NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICS DEPARTMENT

HYDROLOGY AND CONTAMINANT PROCESSES
MAPH 6121
SUPPLEMENTARY EXAMINATION

MSC GEOPHYSICS: JULY 2014 *DURATION: 4 HOURS*

ANSWER ALL QUESTIONS IN THIS PAPER. THE MAXIMUM POSSIBLE MARKS IS 120.

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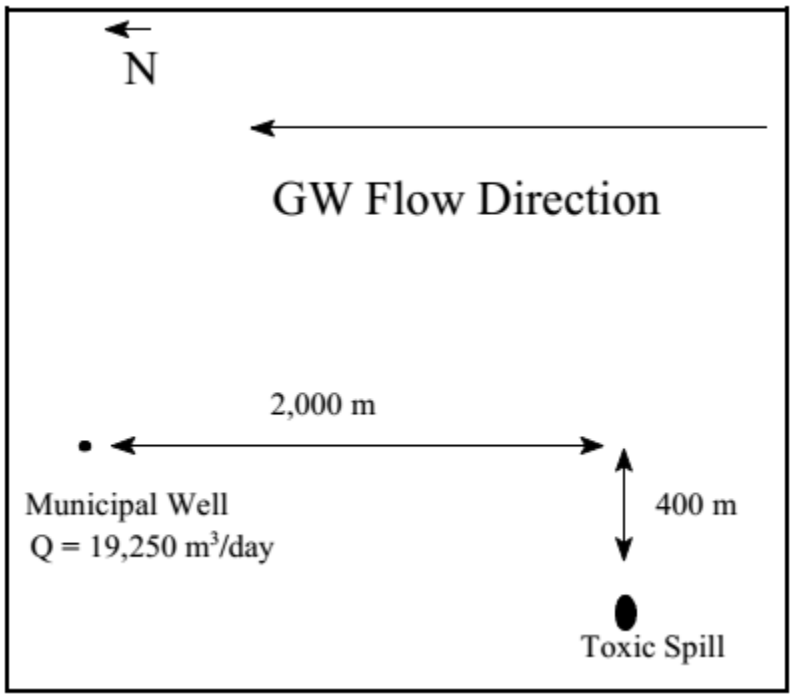
1. Describe the geological setting and properties of the following aquifer formations:
   (a) Unconfined aquifer. [6]
   (b) Artesian aquifer. [4]
   (c) Perched aquifer. [4]
2. Give an outline of the Dupiut assumptions used in deriving groundwater flow equations. [9]

3. (a) With the aid of relevant equations, distinguish between specific yield and specific retention, for saturated flow. [6]
   (b) Estimate the average drawdown over an area where 25 million cubic meters of water has been pumped through a number of uniformly distributed wells. The area is 150 km^2 and the specific yield of the unconfined aquifer is 25 percent. [6]
4. (a) State the Darcy equation for saturated groundwater flow, describing all symbols used. [2]
   (b) (i) Describe a laboratory experiment that can be used to demonstrate Darcy's law for a given soil profile. [4]
   (ii) Determine the flux for a soil in which the unsaturated hydraulic conductivity is expressed as a function of the suction head as K= 250(-ψ-2.11 in cm/d at depth z_1 = 80 cm, h_1 = -145 cm, and ψ_1= -65 cm at depth z^2 = 100 cm, h_2. = -160 cm, and ψ_2 = -60 cm. [4]
5. Discuss any two geophysical methods that could be used in delineating contaminant transport at a landfill site. [12]
6. Discus the importance and application of flow nets and flow lines in characterizing groundwater flow. [10]
7. 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 drawdowns in wells 18 and 45 m from the pumped well were found to be 1.8 and 1.1 m respectively.
   (a) What is the transmissivity of the aquifer? [5]
   (b) What is the approximate draw down .in the pumped well? [5]
   (c) Determine the radius of influence of the pumping well? [5]

8. The municipal well (which pumps at 19,250 m /day) is screened in a confined aquifer located 30 m to 80 m below the surface. Aquifer materials consist of coarse sands with a hydraulic conductivity of about 80 m/day. The well has been pumping for several years and conditions approach steady state. Groundwater flow in the aquifer trends toward the north. The potentiometric surface of the aquifer (measured before pumping commenced) drops approximately 1 m for every 200m. The location of the well relative to the toxic spill is illustrated by Figure 2. Estimate the spatial extent of the capture zone of the pumping well.



[15]

9. (a) Describe a procedure for using tracer tests in determining the hydraulic conductivity in unconfined aquifers. Include a detailed mathematical analysis in your description. [10]

(b) A tracer test is conducted to determine the hydraulic conductivity of an unconfined aquifer. The water levels in the two observation wells 20 m apart are 18.4 m and 17.1 m. The tracer injected in the first well arrives at the second observation well in 167 hours. Compute the hydraulic conductivity of the unconfined aquifer given that the porosity of the formation is 0.25. [6]

(c) An unconfined aquifer consists of three horizontal layers, each individually isotropic. The top layer has a thickness of 10 m and a hydraulic conductivity of 11.6 m/day. The middle layer has a thickness of 4.4 m and a hydraulic conductivity of 4.5 m/day. The bottom layer has a thickness of 6.2 m and a hydraulic conductivity of 2.2 m/day. Compute the equivalent horizontal and vertical hydraulic conductivities. [6]

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