**Proof of Equivalence of “Surface Water” and “Ground Water” Mass Balance Equations**

In surface water modeling, if one is interested in the dissolved concentration, it is common to multiply the total concentration times the fraction dissolved, Fd, where Fd is the ratio of the dissolved chemical mass to the total chemical mass. Thus, Cd is related to CT, including a porosity-correction, as

 (1)

By definition, CT is

 (2)

where Cs is the sorbed concentration with units of mass of chemical per mass of solids (Mc/Ms). Substituting (2) into (1), Fd can be expressed as

 (3)

Now, at instantaneous liquid/solids sorption equilibrium (which the standard groundwater PDE equation assumes), Cs and Cd are related as

 (4)

where Kd is the well-known equilibrium partitioning coefficient (Lw3/Ms). Substituting from (3) into (2), Fd can be written as

 (5)

which, after a minor rearrangement of equation , can be seen to be identically 1/R. Therefore, from (4) and (1), Cd can be written as

 (6)

Substituting for Cd from (6) into , and treating R and θ as time and space constants gives

 (7)

Cancelling the common Rθ term and recognizing that the remaining R is implicitly 1.0, because partitioning is moot when modeling total concentration, leaves identically equation , the standard surface water PDE. The result shows that the “surface water” parameter, Fd, and the ground water parameter, R, are simply the inverse of each other.