CE 3372 Water Systems Design
Fall 2016
Equation List

Unit conversions

$$1 \text{ meter} = 3.28 \text{ feet} \tag{1}$$

$$1 \text{ cubic foot} = 7.48 \text{ gallons} \tag{2}$$

$$1 \text{ kilogram } \approx 2.2 \text{ pounds} \tag{3}$$

$$1 \text{ acre} = 43,560 \text{ square feet} \tag{4}$$

$$1 \ \frac{\text{newton-meter}}{\text{second}} = 1\text{Watt} \tag{5}$$

Modified Bernoulli (Energy) equation.

$$\frac{p_1}{\rho g} + \alpha_1 \frac{V_1^2}{2g} + z_1 + h_p = \frac{p_2}{\rho g} + \alpha_2 \frac{V_2^2}{2g} + z_2 + h_t + h_l \tag{6}$$

Darcy-Weisbach head-loss equation

$$h_l = f \frac{L}{D} \frac{V^2}{2g} \tag{7}$$

Hazen-Williams head-loss equation (U.S. Customary)

$$h_f = 3.02 \ L \ D^{-1.167} (\frac{V}{C_h})^{1.85} \tag{8}$$

Jain equation for pressurized pipes (U.S. or S.I.)

$$Q = -2.22 D^{5/2} \times \sqrt{g h_f / L} \times [log_{10}(\frac{k_s}{3.7D} + \frac{1.78\nu}{D^{3/2}\sqrt{g h_f / L}})] \tag{9}$$

Jain approximation for friction factor (U.S. or S.I.)

$$f = \frac{0.25}{[log_{10}(\frac{\frac{k_e}{D}}{3.7} + \frac{5.74}{Re_d^{0.9}})]^2} \tag{10}$$

Jain approximation for diameter (U.S. or S.I.)

$$D = 0.66[\epsilon^{1.25} \times (\frac{LQ^2}{g h_f})^{4.75} + \nu Q^{9.4} \times (\frac{L}{g h_f})^{5.2}]^{0.04} \tag{11}$$

Manning's equation (U.S. Customary and S.I. units)

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \text{ (U.S. Customary)} \tag{12}$$

$$Q = \frac{1.0}{n} A R^{2/3} S^{1/2} \text{ (S.I.)} \tag{13}$$

Rational runoff equation (U.S. Customary)

$$Q_{peak} = C \times i \times A \tag{14}$$

where i is intensity in inches-per-hour, and A is drainage area in acres.

Depth-Area, -Topwidth, -Perimeter for Trapezoidal Channel (both side slopes same)

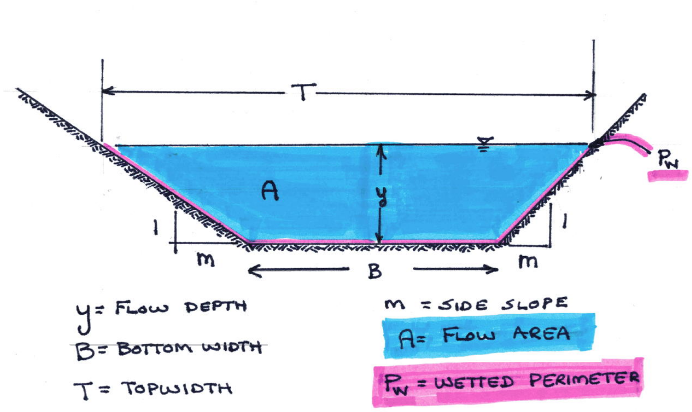

Figure 1: Definition Sketch for a Trapezoidal Channel

$$A_{\text{trap.}}(y) = By + y^2 m \tag{15}$$

$$T_{\text{trap.}}(y) = B + 2my \tag{16}$$

$$P_{w\ \text{trap.}}(y) = B + 2\sqrt{y^2 + my^2} \tag{17}$$

Depth-Area, -Topwidth, -Perimeter for Circular Conduit

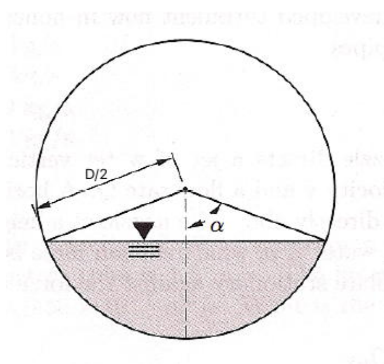

Figure 2: Definition Sketch for a Circular Conduit

$$\alpha_{\text{circ.}}(y) = cos^{-1}(1 - \frac{2y}{D}) \tag{18}$$

$$A_{\text{circ.}}(y) = \frac{D^2}{4}(\alpha - sin\alpha\ cos\alpha) \tag{19}$$

$$T_{\text{circ.}}(y) = D\ sin\alpha \tag{20}$$

$$P_{w\ \text{circ.}}(y) = D\ \alpha \tag{21}$$

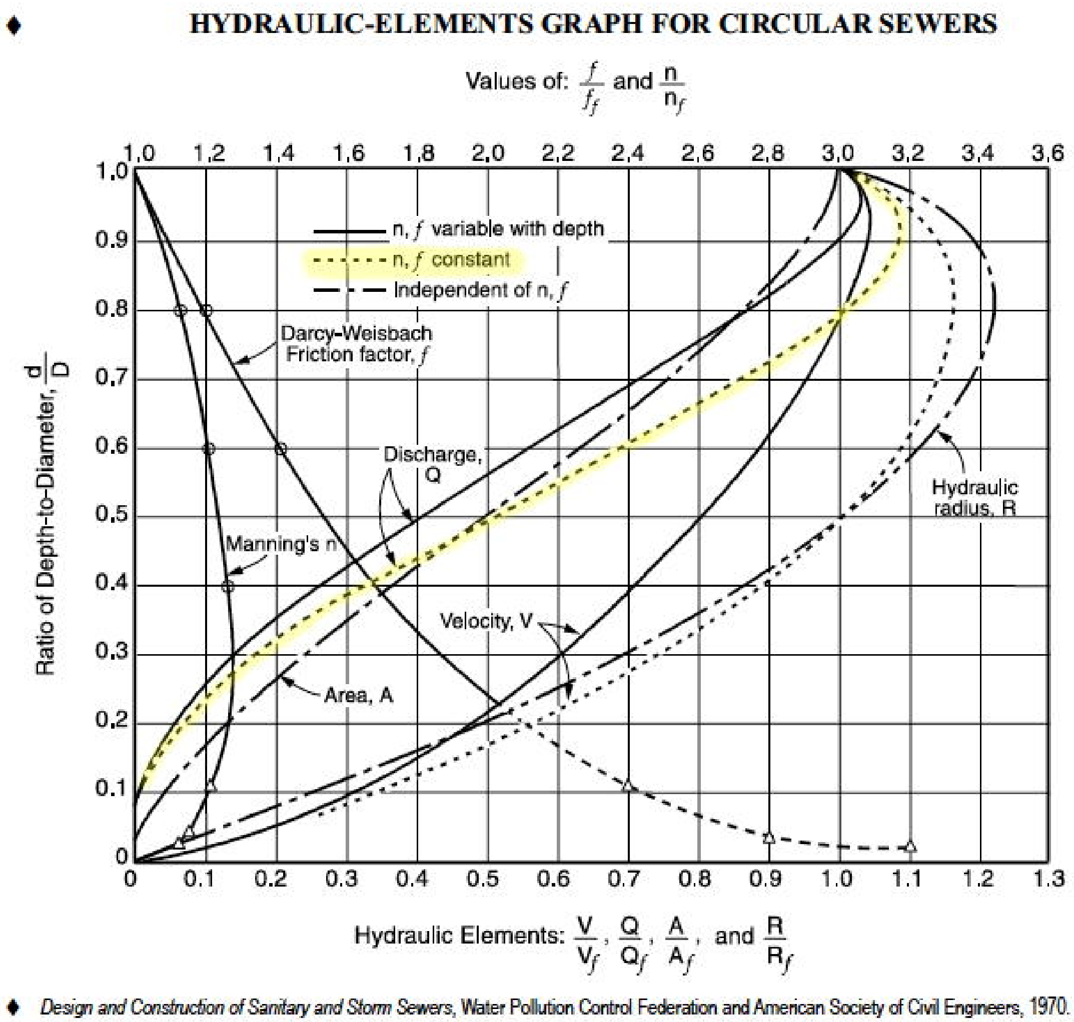

Figure 3: Hydraulic element chart for a circular conduit