Problem #1

In a plan view of a contaminant plume you observe that a conservative constituent (e.g. chloride) has moved about 1500 meters while a reactive constituent (e.g. chromium) has moved only 400 meters. Assuming both species were released at the same time, estimate the distribution coefficient of the reactive species for the porosity is 0.35 and the solids density is 2.22 g/mL.

Problem #2

Dissolution of constituents from a residual NAPL source results in a contaminant plume whose maximum length is determined by the balance between advection and decay. Develop an expression for the maximum plume length if the constituent source-term concentration is C_o. Apply the expression to estimate the maximum length of a benzene plume whose equilibrium concentration in water at the source is 2.4 mg/L and whose MCL is 0.005mg/L. Assume that the pore velocity is 0.35 m/d and the half-life of the benzene in a first order decay model is 60 days. Assume that the retardation coefficient for benzene in the aquifer is 2.

Problem #3

Water in the unsaturated zone contains chlorobenzene at a concentration of 50 mg/L. What is the equilibrium concentration of soil air with this water?

Problem #4

A circular lake with radius 600m is located in an alluvial valley in direct contact with an underlying unconfined aquifer. The mean regional aquifer flux is 0.1 m^2/d. The lake is sustained by a number of creeks and water is lost by evaporation. The net recharge rate is estimated to be 300m^3/d. Is the lake recharged by groundwater or does it act solely as a source of groundwater recharge?

Problem #5

A 200 m wide plume of contaminant exists in a sandy aquifer and a set of production wells is to be placed downgradient of the plume to prevent off-site migration. The saturated thickness of the aquifer is 12 m, the hydraulic conductivity is 6 m/d, the regional gradient is 0.004. To prevent excessive draw-down the well production rate is limited to 30 m^3/d per well. How many wells are required to capture the plume? (You may use the capture zone type-curves from the exercises or the analytical solutions for this problem).