Points deducted -43.3

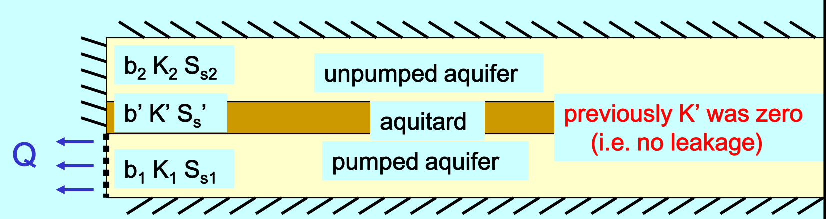
Points earned 56.7 / 100

Scaled Score +25 81.7

Average = 81.7		#students	%students	
A	>90	16	33	
B	80-90	8	17	50
C	70-80	12	25	
D	60-70	5	10	
F	50-60	4	8	
F	<50	3	6	

EXAM and KEYS are on the class web page
Let's review that now

Leaky Aquifers

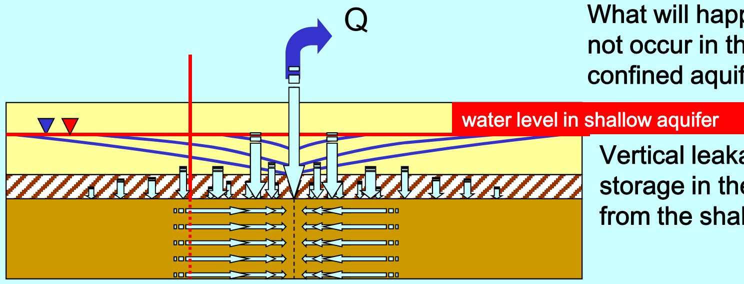


subscript 1 = pumped zone
subscript 2 = unpumped aquifer
prime = aquitard
Q = pumping rate
b = thickness
K = hydraulic conductivity
S_s = specific storage

assume:
no head change in unpumped aquifer
horizontal flow in aquifers
vertical flow in aquitards
aquifer extends far enough to intercept enough leakage to satisfy Q
Theis assumptions (other than impermeable aquitard) apply

What conditions justify assuming no head change in the unpumped aquifer?

A sufficiently permeable unpumped aquifer so flow to the "disk" above the drawdown cone is low enough to require nearly zero gradient.



What will happen that did not occur in the completely confined aquifer?

Vertical leakage, first from storage in the aquitard, then from the shallow aquifer.

What do we expect regarding the magnitude of leakage?

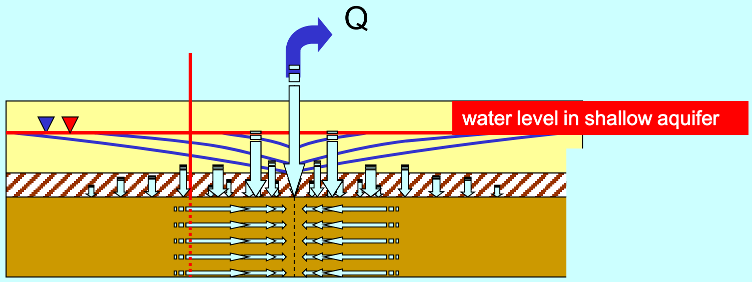
Greatest leakage where head difference is largest, decreasing away from the well.

What will be the maximum extent of drawdown?

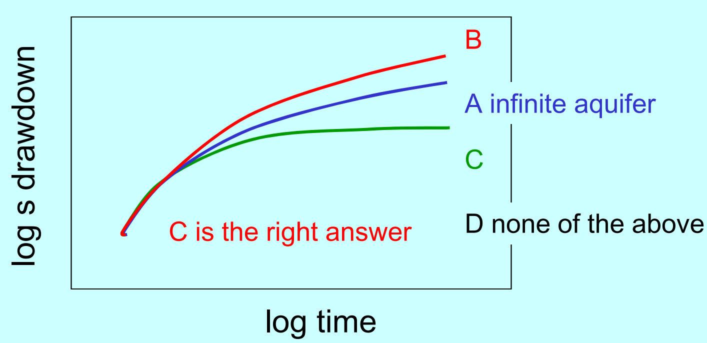
Drawdown will be limited to the radius at which the entire Q leaks from the upper aquifer to the lower.

What controls the rate of drawdown cone development?

S & T of aquifer
AND
S and Kv of the aquitard

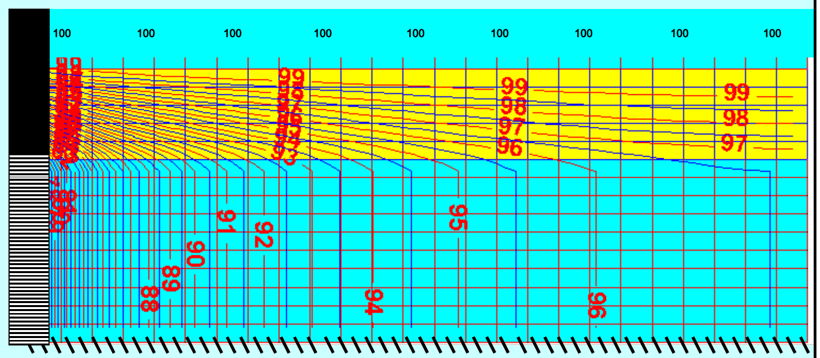


Will drawdown vs time at the red observation well look more like? …..



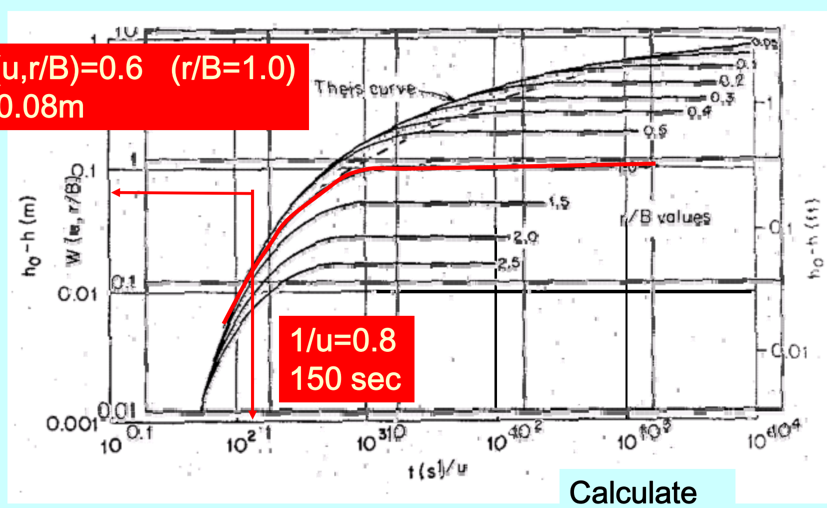
At the start all heads are 100, then decrease at the well

Days
0.29
0.8
2.0
5.2
13
32
81
201
500



Contour Interval = 0.5ft
Major interval RED
Minor interval BLUE

$K= 1x10^{-1}$ ft/day
$K'=1x10^{-6}$ ft/day
S & $S' = 1x10^{-5}$
b = 10 ft   b'=5 ft
Q = 0.2 GPM
head in shallow aquifer = 100ft



Calculate
K_1 S_{s1} K'

$Q=0.004\ m^3/sec$
r=55m
$b_1=30.5m$
b'=3.05m

Q=0.004 m^3/sec b$_1$=30.5m
r=55m b'=3.05m

W(u,r/b)=0.6 (r/B=1.0) 1/u=0.8 u=1.25
s=0.08m 150 sec

$$s = h_o - h = \frac{Q}{4\pi T} W(u, r/B)$$

$$u = \frac{r^2 S}{4Tt} \qquad \frac{r}{B} = r\sqrt{\frac{K'}{K_1 b_1 b'}}$$

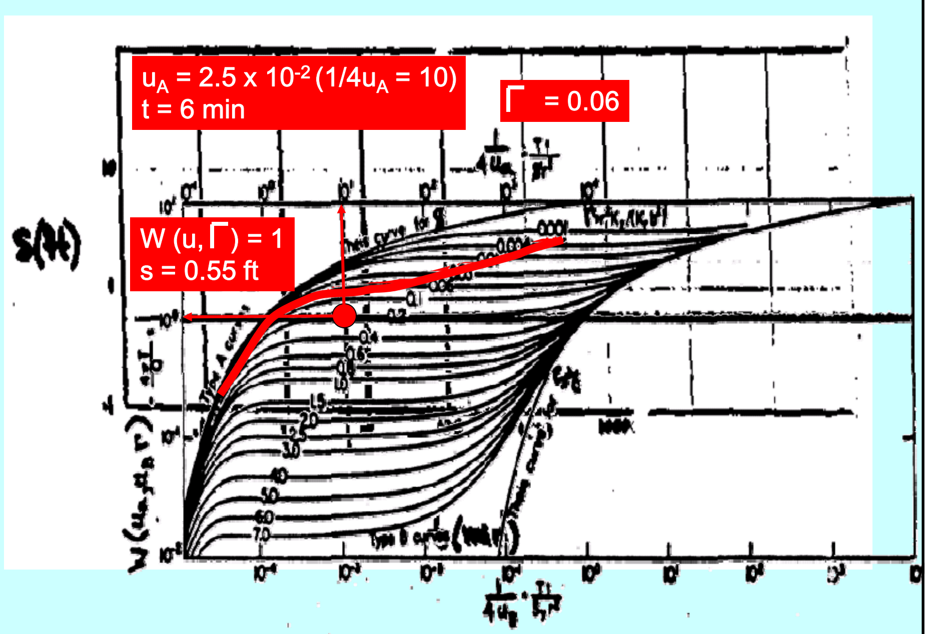
T = $\dfrac{0.004\ m^3/sec\ 0.6}{4 * 3.1416 * 0.08m}$ = $2.4x10^{-3}\ m^2$/sec

K_1 = T/b = $7.8x10^{-5}$ m/sec

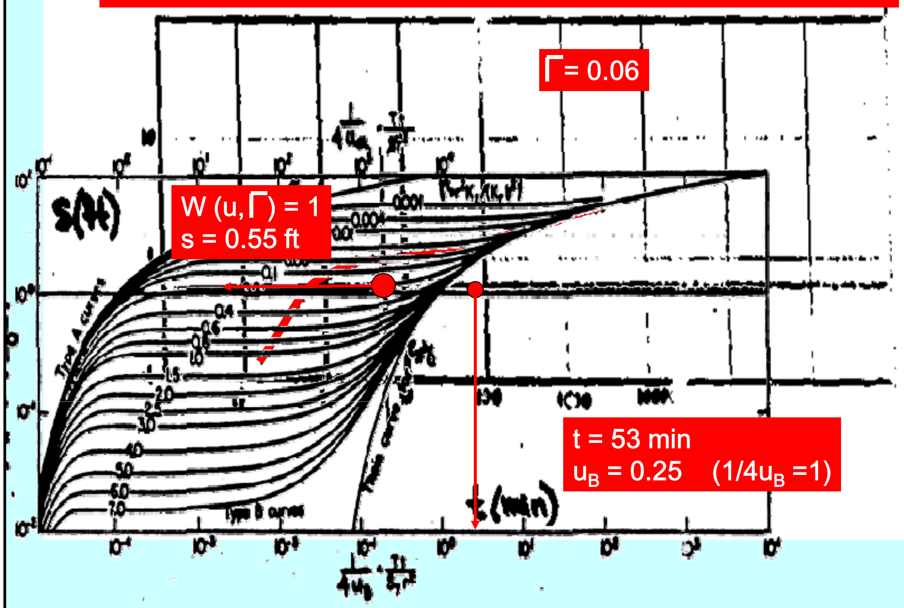
K' = $(1/55m)^2$ *$7.8x10^{-5}$ m/sec*30.5m*3.05m
= $2.4x10^{-6}$ m/sec

S = (1.25*4*$2.4x10^{-3}$ m^2/sec*150sec)/$(55m)^2$
= $6x10^{-4}$

S_s = S/b = $2x10^{-5}$ m^{-1}



SLIDE LATERALLY DO NOT SHIFT UP AND DOWN
T DOES NOT CHANGE WITH TIME BUT S DOES



Match
early time $\Gamma = 0.06$
$W(u, \Gamma) = 1$
$u_A = 2.5 \times 10^{-2}$ $(1/4u_A = 10)$
t = 6 min
s = 0.55 ft
Q = 144.4 ft^3/min
r = 73 ft
b = 100 ft

late time same Γ
slide horizontally
same s = 0.55
t = 53 min
$u_B = 0.25$ $(1/4u_B = 1)$

Calculate T S K_v K_h S_y

Early time match results:

$$T = \frac{Q}{4\pi s} W(u_A, \Gamma) = \frac{144.4\,\frac{ft^3}{min}}{4\pi(0.55ft)}(1) = 20.9\,\frac{ft^2}{min}$$

$$S = \frac{4u_A Tt}{r^2} = \frac{4(2.5x10^{-2})\left(20.9\,\frac{ft^2}{min}\right)6\,min}{(73ft)^2} = 2x10^{-3}$$

Late time match results:

T .... Same (match by sliding horizontally)

$$S_y = \frac{4u_B Tt}{r^2} = \frac{4(0.25)\left(20.9\,\frac{ft^2}{min}\right)53\,min}{(73ft)^2} = 0.21$$

$$K_H = \frac{T}{b} = 2x10^{-1}\,\frac{ft}{min}$$

$$K_V = \frac{\Gamma b^2 K_H}{r^2} = \frac{0.06(100ft)^2\,0.2\,\frac{ft}{min}}{(73ft)^2} = 2x10^{-2}\,\frac{ft}{min}$$