For analyses concerning the effect of suspended particles and chemical partitioning in the water column, equation (1.1) can be manipulated to show how partitioning effects chemical loss in the water column and infers chemical flux into the sediment bed.

$$\frac{\partial C_T}{\partial t} = -u_x \frac{\partial C_T}{\partial x} - \frac{\left(u_z^s \beta + u_z^f\right)}{\left(1+\beta\right)} \frac{\partial C_T}{\partial z} - \lambda C_T$$
$$\frac{\partial C_T}{\partial t} = -u_x \frac{\partial C_T}{\partial x} - \frac{u_z^s \beta}{\left(1+\beta\right)} \frac{\partial C_T}{\partial z} - \lambda C_T \quad \text{for} \quad u_z^s >> u_z^f \tag{1.1}$$

Where C_T is the total chemical concentration and u_x is the horizontal velocity, u_z^s is the vertical solids velocity, u_z^f is the vertical water velocity, λ is the reactive term, and assuming a linear equilibrium isotherm relation between the solid and water concentrations ($C_s = \beta C_f$). Using scaling analysis, equation (1.1) can be modified into non-dimensional terms.

$$\frac{\partial C_T}{\partial t' T} = -u'U \frac{\partial C_T}{\partial x' L} - w'W \frac{\partial C_T}{\partial z' Z} - \lambda C_T$$
where:
$$u_x = u'U$$
$$u_z^s = w'W \tag{1.2}$$
$$x = x'L$$
$$z = z'H$$
$$t = t'T$$

Where the primed terms are non-dimensional terms, W is a characteristic settling velocity, and T is a characteristic time scale. Equation (1.2) can be further manipulated.

$$\frac{\partial C_T}{\partial t'} = -u' \frac{\partial C_T}{\partial x'} - w' \left(\frac{f_p}{Pe}\right) \frac{\partial C_T}{\partial z'} - GC_T$$
where:
$$\frac{1}{Pe} = \frac{LW}{UH}$$
$$f_p = \frac{\beta}{1+\beta} \tag{1.3}$$
$$G = \frac{\lambda L}{U}$$
$$T = \frac{L}{U}$$

Where P_e is a Peclet like number, f_p is the particle fraction, and G is the growth number. When assessing chemical deposition via suspended sediments, equation (1.3) suggests the particle fraction is an additional parameter that must be considered; this parameter and its dynamic behavior should be adequately characterized before assessing the transport of sorbed chemicals into the sediment bed.

Chemical deposition is a function of settling velocity and chemical partitioning, equation (1.3) provides information about sorbed chemicals into the sediment bed.

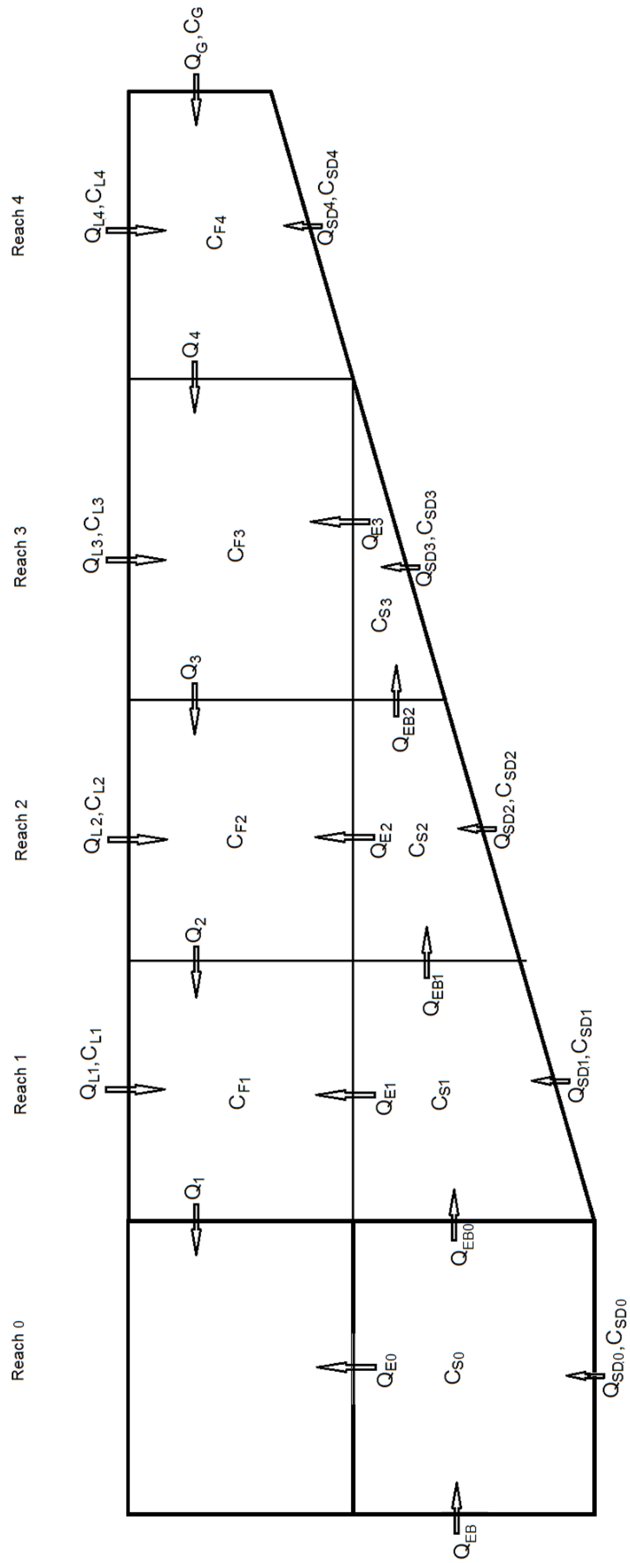
$$\begin{gathered} w'\left(\frac{f_p}{Pe}\right)\frac{\partial C_T}{\partial z'} \\ \left(\frac{w'}{Pe}\right)\frac{\partial}{\partial z'}\left(C_T f_p\right) \\ \left(\frac{w'WL}{UH}\right)\frac{\partial}{\partial z'}\left(\frac{C_T\beta}{1+\beta}\right) \\ \left(\frac{u_z^s L}{UH}\right)\frac{\partial}{\partial z'}\left(\frac{C_T\beta}{1+\beta}\right) \end{gathered} \tag{1.4}$$

Left of the differential, the terms describes physical characteristics of the estuary and the particle, and right of the differential the terms describes the geochemical characteristic between the particles and the chemical. For a given site and a discharge containing multiple sediment particle types, chemical deposition from any particle type should be determined by the settling velocity and the particle water distribution coefficient β because the physical characteristics are the same for all particle types.

$$\begin{gathered} \left[\frac{L}{UH}\right]\left[\frac{W_i\beta_i}{1+\sum\beta_i}\right] \\ \beta_i = \rho_{bs}K_i = (1-\eta)\gamma\rho_w K_i \end{gathered} \tag{1.5}$$

Where ρ_{bs} is the bulk sediment density, η is the porosity, γ is specific gravity of the solid type, ρ_w is the density of water, and K is the partitioning coefficient.

Duwamish Estuary Mass Balance



Mass concentrations in the fresh water lenses.

$$c_{F1} = \left(\frac{\sum_{1}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}}{Q_1} \right) \left(\frac{\sum_{0}^{3} Q_{Ei} - \sum_{0}^{3} Q_{SDi}}{\sum_{0}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}} \right) c_{EB} + \left(\frac{\sum_{1}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}}{Q_1} \right) \left(\frac{Q_{SD0}}{\sum_{0}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}} \right) c_{SD0} + \sum_{1}^{4} \frac{Q_{SDi}}{Q_1} c_{SDi} + \sum_{1}^{4} \frac{Q_{Li}}{Q_1} c_{Li} + \frac{Q_G}{Q_1} c_G \qquad (1.6)$$

$$c_{F2} = \left(\frac{\sum_{2}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}}{Q_2} \right) \left(\frac{\sum_{1}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}}{\sum_{1}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}} \right) \left(\frac{\sum_{0}^{3} Q_{Ei} - \sum_{0}^{3} Q_{SDi}}{\sum_{0}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}} \right) c_{EB} + \left(\frac{\sum_{2}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}}{Q_2} \right) \left(\frac{\sum_{1}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}}{\sum_{1}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}} \right) \left(\frac{Q_{SD0}}{\sum_{0}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}} \right) c_{SD0} + \left(\frac{\sum_{2}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}}{Q_2} \right) \left(\frac{Q_{SD1}}{\sum_{1}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}} \right) c_{SD1} + \sum_{2}^{4} \frac{Q_{SDi}}{Q_2} c_{SDi} + \sum_{2}^{4} \frac{Q_{Li}}{Q_2} c_{Li} + \frac{Q_G}{Q_2} c_G \qquad (1.7)$$

$$c_{F3} = \left(\frac{Q_{E3} - Q_{SD3}}{Q_3}\right)\left(\frac{\sum_2^3 Q_{Ei} - \sum_2^3 Q_{SDi}}{\sum_2^3 Q_{Ei} - \sum_3^3 Q_{SDi}}\right)\left(\frac{\sum_1^3 Q_{Ei} - \sum_1^3 Q_{SDi}}{\sum_1^3 Q_{Ei} - \sum_2^3 Q_{SDi}}\right)\left(\frac{\sum_0^3 Q_{Ei} - \sum_0^3 Q_{SDi}}{\sum_0^3 Q_{Ei} - \sum_1^3 Q_{SDi}}\right)c_{EB}$$

$$+\left(\frac{Q_{E3} - Q_{SD3}}{Q_3}\right)\left(\frac{\sum_2^3 Q_{Ei} - \sum_2^3 Q_{SDi}}{\sum_2^3 Q_{Ei} - \sum_3^3 Q_{SDi}}\right)\left(\frac{\sum_1^3 Q_{Ei} - \sum_1^3 Q_{SDi}}{\sum_1^3 Q_{Ei} - \sum_2^3 Q_{SDi}}\right)\left(\frac{Q_{SD0}}{\sum_0^3 Q_{Ei} - \sum_1^3 Q_{SDi}}\right)c_{SD0}$$

$$+\left(\frac{Q_{E3} - Q_{SD3}}{Q_3}\right)\left(\frac{\sum_2^3 Q_{Ei} - \sum_2^3 Q_{SDi}}{\sum_2^3 Q_{Ei} - \sum_3^3 Q_{SDi}}\right)\left(\frac{Q_{SD1}}{\sum_1^3 Q_{Ei} - \sum_2^3 Q_{SDi}}\right)c_{SD1}$$

$$+\left(\frac{Q_{E3} - Q_{SD3}}{Q_3}\right)\left(\frac{Q_{SD2}}{\sum_2^3 Q_{Ei} - \sum_3^3 Q_{SDi}}\right)c_{SD2}$$

$$+\sum_3^4 \frac{Q_{SDi}}{Q_3} c_{SDi} + \sum_3^4 \frac{Q_{Li}}{Q_3} c_{Li} + \frac{Q_G}{Q_3} c_G \tag{1.8}$$

$$c_{F4} = \frac{Q_{SD4}}{Q_4} c_{SD4} + \frac{Q_{L4}}{Q_4} c_{L4} + \frac{Q_G}{Q_4} c_G \tag{1.9}$$

Mass concentrations in the salt water wedge.

$$
\begin{aligned}
c_{S3} = {} & \left(\frac{Q_{E3}-Q_{SD3}}{Q_{E3}}\right)\left(\frac{\sum_{2}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)\left(\frac{\sum_{1}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}{\sum_{1}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}\right)\left(\frac{\sum_{0}^{3}Q_{Ei}-\sum_{0}^{3}Q_{SDi}}{\sum_{0}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}\right)c_{EB} \\
& +\left(\frac{Q_{E3}-Q_{SD3}}{Q_{E3}}\right)\left(\frac{\sum_{2}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)\left(\frac{\sum_{1}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}{\sum_{1}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}\right)\left(\frac{Q_{SD0}}{\sum_{0}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}\right)c_{SD0} \\
& +\left(\frac{Q_{E3}-Q_{SD3}}{Q_{E3}}\right)\left(\frac{\sum_{2}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)\left(\frac{Q_{SD1}}{\sum_{1}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}\right)c_{SD1} \\
& +\left(\frac{Q_{E3}-Q_{SD3}}{Q_{E3}}\right)\left(\frac{Q_{SD2}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)c_{SD2}+\frac{Q_{SD3}}{Q_{E3}}c_{SD3}
\end{aligned}
\tag{1.10}
$$

$$
\begin{aligned}
c_{S2} = {} & \left(\frac{\sum_{2}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)\left(\frac{\sum_{1}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}{\sum_{1}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}\right)\left(\frac{\sum_{0}^{3}Q_{Ei}-\sum_{0}^{3}Q_{SDi}}{\sum_{0}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}\right)c_{EB} \\
& +\left(\frac{\sum_{2}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)\left(\frac{\sum_{1}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}{\sum_{1}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}\right)\left(\frac{Q_{SD0}}{\sum_{0}^{3}Q_{Ei}-\sum_{1}^{3}Q_{SDi}}\right)c_{SD0} \\
& +\left(\frac{\sum_{2}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)\left(\frac{Q_{SD1}}{\sum_{1}^{3}Q_{Ei}-\sum_{2}^{3}Q_{SDi}}\right)c_{SD1} \\
& +\left(\frac{Q_{SD2}}{\sum_{2}^{3}Q_{Ei}-\sum_{3}^{3}Q_{SDi}}\right)c_{SD2}
\end{aligned}
\tag{1.11}
$$

$$c_{S1} = \left(\frac{\sum_{2}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}}{\sum_{2}^{3} Q_{Ei} - \sum_{3}^{3} Q_{SDi}} \right) \left(\frac{\sum_{1}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}}{\sum_{1}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}} \right) c_{EB} + \left(\frac{\sum_{1}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}}{\sum_{1}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}} \right) \left(\frac{Q_{SD0}}{\sum_{0}^{3} Q_{Ei} - \sum_{1}^{3} Q_{SDi}} \right) c_{SD0} + \left(\frac{Q_{SD1}}{\sum_{1}^{3} Q_{Ei} - \sum_{2}^{3} Q_{SDi}} \right) c_{SD1} \quad (1.12)$$

Fresh water flows

$$\begin{aligned} Q_4 &= Q_{L4} + Q_{SD4} + Q_G \\ Q_3 &= Q_{E3} + \sum_{3}^{4} Q_{Li} + \sum_{3}^{4} Q_{SDi} + Q_G \\ Q_2 &= \sum_{2}^{3} Q_{Ei} + \sum_{2}^{4} Q_{Li} + \sum_{2}^{4} Q_{SDi} + Q_G \\ Q_1 &= \sum_{1}^{3} Q_{Ei} + \sum_{1}^{4} Q_{Li} + \sum_{1}^{4} Q_{SDi} + Q_G \end{aligned} \quad (1.13)$$