Addis Ababa Institute of Technology (AAiT), School of Civil and Environmental Engineering

CENG 6606: GROUNDWATER HYDRAULICS, **Practice exercise 2**

1. A 1m diameter well penetrates vertically through a confined aquifer 30 m thick. When the well is pumped at 113 $m^3$/hr, the drawdown in a well 15 m away is 1.8 m; in another well 50 m away, it is 0.5 m. what is the approximate head in the pumping well for steady state conditions and what is the approximate drawdown in the well? Also compute the Transmissivity of the aquifer and the radius of influence. Take the initial piezometric level as 40 m above the datum.
2. A well 0.5 m in diameter penetrates 33 m below the static water table. After a long period of pumping at a rate of 80 $m^3$/hr, the drawdown in the wells at 18 and 45 m from the pumped well were found to be 1.8 and 1.1 m, respectively.
   a. What is the approximate drawdown in the pumped well?
   b. Determine the radius of influence of the pumping well
3. A well penetrating a confined aquifer is pumped at a uniform rate of 6807 $m^3$/day. Drawdown during the pumping test are measured in the pumping well of 0.127m radius is listed below.
   a. Using Theis method determine T and S for this confined aquifer.
   b. Rework (a) using Cooper Jacob method
   c. Determine the transmissivity from the residual drawdown analysis

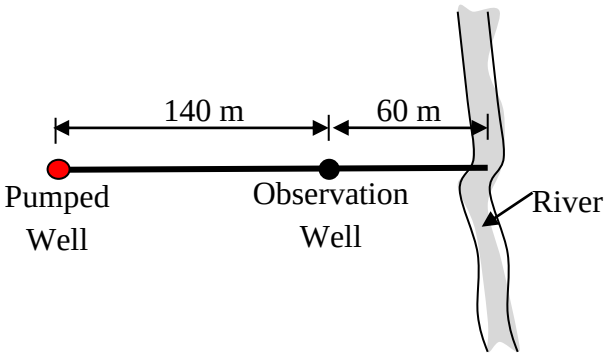
| t (min) | s (m) | t (min) | s (m) | t (min) | s (m) | t (min) | s (m) | t (min) | s (m) | t (min) | s (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 70 | 79.91 | 960 | 83.42 | 2400 | 84.45 | 3780 | 83.87 | 4336 | 14.3 |
| 1 | 41.02 | 80 | 80.12 | 1020 | 83.47 | 2460 | 84.45 | 3840 | 84.06 | 4338 | 14.1 |
| 2 | 56.37 | 90 | 80.62 | 1080 | 83.82 | 2520 | 84.46 | 3900 | 84.14 | 4340 | 14 |
| 3 | 64.97 | 100 | 80.74 | 1140 | 83.87 | 2580 | 84.46 | 3960 | 84.29 | 4345 | 13.6 |
| 4 | 69.27 | 120 | 80.87 | 1200 | 84.07 | 2640 | 84.47 | 4020 | 84.42 | 4350 | 13.2 |
| 5 | 71.82 | 140 | 81.14 | 1260 | 84.16 | 2700 | 84.47 | 4080 | 84.44 | 4355 | 13 |
| 6 | 73.42 | 160 | 81.41 | 1320 | 84.34 | 2760 | 84.47 | 4140 | 84.47 | 4360 | 12.9 |
| 7 | 74.87 | 180 | 81.69 | 1440 | 84.38 | 2820 | 84.48 | 4200 | 84.65 | 4365 | 12.7 |
| 8 | 75.19 | 210 | 81.92 | 1500 | 84.4 | 2880 | 84.49 | 4260 | 84.47 | 4370 | 12.6 |
| 9 | 75.72 | 240 | 81.95 | 1560 | 84.42 | 2940 | 84.49 | 4320 | 84.5 | 4380 | 12.4 |
| 10 | 76.37 | 270 | 81.98 | 1620 | 84.42 | 3000 | 84.35 | 4320 | 84.5 | 4390 | 12.1 |
| 12 | 76.89 | 300 | 82 | 1680 | 84.42 | 3060 | 84.41 | 4321 | 42.7 | 4400 | 12 |
| 14 | 77.27 | 330 | 82.14 | 1740 | 84.43 | 3120 | 84.42 | 4322 | 24.8 | 4410 | 11.8 |
| 16 | 77.77 | 360 | 82.16 | 1800 | 84.43 | 3180 | 84.44 | 4323 | 19.6 | 4420 | 11.8 |
| 18 | 77.87 | 420 | 82.16 | 1860 | 84.43 | 3240 | 84.4 | 4324 | 18.3 | 4440 | 11.7 |
| 20 | 78.07 | 480 | 82.17 | 1920 | 84.43 | 3300 | 84.31 | 4325 | 17.4 | | |
| 25 | 78.42 | 540 | 82.37 | 1980 | 84.44 | 3360 | 84.33 | 4326 | 16.7 | | |
| 30 | 78.77 | 600 | 82.56 | 2040 | 84.44 | 3420 | 84.26 | 4327 | 16.3 | | |
| 35 | 79.07 | 660 | 82.59 | 2100 | 84.44 | 3480 | 84.18 | 4328 | 15.9 | | |
| 40 | 79.29 | 720 | 83.07 | 2160 | 84.44 | 3540 | 84.21 | 4329 | 15.7 | | |
| 45 | 79.39 | 780 | 83.47 | 2220 | 84.45 | 3600 | 84.15 | 4330 | 15.5 | | |
| 50 | 79.69 | 840 | 83.42 | 2280 | 84.45 | 3660 | 84.09 | 4332 | 14.8 | | |
| 60 | 79.87 | 900 | 83.27 | 2340 | 84.45 | 3720 | 84.01 | 4334 | 14.6 | | |

4. A pumping test was done to determine the aquifer characteristics of a certain site. The observed drawdown, after 1 day of pumping at three observation wells, was as shown in the Table below. The well yield was 100 liter per second.

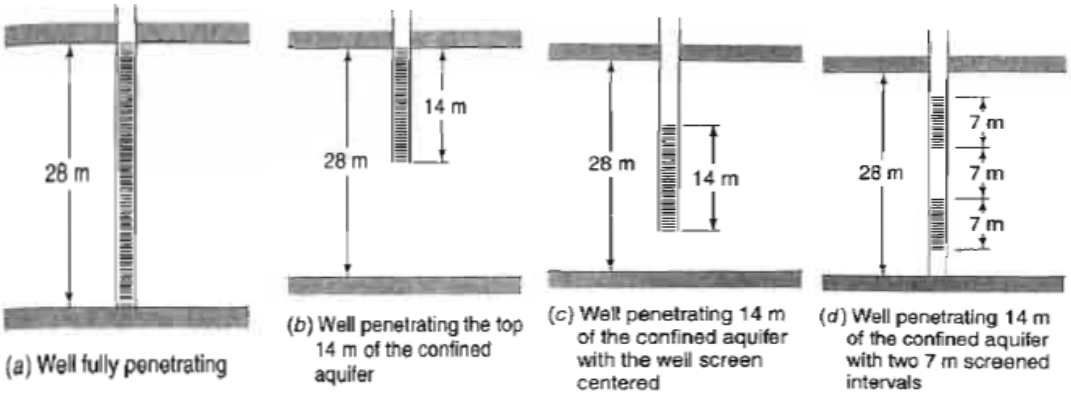
| Distance (m) | 10 | 20 | 40 |
|---|---|---|---|
| Drawdown (m) | 4 | 3 | 2 |

a. Estimate the Transmissivity and Storativity of the aquifer.
b. What would be the well efficiency, if the pumping well diameter is 20 cm and the drawdown observed after 1 day is 11 meter?

5. A 0.5 m diameter well (200m from a river) is pumping at an unknown rate from a confined aquifer (see the figure below). The aquifer properties are T = 432 $m^2$/day and S = 0.0004. After 8 hours of pumping, the drawdown in the observation well (60 m from the fault) is 8 m. Compute the rate of pumping and the drawdown in the pumped well. What is the effect of the River on drawdown in the observation and pumping well?

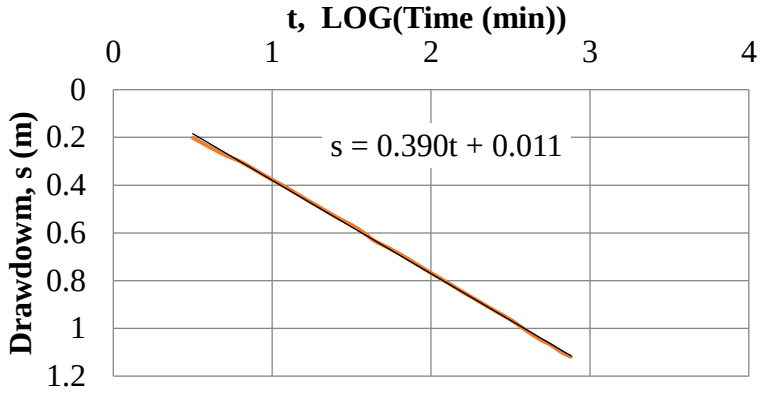



6. Compare the four cases that are depicted below where a 1 m diameter well fully/partially penetrates vertically through a confined aquifer whose thickness is 28 m. Comment on their relative efficiencies by evaluating the specific capacity for each case.



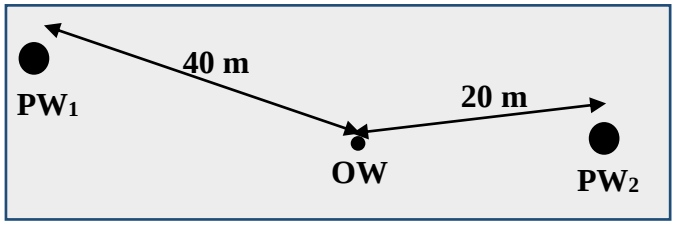

(a) Well fully penetrating
(b) Well penetrating the top 14 m of the confined aquifer
(c) Well penetrating 14 m of the confined aquifer with the well screen centered
(d) Well penetrating 14 m of the confined aquifer with two 7 m screened intervals

7. The following curve is from a pumping test where a well was pumped at a rate of 12.5 liters per second. Drawdown as shown below was measured in an observation well 75 m away from the pumping well. The geologist's log of the well is: 0-7 m: Clayey soil; 7-23.5 m: Fractured Dolomite; 23.5-55 m: Dense Shale; 55-66 m: Sandstone; and66-67 m: Shale, limey. A steel well casing was grouted to a depth of 55 m and the well was extended as an open boring past that point. Assume the well is fully penetrating and no external leakage is occurring.

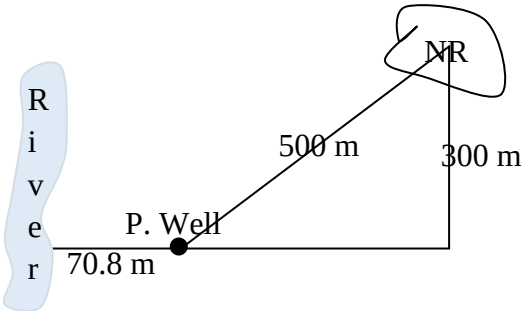



a) Is the aquifer confined or unconfined? (Give reason/s)
b) Determine the Storativity, Storage coefficient, Transmissivity and Hydraulic conductivity of the aquifer.

8. A pump test ($PW_1$) with discharge capacity of 45 lit/s is conducted in a confined aquifer to estimate the rate of pumping of a pumping well ($PW_2$) (**Figure below**). The log time (t) vs. draw down (s) obtained at the location of the observation well (OW) is approximated by $s = \log(t) - 2.05$ where t is in seconds and s is in meters. Determine the Pumping rate from $PW_2$. The storativity and transmissivity of the aquifer is 0.02 $m^2/s$ and 0.004, respectively.




10. Groundwater is pumped from a confined aquifer. The pumping discharge is 314.2 $m^3$/day. The saturated depth of the aquifer is 50 m; the hydraulic conductivity of the aquifer equals 10 m/day and the storage coefficient of the aquifer is 0.0001. A river (R) is located at a distance of 70.8 m of the pumping station, and the midpoint of a nature reserve (NR) is located at a distance of 500 m from the pumping well.
   a. Determine the lowering of the hydraulic head as a function of time in the midpoint of the nature reserve given the setup shown below.
   b. What would be the drawdown variation, if there is a fault (impermeable geologic medium) at the location of the river?
   c. What do you observe from the results of the above questions?




9. A step drawdown test was carried out on a pumping well and the relation between the discharge ***Q*** (in $m^3$/day) the corresponding specific capacity (**Sc**) could be approximated by

$Sc = \frac{10^6}{800 + 2Q}$. What is the well's efficiency?

10. The step draw-down test carried out in a pumping well has resulted in a relation given by: s/Q = 3 + 0.005Q; where s is the drawdown in meters and Q is the well yield. Determine the well's efficiency.
11. Suppose that from a step test we have determined the value of *Specific capacity* = 320 $m^3$/d/m of drawdown. And the static water level (SWL) in the borehole lies at 5 m below ground level (m bgl), and we want at least 2 m of water in the hole above the pump during operation for safety reasons (you should never pump dry!). If the client insists on a yield of 2000 $m^3$/d. Decide on the length of the rising main to use.
12. A pumping test was done to determine the aquifer characteristics of a certain site. The observed drawdown, after 1 day of pumping at three observation wells that are placed at different distance from the pumping well, was as shown in the Table below. The discharge observed was 100 liter per second.

| Distance | 1 | 10 | 100 |
|---|---|---|---|
| Drawdown | 4 | 3 | 2 |

    a. Estimate the Transmissivity and Storativity of the aquifer. **(10 %)**
    b. What would be the well efficiency, if the pumping well diameter is 20 cm and the drawdown observed after 1 day is 11 meter? **What is your recommendation on the well? (10 %)**
13. A pump test (on $PW_1$) with discharge capacity of 45 lit/s is conducted in a confined aquifer to estimate the rate of pumping in $PW_2$ well (**Figure below**). The log time (t) vs. draw down (s) obtained at the location of the observation well (OW) is found to be 0.5 m. Determine the Pumping rate from $PW_2$. The storativity and transmissivity of the aquifer are 0.02 $m^2$/s and 0.004, respectively. **(25%)**