SSC 107 Soil Physics
Nov. 13, 2002
Due November 22, 2002

Problem Set #6

1. Large quantities of nitrate (a mobile anion) and an industrial solvent with a distribution coefficient of K_d = 0.5 cm^3/g were spilled on the soil surface. Meteorological data shows that annual rainfall and evaporation are 1000 mm and 550 mm, respectively. There is a water table at 60 m below ground surface. Assume that the soil has an average water content of 0.25 kg/kg and a bulk density of 1500 kg/cm^3.

a. Estimate the approximate positions of both peaks 30 years after they were spilled.
b. Estimate the expected future arrival time of both peaks at the water table.

2. Water is applied to a soil by sprinkler irrigation at a steady rate of 4 cm/hr. Part way through the irrigation, an 8-cm depth of nitrate solution is applied to the soil through the sprinkler system and then switched back to pure water. If the average volumetric water content of the soil is 0.25 cm^3/cm^3, how much time will it take for the peak of the nitrate pulse to reach the 40-cm depth?

3. A potentially hazardous chemical spills from its holding tank onto the soil on which the tank sits. A water table lies 50 m from the soil surface. The soil is bare except for a good stand of weeds. Rainfall for the area is 90 cm/year. Evapotranspiration from the field is 50 cm/year. Measurements show that the yearly average water content of the soil was 0.30 cm^3 water/cm^3 soil. Assuming the chemical behaves like Cl^-, how long will it take for the peak of the chemical to reach the water table? Draw an approximate breakthrough curve for this case. Assume one-dimensional flow. State any assumptions.

4. A conservation tracer ion (Cl^-) is applied to a vertical column at the steady-state flow condition. The initial concentration of the tracer when entering the column is C_0. The column is saturated, with a water content is 0.40 cm^3/cm^3. After 30 minutes, the tracer concentration in the effluent is the half of the initial concentration. If the column is 100 cm long with a cross sectional area of 10 cm^2 and the total head gradient is 3 across the soil column,

a. Calculate the total discharge after 30 minutes,
b. Calculate the flux through the column,
c. Calculate the pore-water velocity,
d. Calculate the hydraulic conductivity.

5. The steady state infiltration rate (*i*) is measured at random locations throughout a large field. The data are given in the table below.

a) Construct (plot) the cumulative distribution function (cdf) for *i* using an interval of 2 cm/day.

b) Calculate the sample mean and variance of *i*.

c) Assuming that the sample is representative for the field, use the cdf to estimate the probability that the the steady state infiltration rate of an additional measured location will be between 8 and 10 cm/day.

Sample No	*i* (cm/day)
1	8.2
2	22.6
3	3.0
4	5.5
5	7.0
6	7.2
7	10.0
8	8.5
9	25.0
10	9.6
11	17.3
12	15.0
13	16.1
14	5.9
15	6.0
16	9.0
17	8.0
18	12.0
19	7.4
20	8.2