Assignment #3 Cover Page

Name:

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#	Part A	Part B	Part C	Part D	Part E	Total
1	/10	/15	/15	--	--	/40
2	/2	/2	/5	/6	/5	/20
3	/5	/5	--	--	--	/10
Total						/70

Note: All assignments must use this cover page (assignments will not be marked without the cover page).

EARTH 458
Assignment # 3

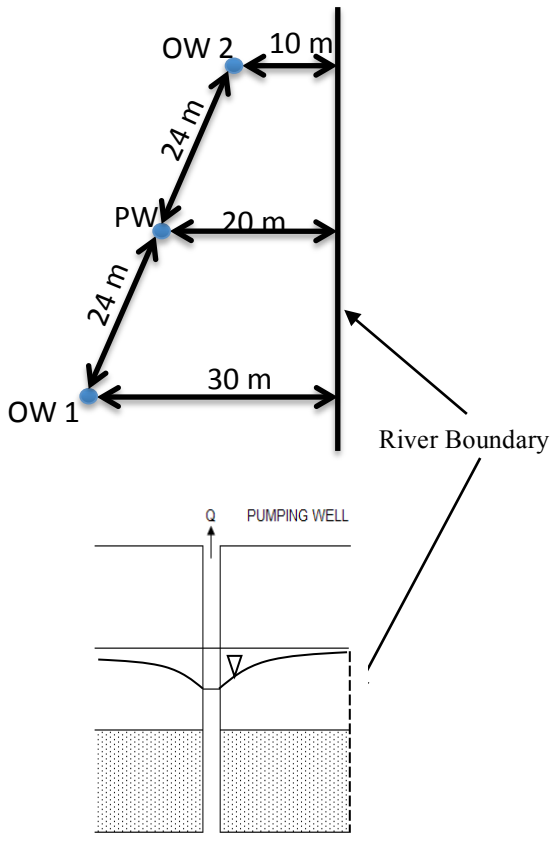
Assigned:	November 14, 2016
Due:	November 21, 2016 (at the beginning of class)
Total Possible Marks:	**70**

Problem 1:
A well in a confined aquifer was pumped at a rate of $75m^3$/day for a period of 5 years. The storativity and transmissivity of the aquifer was $4.0x10^{-4}$ and 6.0 m^2/day, respectively. The pumping well (PW) was located at a distance of 20m from the river boundary.

a) Calculate the drawdown at two observation wells (shown in the figure, OW1 & OW2) **without a river boundary** at the end of pumping. **(10 points)**

b) Calculate the drawdown at two observation wells (shown in the figure, OW1 & OW2) **with a river boundary** at the end of pumping. **(15 points)**
Hint: Use image wells!

c) Now, lets assume that the river boundary was actually to sheet pile creating a **no flow boundary condition**. What are the drawdowns in the observation wells? **(15 points)**
Hint: Use image wells!



Problem 2:

A cylinder of soil is collected in the field and has a volume of 25.0 cm^3. It is then saturated with water and reweighed. The saturated weight is 57.375 g. The sample is allowed to drain the water and then reweighed. The mass is found to be 51.125 g. Finally, the sample is oven dried to remove all the water and reweighed. The dry mass is 49.875 g. Assume the density of water is 1.0 g/cm^3.

a) Calculate the saturated volumetric moisture content. **(2 points)**

b) Calculate the residual volumetric moisture content. **(2 points)**

c) Construct the soil water characteristic curve showing pressure head vs. water content ($\psi = 0$ m to -3.0 m at an interval of 0.1) using the most popular van Genuchten formula (1980) which is given as follows:

$$\theta(\psi) = \frac{(\theta_s - \theta_r)}{\left[1 + \left(a|\psi|\right)^N\right]^{1-\frac{1}{N}}} + \theta_r$$

Where θ_s is the saturated moisture content, θ_r is the residual moisture content, ψ is the pressure head, a and N are called van Genuchten parameters. Assume a =2.1 $(kg/m^2)^{-1}$ and N = 2.6. Normally these parameters are obtained by curve fitting of laboratory experimental data, but this has already been done for you. **(5 points)**

d) Construct the pressure head vs. hydraulic conductivity curve for the same soil using the van Genuchten formula that is given as follows:

$$K(\psi) = K_s \frac{\left[1 - \left\{\left(a|\psi|\right)^{N-1}\right\}\left\{1 + \left(a|\psi|\right)^N\right\}^{\frac{1}{N}-1}\right]^2}{\left[1 + \left(a|\psi|\right)^N\right]^{0.5\left(1-\frac{1}{N}\right)}}$$

Where K_s is the saturated hydraulic conductivity measured in the field and assume it is 1.0×10^{-4} m/s. **(6 points)**

e) Calculate the pressure head and hydraulic conductivities for moisture content 0.09, 0.23 and 0.30 and comment on how moisture content and hydraulic conductivity are related. **(5 points)**

Problem 3:
Answer the following questions related to capillary forces and vadose zone flow.

a) Estimate the height of capillary rise in a very thin tube having a diameter of 8μm. Assume the fluid is perfectly wetting. **(5 marks)**

b) The thickness of the capillary fringe in this soil is known to be about 0.75 m. Estimate the radius of the largest pores in this soil, which control the maximum height of the capillary fringe. **(5 marks)**