Assessing Aquifer Properties from Sparse Data

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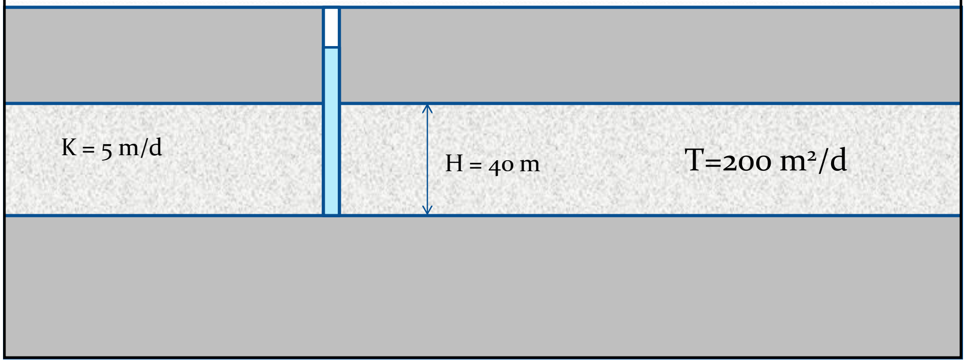
NORPLAN

Aquifer properties

- Type (porous / fractured / karstic)
- Thickness / geometry
- Permeability / hydraulic conductivity (K) — An intrinsic measure of how easily a material transmits water
- Porosity (n) / storage (S) — How much water a material stores
- Transmissivity (T) — An overall measure of how "good" an aquifer is

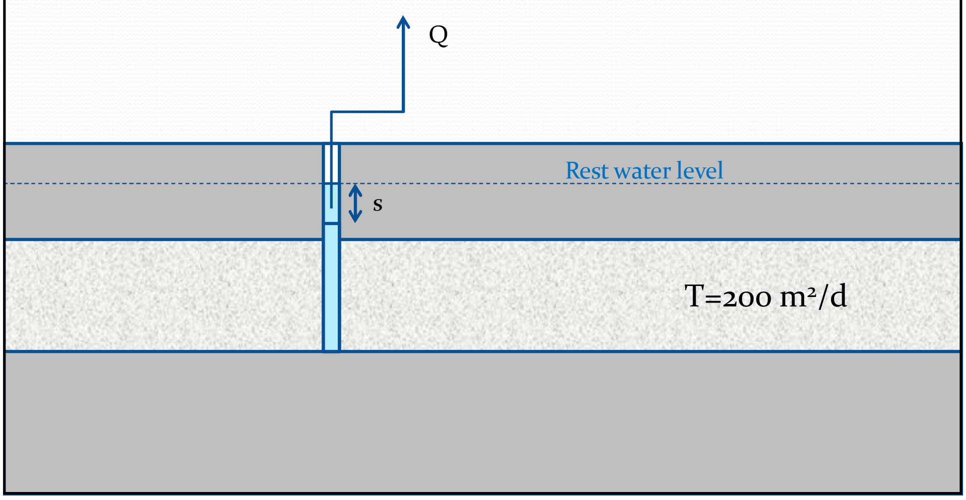
Transmissivity

- How "good" is an aquifer? It depends on permeability and thickness.
- T = K x H



Water yield (Q)

- Depends on transmissivity (T) and on drawdown (s)



So, how do we determine transmissivity?

- Best way is some kind of pumping test

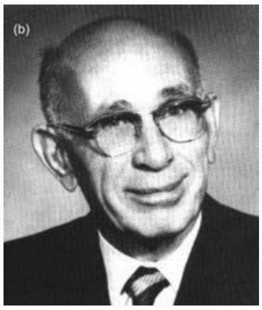
- Pump at constant rate and measure drawdown in water level

How can we calculate transmissivity? 1. The Theis Equation

$$T = \frac{Q}{s}\frac{1}{4\pi}\left(-0.5772 - \ln u + u - \frac{u^2}{2.2!} + \frac{u^3}{3.3!} - \frac{u^4}{4.4!} + \frac{u^5}{5.5!} - ....\right)$$

$$u = \frac{r^2.S}{4.T.t}$$

r = radius
t = time
S = storage
T = transmissivity
s = drawdown
Q = yield



Charles Vernon Theis

How can we calculate transmissivity? 2. The Cooper-Jacob Approximation

$$T = \frac{Q}{s}\frac{1}{4\pi}\ln\left(\frac{2.25Tt}{r^2 S}\right)$$

r = radius
t = time
S = storage
T = transmissivity
s = drawdown
Q = yield

How can we calculate transmissivity? 3. The Logan Approximation

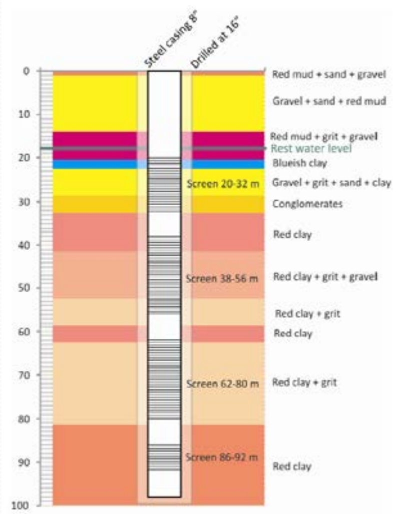
$$T = \frac{Q}{s}\times 1.22$$

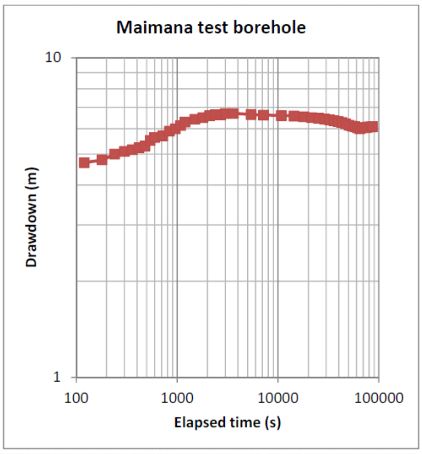
For “ideal” wells

$$T = 2\times\frac{Q}{s}$$

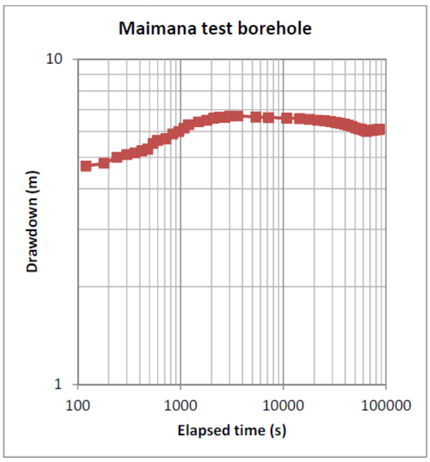
For “real” wells

For example: Maimana test borehole





Maimana test borehole



Pumping test not good enough to be analysed by conventional analysis

But we do know:

Yield = 10 L/s = 864 m³/d
Drawdown = c. 6.7 m

Thus

T = 2 x Q/s

= 2 x 864 / 6.7 m²/d = c. 260 m2/d

Other boreholes in Faryab

	Yield (L/s)	Yield (m3/d)	Drawdown (s)	T (m2/d)	
Bibi Aina borehole	8	691	6		
Arzolik borehole	4	346	13.6		
Sar Asyab borehole	5	432	15.2		
Nughayli Bala borehole	3	259	19		
Bish Qara borehole	3.5	302	15.3		
Shoran Shikhan borehole	1.85	160	25		
Maymana University borehole	0.7	60	1.5		
Jamshidy Bala	3.5	302	34.3		

$$T = \frac{Q}{s} \times 1.22$$

For "ideal" wells

$$T = 2 \times \frac{Q}{s}$$

For "real" wells

Other boreholes in Faryab

	Yield (L/s)	Yield (m3/d)	Drawdown (s)	T (m2/d)	
Bibi Aina borehole	8	691	6	141	230
Arzolik borehole	4	346	13.6	31	51
Sar Asyab borehole	5	432	15.2	35	57
Nughayli Bala borehole	3	259	19	17	27
Bish Qara borehole	3.5	302	15.3	24	40
Shoran Shikhan borehole	1.85	160	25	8	13
Maymana University borehole	0.7	60	1.5	49	81
Jamshidy Bala	3.5	302	34.3	11	18