Math Field Day 2012 Short Course Event
Symbols, Formulas, Conversion Factors, Constants, and Definitions
(foot-pound-second system of units - USCS)

Symbols	
a	acceleration in ft/sec^2
A	area in ft^2
cfs	cubic feet per second, ft^3 /sec
d	depth or diameter
f	Darcy-Weisbach friction factor
g	gravitational acceleration in ft/sec^2 = 32.2 ft/sec^2
gpm	gallons per minute
mgd	million gallons per day
h	head in ft, height in ft, pressure head in ft
h_L	Lost head in ft
in	inch
lb	pound
n	roughness factor in Manning's formulas
p	pressure in lb/ft^2 , wetted perimeter in ft
psf	lb/ft^2 , gage
psi	lb/in^2 , gage
Q	volume rate of flow in cfs
q	volume flow rate per unit width of channel
R	hydraulic radius
w	unit weight in lb/ft^3 (62.4 lb/ft^3 for water)
S	Slope
t	Time
v or V	velocity

Conversion Factors
7.48 gal = 1 ft^3
12 in = 1 ft
60 s = 1 min
144 in^2 = 1 ft^2

Unit Conversions
$gpm \rightarrow {ft^3}/{\sec} \Rightarrow \frac{gal}{\min} \times \frac{1\min}{60\sec} \times \frac{1ft^3}{7.48gal}$
$psi \rightarrow psf \Rightarrow \frac{lb}{in^2} \times \frac{144in^2}{1ft^2}$

Constants
$g = 32.2\ {ft}/{\sec^2}$
$w = 62.4\ {lb}/{ft^3}$ (water)

Equations of Fluid Flow	
1. Equation of Continuity	$Q = A_1V_1 = A_2V_2$ = constant
2. Energy Equation (Bernoulli Theorem)	$\frac{p_1}{w} + \frac{v_1^2}{2g} + z_1 - h_L = \frac{p_2}{w} + \frac{v_2^2}{2g} + z_2$
2a. Pressure head	$h_p = \frac{p}{w}$
2b. Velocity head	$h_v = \frac{v^2}{2g}$
2c. Static head	$h_s = z$ = elevation above a reference
3. Manning formula for open channel flow (use only in the foot-pound-second system)	$Q = AV = A(\frac{1.486}{n})R^{2/3}S^{1/2}$
3a. Hydraulic Radius formula (use to get R in the Manning formula)	$R = \frac{cross\ sectional\ area\ of\ flow}{wetted\ \ perimeter}$
4. Darcy-Weisbach formula, head loss for flow in pipes under pressure	$h_L = f\left(\frac{L}{d}\right)\left(\frac{V^2}{2g}\right)$

Hydraulic Jump (constant flow in rectangular channel)
5a. Depths Relationship: $\frac{q^2}{g} = y_1y_2\left(\frac{y_1 + y_2}{2}\right)$
5b. Specific Energy (E): $E = depth + velocity\ \ head$ $E = y + {V^2}/{2g}$
5c. Loss of head = $E_1 - E_2$