Hydrogeolgy Equation Sheet

$$\rho_{dry} = \frac{M_s}{V_T} \qquad \rho_m = \frac{M_s}{V_S} \qquad \rho_{sat} = \frac{M_{sat}}{V_T} \qquad V_T = V_s + V_v \qquad n = \frac{V_v}{V_T} \qquad \theta = \frac{V_w}{V_T} \qquad n = 1 - \left(\frac{\rho_{dry}}{\rho_m}\right)$$

$$V_s = (1-n)V_T \qquad e = \frac{V_v}{V_s} \qquad n = \frac{e}{1+e} \qquad C_u = \frac{d_{60}}{d_{10}} \qquad S_y = \frac{V_{wd}}{V_T} \qquad S_r = \frac{V_{wr}}{V_T} \qquad n = S_y + S_r$$

$$\tau = \mu\left(\frac{dv}{dx}\right) \qquad R_e = \frac{\rho v d}{\mu} \qquad E = \frac{PW}{\rho g} + \frac{mv^2}{2} + zW \qquad h = \frac{P}{\rho g} + \frac{v^2}{2g} + z \qquad \Phi = gh$$

$$P = \rho g h \qquad \sigma = \frac{F}{A} \qquad \sigma_T = \rho_s(1-n)gz + n\rho_w g h \qquad \sigma_e = \sigma_T - P \qquad F_s = \rho g \frac{dh}{dz}$$

$$Q = -KA\left(\frac{dh}{dl}\right) \qquad q = \frac{Q}{A} \qquad v = \frac{q}{n} \qquad K = k_i\left(\frac{\rho g}{\mu}\right) \qquad v_z = \frac{q_z}{\theta} = -\frac{K(\theta)}{\theta}\cdot\frac{d}{dz}\left(\psi(\theta)+z\right)$$

$$K_{\parallel} = \sum \frac{K_i b_i}{b_T} \qquad K_{\perp} = \frac{b_T}{\sum \frac{b_i}{K_i}} \qquad \beta = -\left(\frac{d\rho/\rho}{dP}\right) \qquad \beta = -\left(\frac{dV_w/V_w}{dP}\right) \qquad \alpha = -\left(\frac{dV_T/V_T}{d\sigma_e}\right)$$

$$S_s = \rho_w g(\alpha + n\beta) \qquad S = S_s b \qquad T = Kb \qquad V_w = SA\Delta h$$

$$\frac{\partial}{\partial x}\left(K_x\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y\frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z\frac{\partial h}{\partial z}\right) = 0 \qquad \frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} + \frac{\partial^2 h}{\partial z^2} = 0$$

$$\frac{\partial}{\partial x}\left(K_x\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y\frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z\frac{\partial h}{\partial z}\right) = S_s\frac{\partial h}{\partial t} \qquad \frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} + \frac{\partial^2 h}{\partial z^2} = \frac{S_s}{K}\frac{\partial h}{\partial t}$$

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = \frac{S}{T}\frac{\partial h}{\partial t} \qquad \frac{\partial^2 h}{\partial r^2} + \frac{1}{r}\frac{\partial h}{\partial r} = \frac{S}{T}\frac{\partial h}{\partial t}$$

$$Q = \frac{pKH}{f} \qquad p = \#\ \text{streamtubes and}\ f = \#\ \text{head drops}$$

$$h_o - h = \frac{Q}{4\pi T}W(u) \qquad u = \frac{r^2 S}{4Tt} \qquad W(u) = -0.5772 - ln(u) + u - \frac{u^2}{2\cdot 2!} + \frac{u^3}{3\cdot 3!} - \frac{u^4}{4\cdot 4!} + \cdots$$

$$\text{Theis Relations:} \qquad T = \frac{Q}{4\pi(h_o - h)}W(u) \qquad \text{and} \qquad S = \frac{4Tut}{r^2}$$

$$\text{Cooper-Jacob Relations:} \qquad T = \frac{2.3Q}{4\pi\Delta(h_o - h)} \qquad \text{and} \qquad S = \frac{2.25Tt_o}{r^2}$$

$$z = \left(\frac{\rho_f}{\rho_s - \rho_f}\right)h \qquad \text{or} \qquad z \approx 40h$$