CIVE 3331 - ENVIRONMENTAL ENGINEERING
Spring 2003

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Purpose: Exercises related to Lecture # 9. These exercises develop skills in selected environmental groundwater quality problems. Critical thinking is exercised in determination of analogies between lecture examples and the problems in this exercise set. Direct relationships to various accreditation objectives are highlighted in **Bold** type in the following sections. The exercises start on the next page.

Relevant ABET EC 2000 Criteria: Criterion 3 Program Outcomes and Assessment

(3-a) an ability to **apply knowledge of** mathematics**, science,** and engineering.
(3-e) an ability to identify, formulate, and solve engineering problems.
(3-k) **an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.**

Relevant CEE Educational Objectives:

(3) Emphasize problem-identification, problem-formulation and **communication skills**, **problem-solving techniques** and the **many facets of engineering design** throughout the curriculum.

(5) **Prepare every student to develop the skills for critical thinking and lifelong learning.**

Relevant CEE Program Outcomes:

ii. **Students should acquire the ability to solve practical civil engineering problems by applying the knowledge of mathematics, science**, **engineering, modern techniques**, **skills and practical tools they gained in their courses.**

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Exercise_009-1

A 50 cm^3 sample of dry soil from an aquifer weighs 100g. When it is poured into a graduated cylinder, it displaces 35 cm^3 of water.

a) What is the porosity of the soil?
b) What is the average density of the actual solids in the sample?

Exercise_009-2

Three wells are located in an x-y plane at the following coordinates: well1 (0,0); well 2 (100m,0); and well 3 (100m,100m). The gorund surface is level and the distance from the surface to the water table for each well is: well 1, 10m; well 2, 10.2m; well 3, 10.1m. Sketch the well field and find the hydraulic gradient.

Exercise_009-3

A confined aquifer 30 m thick has been pumped from a fully penetrating well at a steady rate of $5000 m^3$/day for a long enough time so that steady flow conditions exist. Drawdown at an observation well 15m from the pumped well is 3 m and drawdown at a second observation well 150 m away is 0.3 m. Find the hydraulic conductivity of the aquifer.

Exercise_006-4

For the aquifer in the previous exercise, determine the travel time for groundwater to travel to the observation well 15 m away to the pumped well with a diameter of 0.4 m. The porosity is 0.30. (See problem 5.47 in textbook for the appropriate formula).

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Exercise_006-5

Suppose a spill of 0.1 m^3 of trichloroethylene (TCE) distributes itself evenly throughout an aquifer 10.0 m thick, forming a rectangular plume 2000 m long and 250 m wide. The aquifer has porosity of 40%, hydraulic gradient 0.001, and hydraulic conductivity 0.001 m/sec.

Figure 1. Groundwater Plume (see. problem 5.50 in text)

a) Given the solubility of TCE could this much TCE be dissolved in the aquifer? What would be the concentration of TCE in this idealized groundwater plume?
b) Using capture-zone type curves, design an extraction fiels to pump out the plume under the assumption that the wells are to e lined up along the leading edge of the plume with each well to be pumped at the same rate, not to exceed 0.003m^3/sec per well. What is the smallest number of wells that could be used to capture the whole plume? What is the pumping rate for these wells?
c) What is the optimal spacing between the wells?

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Exercise_006-6

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