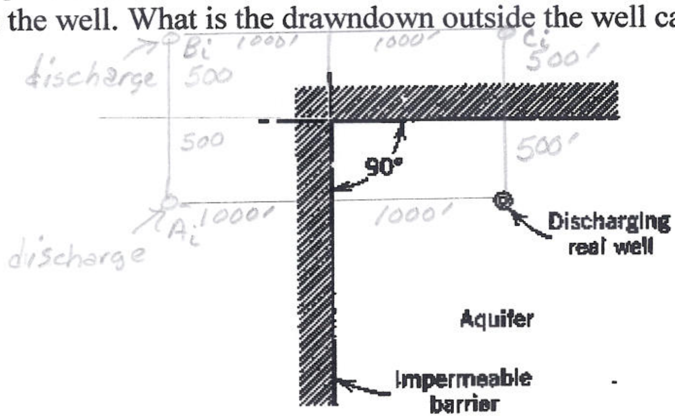
David Dammon

ENCE 4330
GROUNDWATER

TEST 3

1. A 12 inch diameter well in an unconfined aquifer is pumped continuously at a rate of 1000 gpm. The tranmissivity of the aquifer is 200,000 gpd/ft and the coefficient of storage is 0.20. There are two impermeable boundaries that are 500 feet and 1000 feet from the well. What is the drawndown outside the well casing after one year?



$n = \frac{360^\circ}{90^\circ} - 1 = 3$

all wells discharge

$A_i \rightarrow Real = 2000'$

$B_i \rightarrow Real = 2236'$

$C_i \rightarrow Real = 1000'$

$u_{real} = \frac{r^2 S}{4Tt} = \frac{(.5)^2 (0.20)}{(4)(200{,}000\ gal/day\text{-}ft)(365\ day)(1ft^3/7.48gal)} = 1.28 \times 10^{-9}$ $W(u) = 19.92$

$s_{real} = \frac{Q\,W(u)}{4\pi T} = \frac{(1{,}000\ gal/min)(19.92)(1440\ min/day)}{4\pi(200{,}000\ gal/day\text{-}ft)} = \boxed{11.41 ft}$

$u_{Ai} = \frac{(2{,}000')^2 (0.20)}{(4)(200{,}000\ gal/day\text{-}ft)(365\ day)(1ft^3/7.48gal)} = 2.0 \times 10^{-2}$ $W(u) = 3.45$

$s_{Ai} = \frac{(1{,}000\ gal/min)(3.45)(1440\ min/day)}{4\pi(200{,}000\ gal/day\text{-}ft)} = \boxed{1.98 ft}$

$u_{Bi} = \frac{(2236ft)^2 (0.20)}{(4)(200{,}000)(365)(1/7.48)} = 2.6 \times 10^{-2}$ $W(u) = 3.10$

$s_{Bi} = \frac{(1{,}000)(3.10)(1440)}{4\pi(200{,}000)} = \boxed{1.78 ft}$

$u_{ci} = \frac{(1000)^2 (0.20)}{4(200{,}000)(365)\ 1/7.48} = 5.1 \times 10^{-3}$ $W(u) = 4.71$

$s_{ci} = \frac{(1{,}000)(4.71)(1440)}{4\pi(200{,}000)} = \boxed{2.70 ft}$

$s_{total} = 11.41 ft + 1.98 ft + 1.78 ft + 2.70 ft = \boxed{17.87 ft}$

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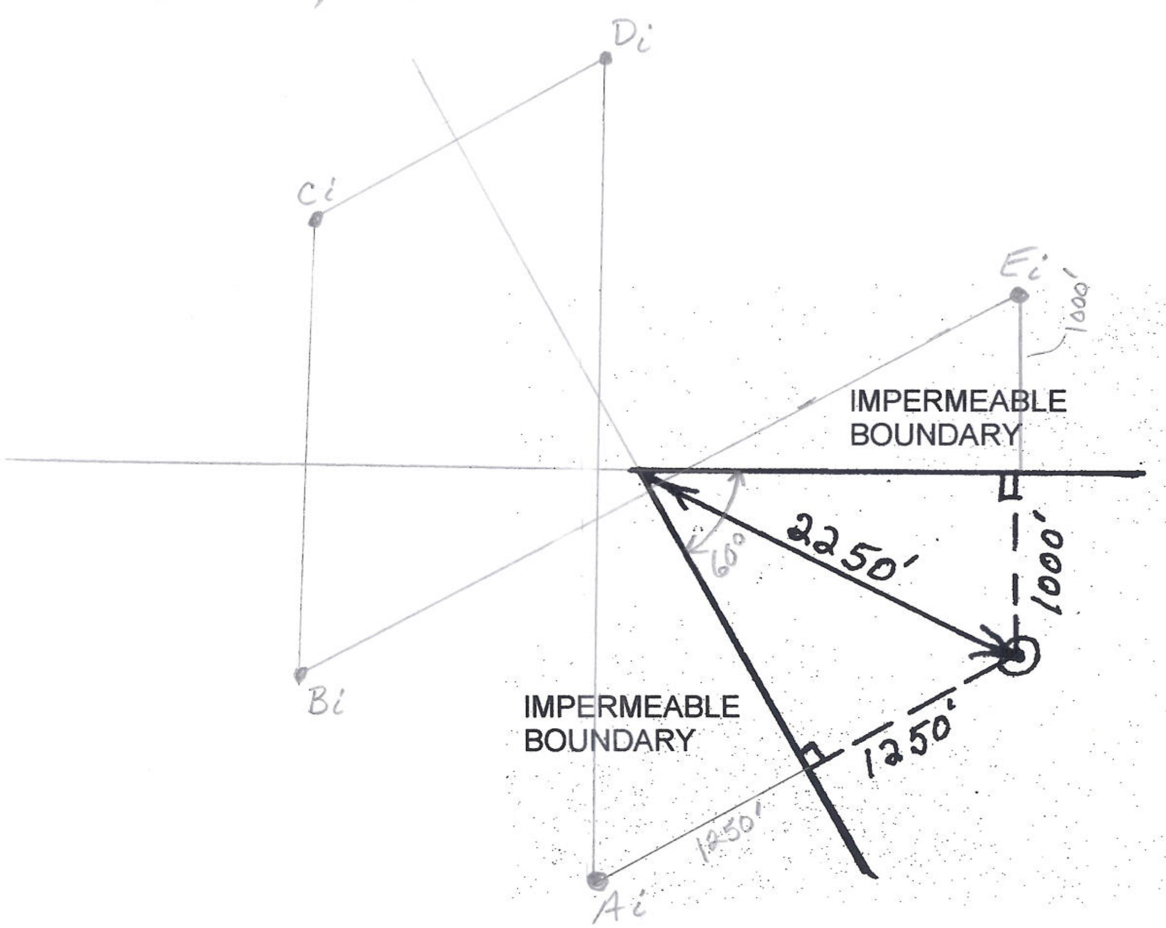
2. Show the image well system in an aquifer bounded by two impermeable barriers intersecting at an angle of 60°. The real well is a discharging well located as shown below. (You must show all distances to the image wells and state whether they are discharging or recharging wells.

$$n = \frac{360^\circ}{60^\circ} - 1 = 5$$

All real & imaginary wells are disharging wells

Real → Ai = 2,500ft
Real → Bi = 3,905 Ft
Real → Ci = 4,500 ft
Real → Di = 3905 ft
Real → Ei = 2,000 ft



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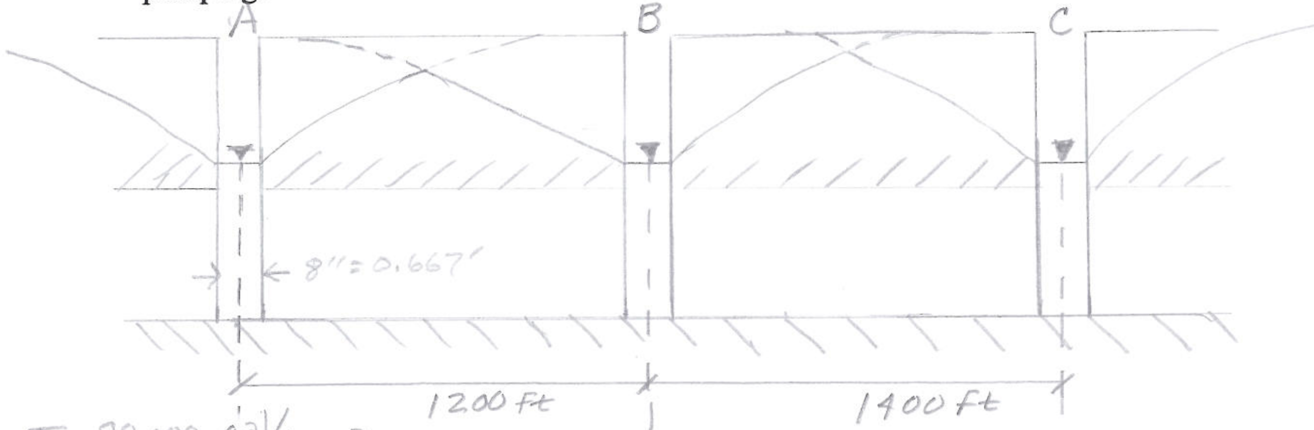
3. There are three 8" diameter wells (Wells A, B, and C) in a confined aquifer that has a transmissivity of 80,000 gpd/ft and a coefficient of storage of 0.0002. Well B is 1200 feet due east of Well A and Well C is 1400 feet due east of Well B. All three are pumped continuously at a rate of 500 gpm, but Well A does not start pumping until 30 days after Wells B and C have started. Wells B and C start pumping at the same time. What is the drawdown outside the well casing of each well, 300 days after Well A has started pumping?



$T = 80{,}000 \text{ gal/day-ft}$

$S = 0.0002$

$Q_A = Q_B = Q_C = 500 \text{ gpm}$

$t_A = 300 \text{ days}, \; t_B = t_C = 330 \text{ days}$

individual well drawdown

$$u_B = u_C = \frac{r^2 S}{4Tt} = \frac{(0.333')^2 (0.0002)}{(4)(80{,}000 \text{ gal/day-ft})(330 \text{ day})(1 \text{ ft}^3/7.48 \text{ gal})} = 1.57 \times 10^{-12}$$

$$W(u) = 26.60$$

$$s_{B \text{ on } B} = s_{C \text{ on } C} = \frac{Q}{4\pi T} W(u) = \frac{(500 \text{ gal/min})(1440 \text{ min/day})}{(4\pi)(80{,}000 \text{ gal/day-ft})}(26.6)$$

$s_{B \text{ on } B} = s_{C \text{ on } C} = 19.05 \text{ ft}$

individual well drawdown well A

$$u_A = \frac{r^2 S}{4Tt} = \frac{(0.333')^2 (0.0002)}{(4)(80{,}000 \text{ gal/day-ft})(300 \text{ day})(1 \text{ ft}^3/7.48 \text{ gal})} = 1.73 \times 10^{-12}$$

$$W(u)_A = 26.50$$

$$s_{A \text{ on } A} = \frac{Q}{4\pi T} W(u) = \frac{(500 \text{ gal/min})(1440 \text{ min/day})(26.5)}{(4\pi)(80{,}000 \text{ gal/day-ft})} = 18.98$$

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#3 Continued

The effect of B on C = C on B

$$u_{B\,on\,C} = u_{C\,on\,B} = \frac{r^2 S}{4Tt} = \frac{(1400\,ft)^2\,(0.0002)}{(4)(80{,}000\,gal/day\text{-}ft)(330\,day)(1\,ft^3/7.48\,gal)}$$

$$= 2.8 \times 10^{-5} \Rightarrow W(u) = 9.9$$

$$s_{B\,on\,C} = s_{C\,on\,B} = \frac{Q\,W(u)}{4\pi T} = \frac{(500\,gal/min)(1440\,min/day)(9.9)}{(4\pi)(80{,}000\,gal/day\text{-}ft)} = \boxed{7.1\,ft}$$

The effect of A on B

$$u_{A\,on\,B} = \frac{(1200)^2(0.0002)}{(4)(80{,}000)(300)(1/7.48)} = 2.2 \times 10^{-5} \Rightarrow W(u) = 10.1$$

$$s_{A\,on\,B} = \frac{(500)(1440)(10.1)}{4\pi(80{,}000)} = \boxed{7.2\,ft}$$

The effect of B on A

$$u_{B\,on\,A} = \frac{(1200)^2(0.0002)}{(4)(80{,}000)(330)(1/7.48)} = 2.0 \times 10^{-5} \Rightarrow W(u) = 10.2$$

$$s_{B\,on\,A} = \frac{(500)(1440)(10.2)}{4\pi(80{,}000)} = \boxed{7.3\,ft}$$

The effect of A on C

$$u_{A\,on\,C} = \frac{(2600)^2(0.0002)}{(4)(80{,}000)(300)(1/7.48)} = 1.1 \times 10^{-4} \Rightarrow W(u) = 8.5$$

$$s_{A\,on\,C} = \frac{(500)(1440)(8.5)}{4\pi(80{,}000)} = \boxed{6.1\,ft}$$

$$u_{C\,on\,A} = \frac{(2600)^2(0.0002)}{(4)(80{,}000)(1/7.48)(330)} = 9.6 \times 10^{-5} \Rightarrow W(u) = 8.7$$

$$s_{C\,on\,A} = \frac{(500)(1440)(8.7)}{4\pi(80{,}000)} = \boxed{6.2\,ft}$$

	A	B	C
Each Well	18.98	19.05	19.05
B on C, C on B		7.1	7.1
A on B		7.2	
B on A	7.3		
A on C			6.1
C on A	6.2		
Total drawdown	32.48	33.35	32.25

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4. A confined aquifer that is 50 feet (→ 15.24 m) thick has a transmissivity of 3050 m^2/day. A well is being installed that is to have a design discharge of 500gpm. What is the percentage of open area in the screen to have the optimum entrance velocity? Use a clogging coefficient of .5. ~ c

$Q = 500\ gpm \times 1440\ min/day \times 1 ft^3/7.48\ gal \times \left(\frac{0.3048\ m}{1\ ft}\right)^3 = 2725.7\ m^3/day$

Nominal pump casing = 30 cm

Naturally Developed Well, Surface casing = 40 cm = .4 m

Gravel packed Well, Surface casing = 60 cm = .6 m

d_s = Nominal Screen ϕ = 20 cm = .2 m

$T = depth\ K \Rightarrow K = T/15.24 = \frac{3050\ m^2/day}{15.24\ m} \Rightarrow K = 200$

since $K = 200 \therefore V_s = (3.00\ m/min)(1440\ min/day) = 4320\ m/day$

Area of screen per meter of screen. $A = \pi(d_s)(1m) = \pi(.2m)(1m) = 0.6283\ m^2$

$V_s = \frac{Q}{c \pi d_s L_s P} \Rightarrow P = \frac{Q}{c \pi d_s L_s V_s} = \frac{2725.7\ m^3/day}{(0.5)(0.6283\ m^2)(4320\ m/day)}$

P = 2.01% per meter