ES476/576 Hydrology Lab Exercise
Well Hydraulics/Aquifer Testing

PART I. Use the AQTESOLV Aquifer Testing Software on the following problems.

(Hint: make sure all units are similar in dimension prior to running AQTESOLV. Remember 1 cu. Ft = 7.48 Gal) (i.e. make sure all distance units are same: Ft, M, Cm, etc; all time units are same: Min, Sec, Day; etc.)

For each AQTESOLV problem in Part 1, complete the following:

1. Save your project files to your H:\drive in the "aqtest" folder... or some other folder you create.

Problem 1	Prob1.aqt
Problem 2	Prob2.aqt
Problem 3	Prob3.aqt
Problem 4	Prob4.aqt

2. Print out a hard copy of all your graphs and calculated aquifer parameters. Remember to put your name on them and make them look fancy.

Problem 1.

The following data are from a pumping test where a well was pumped at a rate of 200 Gal/Min. Drawdown as shown below was measured in an observation well 250 feet away from the pumping well. The geologists log of the well is:

0-23 Ft	Glacial Till, clayey
23-77 Ft	Dolomite, fractured
77-182 Ft	Shale, black, dense
182-217 Ft	Sandstone, coarse
217-221 Ft	Shale, gray, limey

A steel well casing was cemented/grouted to a depth of 182 feet and the well was extended as an open boring past that point. Assume the well is fully penetrating and no external leakage is occurring.

The following is the drawdown data from the observation well:

Elapsed Time (Min)	Drawdown (Ft)
1	0.66
1.5	0.87
2	0.99
2.5	1.11
3	1.21
4	1.36
5	1.49
6	1.59
8	1.75
10	1.86
12	1.97
14	2.08
18	2.2
24	2.36

30	2.49
40	2.65
50	2.78
60	2.88
80	3.04
100	3.16
120	3.28
150	3.42
180	3.51
210	3.61
240	3.67

Preliminary Questions Before You Do the Calculations:

A. What are the aquifer conditions and which aquifer test solving routine is most applicable?

1. Is the aquifer confined or unconfined?
2. Convert your units to make them all consistent, using ft-min for the distance-time parameters.
3. What rock unit(s) make up the aquifer?
4. What is the saturated thickness of the aquifer?
5. Assume that the pumping system is not at equilibrium, wells are fully penetrating, and no leakage is occurring; which aquifer test solving method is the most applicable in this situation?

Using AQTESOLV:

B. Plot the time-drawdown data on a 3 x 5 cycle log-log plot of time (min; x-axis) vs. drawdown (ft; y-axis). Use the Theis-type curve method to find:

1. Aquifer transmissivity in sq. Ft/min
2. Aquifer transmissivity in sq. Ft/day
3. Aquifer storativity
4. Aquifer hydraulic conductivity in Ft/min (remember T=Kb)

C. Use the Cooper-Jacob (straight-line) method. Replot the data on a 4-cycle semi-log plot with drawdown on the arithmetic scale of the y axis and time on the log scale of the x-axis. Determine the following:

1. Aquifer transmissivity in sq. Ft/min
2. Aquifer transmissivity in sq. Ft/day
3. Aquifer storativity
4. Aquifer hydraulic conductivity in Ft/min (remember T=Kb)
5. What is the percent difference in calculation of the hydraulic parameters between the Theis method and the Cooper-Jacob method?

Problem 2

A test well was drilled to a total depth of 117 feet with the following geologists log:

0-73 Ft	Coarse sand
73-82 Ft	Clayey sand
82-117 Ft	Coarse Sand
117 Ft	Crystalline Bedrock, Dense, Impermeable

A pumping well was installed with steel casing cemented to a depth of 82 Ft. The well was screened from 82 to 117 Ft. The static water level rose in the well to a depth of 55 Feet below the surface. During a pumping

test, the well was pumped at a rate of 560 gallons per minute. Drawdown was measured in an observation well that was also screened from 82 to 117 Ft, and was located 82 feet away from the pumping well. The following time-drawdown data were collected from the observation well.

Elapsed Time (Min)	Drawdown (Ft)
1	0.9
2	2.15
3	3.05
4	3.64
5	4.07
6	4.52
7	4.74
8	5.02
9	5.21
10	5.53
15	5.72
20	5.97
30	6.12
40	6.2
50	6.25
60	6.27
90	6.29
120	6.29

Preliminary Questions:

A. What are the aquifer conditions and which aquifer test solving routine is most applicable?
1. Is the aquifer confined or unconfined?
    A. How does the SWL compare to the depth to the top of the aquifer?
2. Make sure you convert all of your parameter units into consistent distance and time dimensions.
3. What sediment unit(s) make up the aquifer?
4. What is the saturated thickness of the aquifer?
5. Assume that the pumping system is not at equilibrium, wells are fully penetrating, and leakage IS occurring.
    A. Which sediment unit is acting as the leaky aquitard in this case?
    B. What is the thickness of the leaky aquitard?

Using AQTESOLV:

B. Plot the time-drawdown data on a 3 x 5 cycle log-log plot of time (min; x-axis) vs. drawdown (ft; y-axis). Use the Hantush leaky confined aquifer routine to solve the following (assume a scenario in which there is NO storage of groundwater in the aquitard). Make sure you first convert all of your parameter units into consistent distance and time dimensions.

Note: at the Hantush menu window, select "starting guesses" and assume an r/B ratio of 0.6026)

1. Aquifer transmissivity in sq. Ft/min
2. Aquifer transmissivity in sq. Ft/day
3. Aquifer storativity
4. Aquifer hydraulic conductivity in Ft/min (remember T=Kb)

5. Determine the vertical hydraulic conductivity of the confining unit (i.e. the leakage rate through the confining unit) in Ft/Min

Use the following equation:

$$K' = (Tb'(r/B)(r/B))/(r*r)$$

where K' = vertical hydraulic conductivity of leaky aquitard, T = transmissivity of confined aquifer, b' = thickness of the leaky aquitard, r/B = the Hantush well function = 0.6026, r*r = the square of the distance of the observation well from the pumping well.

Problem 3.

A slug test was made with a piezometer that had a casing radius of 2.54 cm and a screen radius of 2.54 cm. A slug of 4000 cu. cm of water was injected, raising the water level in the piezometer by 197.3 cm. The well completely penetrated a confined aquifer that was 2.3 m thick. The decline in head with time was recorded as the well began recovery. The data is as follows:

Elapsed Time (Min)	Head (cm)
1	185.4
2	178.6
3	173.6
5	167.7
7	158.8
10	147
13	140
17	129.2
22	118.4
32	99.6
53	74
84	51.3
119	35.5
170	23.3
245	15.2
400	8.7
800	4.3

A. What are the aquifer conditions and which aquifer test solving routine is most applicable?

1. Is the aquifer confined or unconfined?
2. What is the saturated thickness of the aquifer?
3. Why is there no data regarding the distance of the pumping well from the observation well?
4. Check your data units for consistency in distance-time dimensions.

Using AQTESOLV:

B. Plot the head recovery data on a semi-log plot of time (min; logarithmic x-axis) vs. H/Ho (arithmetic, y-axis). Enter the data as is using AQTESOLV Dataset Manager, it will compute the H/Ho values automatically. Use the Cooper et al. slug test solver method (Cooper, Bredehoeft and Papadopulos) to determine the following:

1. Aquifer transmissivity in sq. Cm/sec
2. Aquifer transmissivity in sq. Ft/day
3. Aquifer storativity
4. Aquifer hydraulic conductivity in cm/min (remember T=Kb)

Problem 4

A pump test is conducted in a confined aquifer. Full penetration the wells are assumed. The pumping rate at the pumping well is 500 gallons/minute. The observation well is located 400 Ft away. The following is the time-drawdown data for the observation well:

Time Elapsed (Min)	Drawdown (Ft)
1	0.16
1.5	0.27
2	0.38
2.5	0.46
3	0.53
4	0.67
5	0.77
6	0.87
8	0.99
10	1.12
12	1.21
14	1.3
18	1.43
24	1.58
30	1.7
40	1.88
50	2
60	2.11
80	2.24
100	2.38
120	2.49
150	2.62
180	2.72
210	2.81
240	2.88

A. Using the Cooper-Jacob method determine the transmissivity and storativity of the aquifer. Complete a semi-log plot of the data with drawdown (arithmetic, y-axis) vs. time (logrithmic, x-axis). First check your units for consistent distance-time dimensions.

1. Transmissivity in sq. Ft/min
2. Transmissivity in sq. m/day
3. Storativity
4. Assume the aquifer is 10 Ft thick, what is hydraulic conductivity in Ft/Min?

    A. Hydraulic conductivity in cm/sec?