Week 14

Contaminant Transport Modeling

14.1. Introduction to Contaminant Hydrogeology

Source of ground water contamination

Spill or pulse loading
Continuous source loading - constant concentration
Continuous source loading - variable concentration
Continuous source loading - decaying concentration

Radioactive contaminants

Trace metals

Nutrients

Other inorganic species

Organic contaminants

Biological contaminants

Solute plumes as a manifestation of processes

Multifluid contamination problems

The nonaqueous phase liquid (NAPL)

Design and quality assurance issues in water sampling

Design of sampling networks
Assuring the quality of chemical data

Sampling methods

Solutes in the zone of saturation

NAPL in the zone of saturation

Solid and fluid sampling

Indirect method for detecting contamination

Soil-gas characterization

Geophysical methods

14.2. Modeling Contaminant Transport

Analytical approaches

$$\frac{C(x,t)}{C_0} = F_1(\alpha_x, x, t); \frac{C(y)}{C_0} = F_2(\alpha_y, y); \frac{C(z)}{C_0} = F_3(\alpha_z, z)$$

$$\frac{C(x,y,z,t)}{C_0} = F_1(\alpha_x, x, t)F_2(\alpha_y, y)F_3(\alpha_z, z)$$

Advection and longitudinal dispersion

The one-dimensional form

$$D_d \frac{\partial^2 C}{\partial x^2} - v_x \frac{\partial C}{\partial x} = \frac{\partial C}{\partial t}$$

for the conditions

$C(0,t)=C_0$ and $C(x,0)=0$

Analytic solution

$$C(x,t) = (\frac{C_0}{2})erfc[\frac{(x-vt)}{2(\alpha_x vt)^{1/2}}]$$

The retardation equation

$$\frac{D_x}{R_f}\frac{\partial^2 C}{\partial x^2} - \frac{v_x}{R_f}\frac{\partial C}{\partial x} = \frac{\partial C}{\partial t}$$

where

$$R_f = 1 + (\frac{1-n}{n})\rho_s K_d$$

Analytic solution

$$C(x,t) = (\frac{C_0}{2})erfc[\frac{(R_f x - vt)}{2(\alpha_x vtR_f)^{1/2}}]$$

Numerical modeling