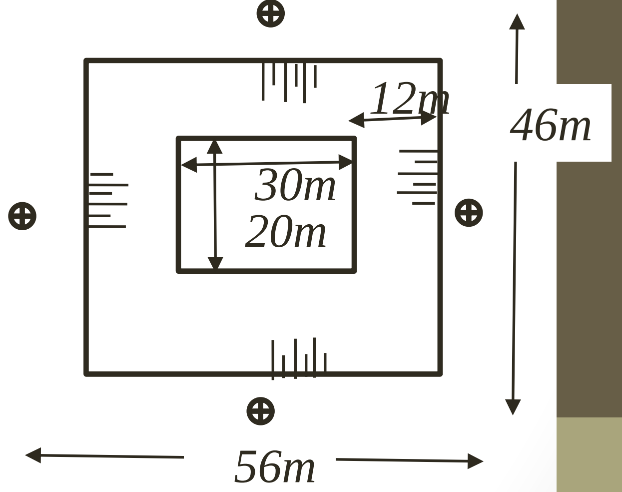
otherwise the pump will not be completely submerged.

Example

Given:

Excavation	30m*20m
F.L.	-10.0 m
G.W.T.	-2.0 m
Imp. Layer	-25.0 m
Med Sand	$K=1*10^{-2}$ cm/sec



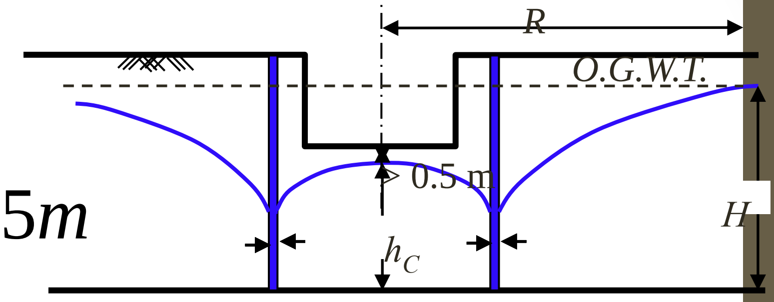


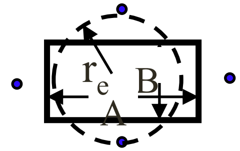
Required:

Design deep well system for the site

- **Approximate the system as a single large well with a radius (r_e)** [*Circular source*]

$$r_e = \sqrt{\frac{A \times B}{\pi}} = \sqrt{\frac{56 \times 46}{\pi}} = 28.65m$$





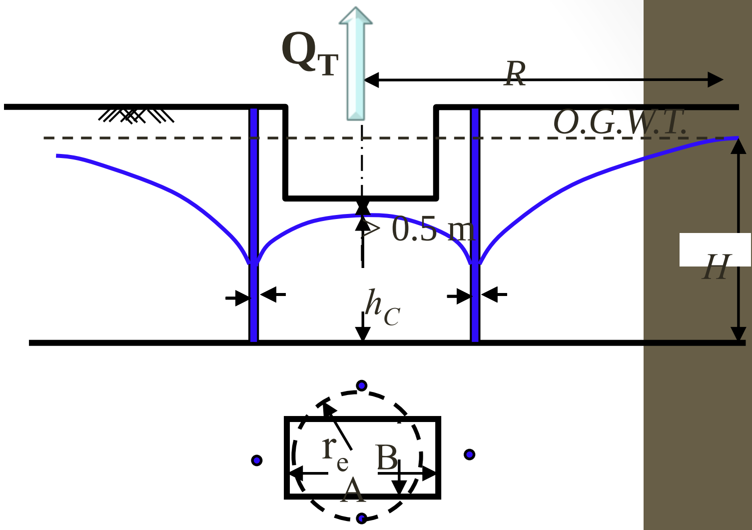
- **Compute the radius of influence of the well (R).**

$$R = 3000\left(H - h_c\right)\sqrt{K} = 300\left(23 - 14.5\right)\sqrt{0.0001} = 255m$$

$(H - h_c)$ = drawdown at well location [m]

K = permeability coefficient [m/sec]

- **Determine the total discharge of the dewatered area (Q_T)**



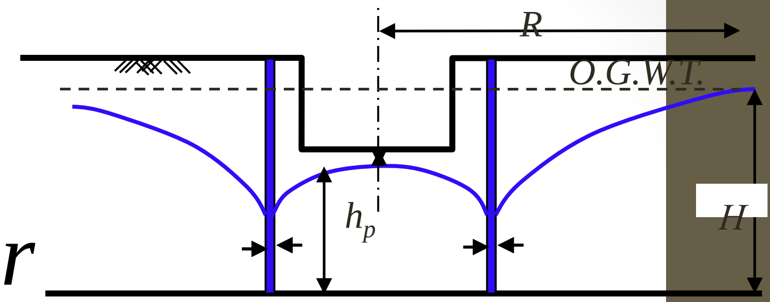
$$Q_T = \frac{\pi K\left(H^2 - h_c^2\right)}{\ln\frac{R}{r_e}} = \frac{\pi * 0.0001\left(23^2 - 14.5^2\right)}{\ln\frac{255}{28.65}}$$

$$= 0.0458\,\text{m}^3/\text{sec} = 164.82\,m^3/hr$$

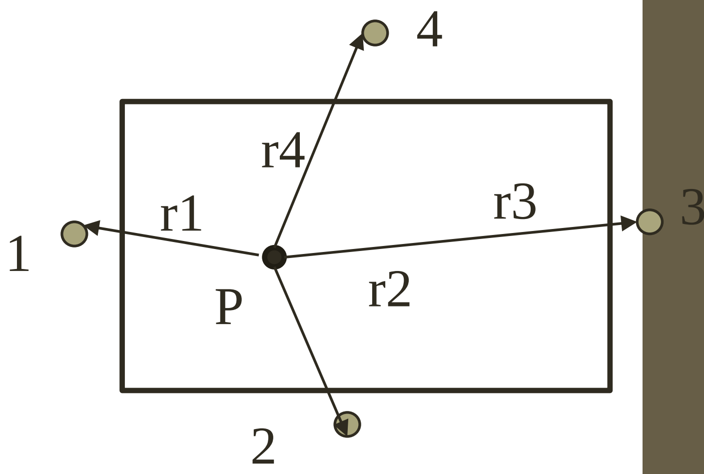
$$Q_{pump} = \frac{0.0458}{4} = 0.01145\,m^2/\text{sec} = 41.21\,m^3/hr$$

- **Check Head at Several Points.**

$$H^2 - h_p^2 = \frac{1}{\pi K} \sum_{1}^{N_p} q_{wi} \ln \frac{R}{r_i} \quad or$$



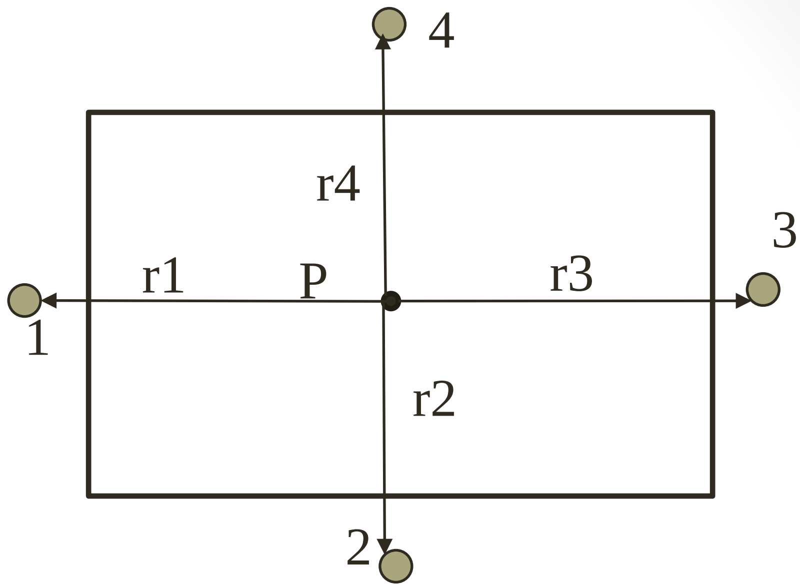
$$h_p^2 = H^2 - \frac{1}{\pi K} \sum_{1}^{N_p} q_{wi} \ln \frac{R}{r_i}$$



- **Check Head at Center**
- **Check Head at Corner**
- **Check Head at well location**

Check head at Center

$$h_p^2 = H^2 - \frac{1}{\pi K}\sum_1^{N_p} q_{wi} \ln\frac{R}{r_i}$$



r1= r3 = 28 m
r2 = r4 = 23 m

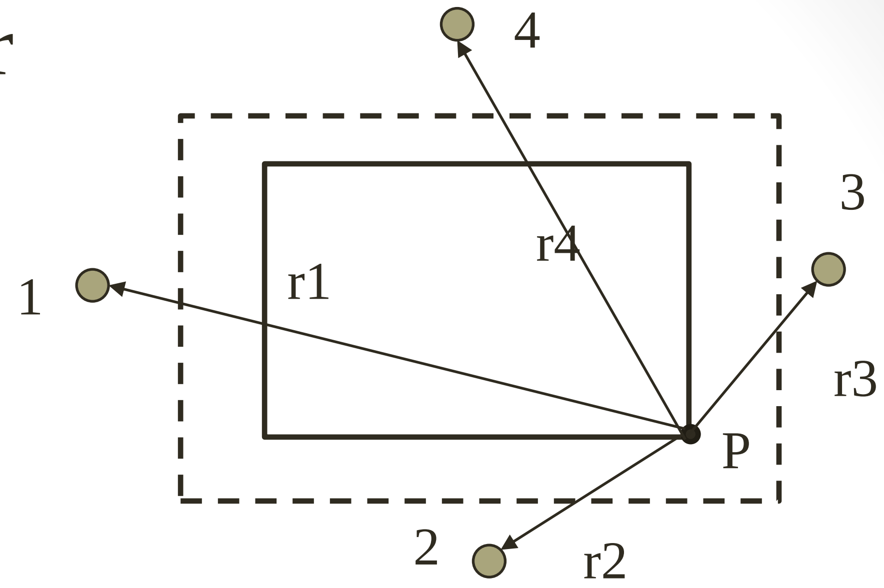
$$h_p^2 = H^2 - \frac{1}{\pi K}\sum_1^{N_p} q_{wi} \ln\frac{R}{r_i}$$

$$= 23^2 - \frac{2\times 0.01145}{\pi \times 0.0001}\left(\ln\left(\frac{255}{28}\right) + \ln\left(\frac{255}{23}\right)\right)$$

$$h_p = 13.87m \quad < 14.5m \;\; OK$$

Check head at Corner

$$h_p^2 = H^2 - \frac{1}{\pi K}\sum_{1}^{N_p} q_{wi} \ln\frac{R}{r_i}$$



r3= 16.4 m　　r2 = 19.2 m

r1 = 44.15m　　r4 = 34.25 m

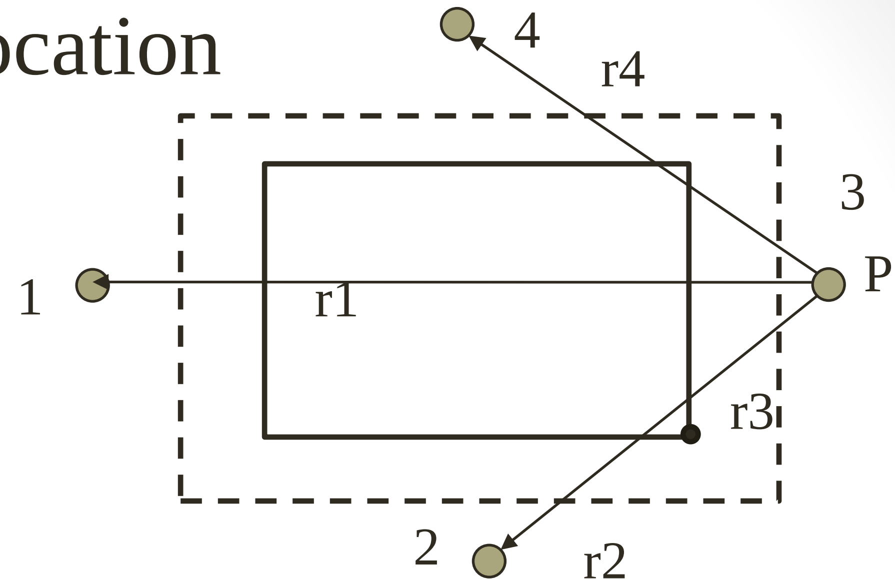
$$h_p^2 = H^2 - \frac{1}{\pi K}\sum_{1}^{N_p} q_{wi} \ln\frac{R}{r_i}$$

$$= 23^2 - \frac{0.01145}{\pi \times 0.0001}\left(\ln\left(\frac{255}{44.15}\right) + \ln\left(\frac{255}{19.2}\right) + \ln\left(\frac{255}{16.4}\right) + \ln\left(\frac{255}{34.25}\right)\right)$$

$$h_p = 14.05m \quad < 14.5m \;\; OK$$

Check head at well location

$$h_p^2 = H^2 - \frac{1}{\pi K}\sum_{1}^{N_p} q_{wi} \ln\frac{R}{r_i}$$



r3= 0.125 m   r2 = r4= 36.24 m

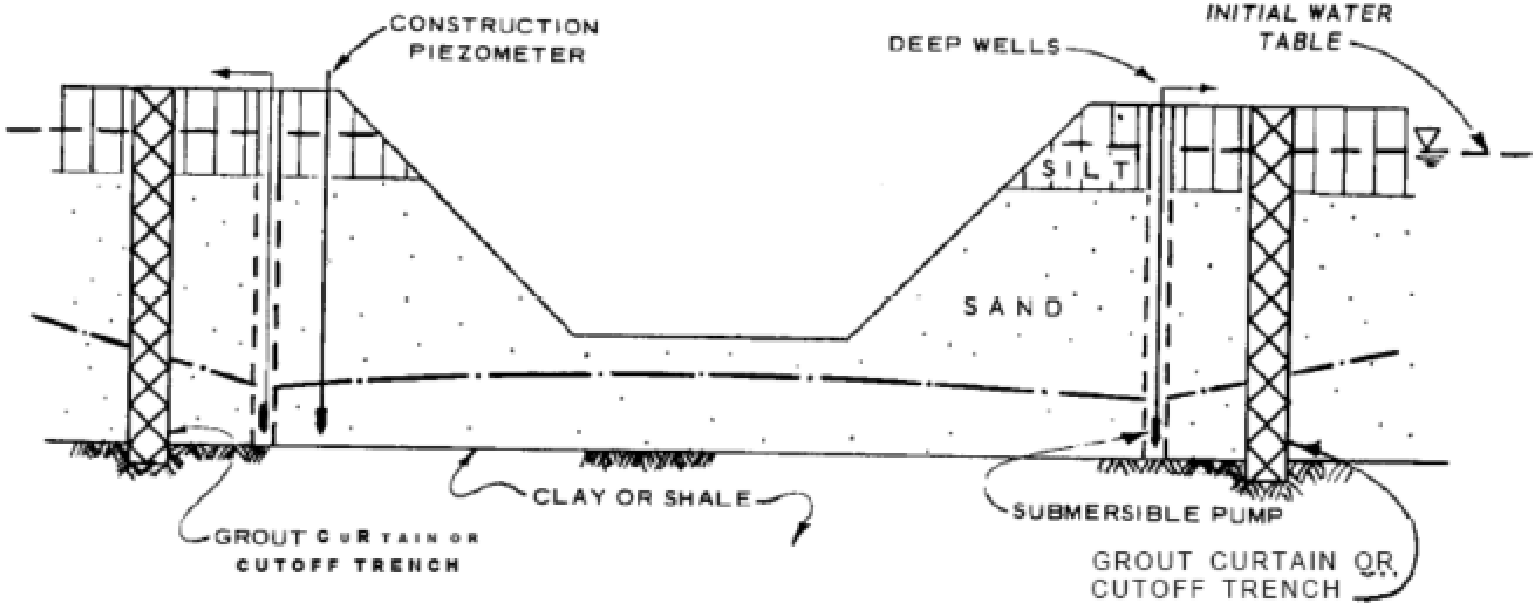
r1 = 56 m

$$h_{w3}^2 = H^2 - \frac{1}{\pi K}\sum_{1}^{N_p} q_{wi} \ln\frac{R}{r_i}$$

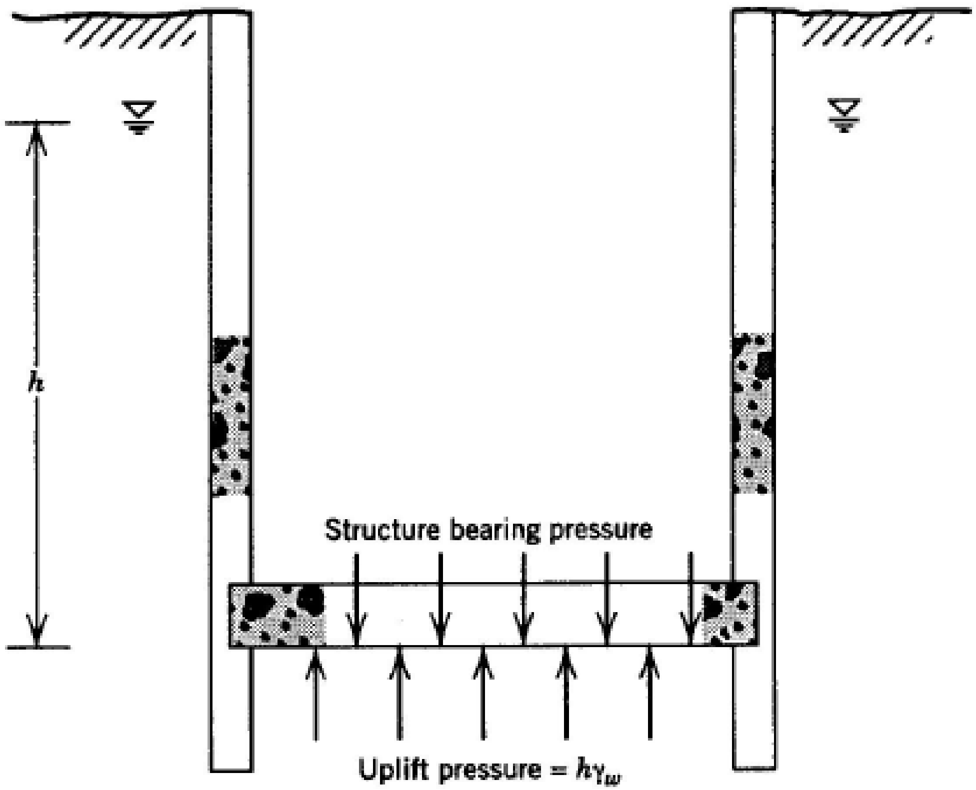
$$= 23^2 - \frac{0.01145}{\pi \times 0.0001}\left(\ln\left(\frac{255}{56}\right) + 2\times\ln\left(\frac{255}{36.24}\right) + \ln\left(\frac{255}{0.125}\right)\right)$$

$$h_{w3} = 7.31\,m \quad > 6.0m \;\; OK$$

Deep Well w/ Cutoff Wall



Buoyancy Effects on Underground Structure

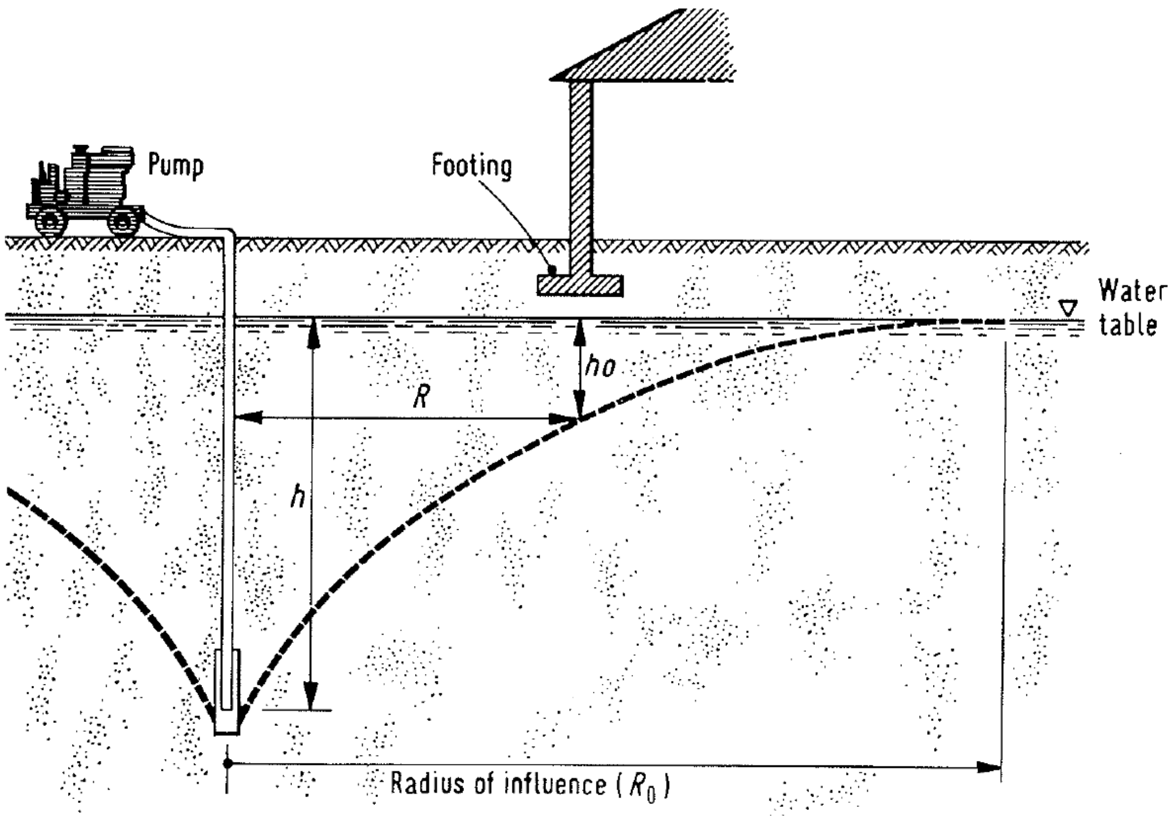


Side effects of groundwater lowering

- Settlement resulting from the instability of excavations when groundwater is not adequately controlled.
- Ground settlements caused by loss of fines.
- Ground settlements induced by increases in effective stress, and associated structural damage or distress.
- Derogation or reduction of groundwater sources.
- Changes in groundwater quality, including movement of contamination plumes and saline intrusion.
- The impact of discharge flows on the surface water environment.
- Other less common effects, including the drying out of timber piles and the desiccation of wetlands and vegetation.

Settlement due to groundwater lowering

- **Settlement due to increases in effective stress**



Settlement due to groundwater lowering

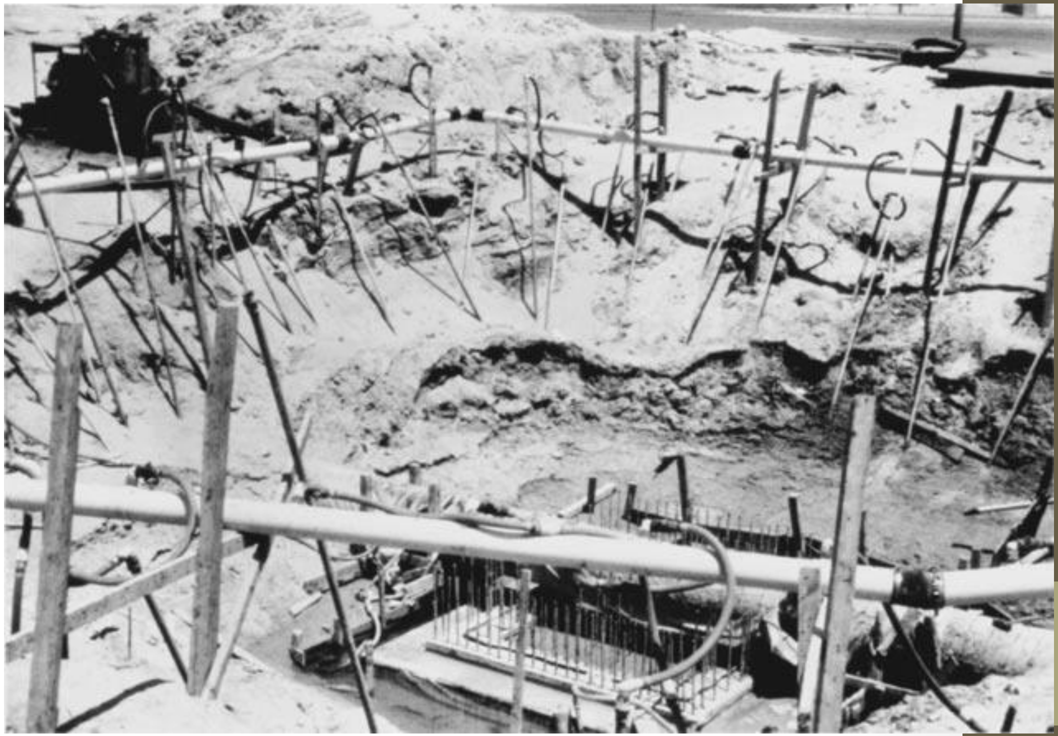
- **Fine Migration**

Settlement due to groundwater lowering

- **Settlement due to poorly controlled groundwater**

  Sometimes groundwater is not adequately controlled, leading to instability of excavation, uncontrolled seepages and perhaps a groundwater 'blow'

Significant ground movement caused by inappropriate sump pumping. The well point risers around the perimeter of the excavation had originally been installed vertically. Loss of fines due to poorly controlled sump pumping resulted in ground movements, distorting the well points from the vertical.



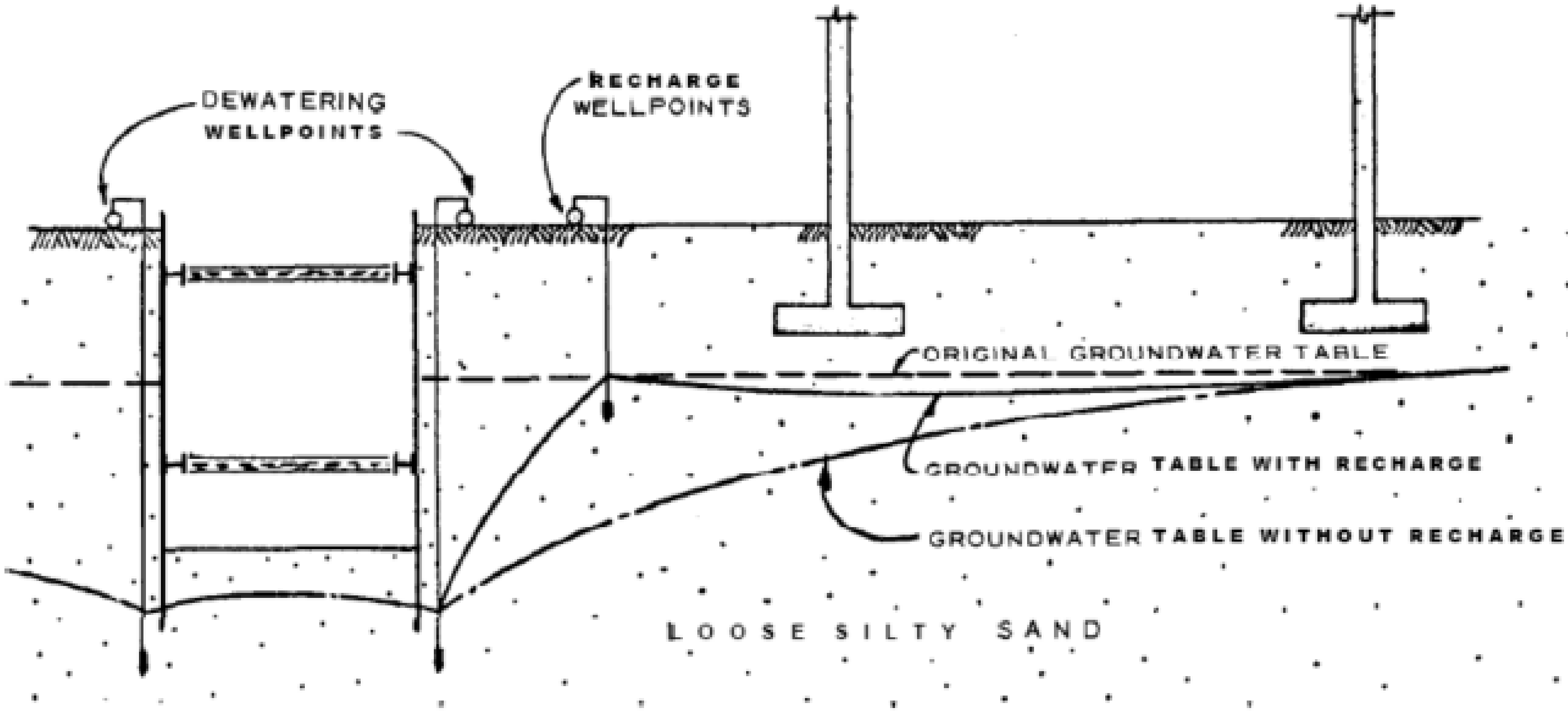
Settlement due to groundwater lowering

- **Landslide**

Settlement due to groundwater lowering

- **Settlement due to loss of fines**

Recharge Groundwater to Prevent Settlement



Recharge Groundwater to Prevent Settlement