HYDROLOGY EXAM SHEET

Change in storage: $\Delta S = Vin - Vout$

Watershed slope: $S = \Delta E/H$

Drainage density: $D = \frac{\sum_{i=1}^{N} L_i}{A}$

Bifurcation ratio: $\frac{N_i}{N_{i+1}} = R_n$

Law of stream number: $N_i = R_n^{K-i}$

Law of stream length: $L_i = L_1 R_L^{i-1}$

The expected value (average): $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$

Variance: $V = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$

Standard deviation $S = \sqrt{V}$

Weibull plotting position: $P(X \leq x) = \frac{m}{n+1}$

Exceedance probability $P(X > x) = 1 - P(X \leq x)$

Return period: $T = \frac{1}{P(X > x)}$

Gumbel distribution (extreme value distribution): $P(X \leq x) = \mathbf{exp}\left[-\mathbf{exp}\left(-\left[\frac{x-u}{\alpha}\right]\right)\right]$

Distribution parameters $\alpha = \frac{\sqrt{6}\,S}{\pi}$ and $u = \bar{x} - 0.5772\alpha$

Extreme rainfall depth at duration d and return period T: $x_{d,T} = \bar{x}_d + K_T S_d$

Frequency factor $K_T = -\frac{\sqrt{6}}{\pi}\left[0.5772 + \mathbf{ln}\left(\mathbf{ln}\left[\frac{T}{T-1}\right]\right)\right]$

Rainfall intensity $i(mm/hr) = \frac{x_{d,T}}{d}$

Rational method of peak flow (m^3/s): $Q = 0.278\,C\,i\,A$ (i in mm/hr) (A in km^2)

Time of concentration (minutes): $t_c = \frac{0.828(L \times n)^{0.467}}{S^{0.235}}$ (L in m) (n surface roughness)

Un-gauged site precipitation (point estimation): $P_{un-gauged} = \frac{\sum P \times W}{\sum W}$ $W = 1/D^2$

Areal precipitation: $\bar{P} = \frac{\sum P \times A}{\sum A}$

Evaporation rate: $E_r = \frac{R_n}{l_v \rho} \times k_s \times k_c$ R_n: Solar radiation, ρ = 1000 kg/m^3.

l_v (KJ/kg) = 2500 – 2.36 T

Infiltration rate: $f = f_c + (f_0 - f_c)e^{-kt}$ f_0: initial infiltration, f_c: equilibrium infiltration

Depression storage: $D_s = S_c\left(1 - e^{-P_n / S_c}\right)$ S_c: Storage capacity, P_n= total rain – E_r – f – interception.

Maximum retention storage: $S = \frac{1000}{CN} - 10$ Excess rain (inches) $P_e = \frac{(P - 0.2S)^2}{(P + 0.8S)}$

For AMC(I) dry soil: $CN(I) = \frac{4.2CN(II)}{10 - 0.058CN(II)}$ For AMC(III) wet soil: $CN(III) = \frac{23CN(II)}{10 + 0.13CN(II)}$

UH convolution equation: $Q_n = \sum_{m=1}^{n \le M} P_m U_{n-m+1}$ or $Q_n = P_1 U_n + P_2 U_{n-1} + P_3 U_{n-2} + \ldots + P_n U_1$

M: total # of rainfall pulses, P_m: excess rainfall depth (cm) at pulse m, U: unit hydrograph value.

$n = N - M + 1$, and N: total hydrograph time steps.

S-hydrograph from given X-hr UH: $S(t) = \Delta t_x\left[U_x(t) + U_x(t - \Delta t_x) + U_x(t - 2\Delta t_x) + U_x(t - 3\Delta t_x)\ldots\right]$

Y-hr UH: $U_y(t) = \frac{1}{\Delta t_y}\left[S(t) - S(t - \Delta t_y)\right]$

Basin lag time (hrs) $T_L = C_t(L \times L_c)^{0.3}$ L & L_c in (km)

Duration of excess rainfall (hr) $D = \frac{T_L}{5.5}$ Adjusted basin lag time (hrs) $T_L' = T_L + 0.25(D' - D)$

For large basins, UH base time (days) $T_b = 3 + \frac{T_L'}{8}$ For small basins, UH base time (hrs) $T_b = 4T_L$.

Peak flow $Q_p = \frac{2.78 C_p A}{T_L'}$ Time to peak $T_p = \frac{D'}{2} + T_L'$

$W50 = 5.87(Q_p / A)^{-1.08}$ $W75 = \frac{W50}{1.75}$

Storage volume of existed reservoir $\Delta V_1 = \frac{h}{2}(A_1 + A_2)$

Darcy equation $V = -k\frac{\partial h}{\partial r} = -k\,s$

Steady flow from the confined aquifer: $Q = \frac{2\pi k\,D(h_2 - h_1)}{\ln(r_2/r_1)}$

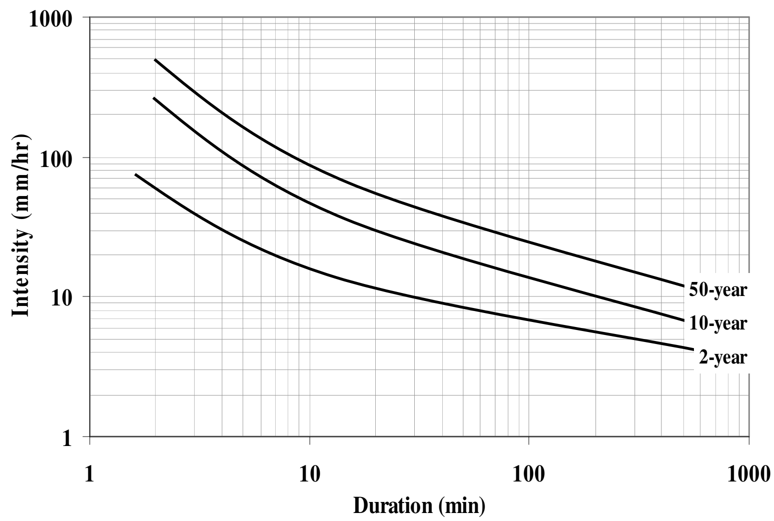
Steady flow from the unconfined aquifer: $Q = \frac{2\pi k\,(h_2^2 - h_1^2)}{\ln(r_2/r_1)}$

Hydraulic conductivity $k_H = \frac{k_1 D_1 + k_2 D_2 + ... + k_n D_n}{D_1 + D_2 + ... + D_n}$

$k_V = \frac{d_1 + d_2 + ... + d_n}{\frac{d_1}{k_1} + \frac{d_2}{k_2} + ... + \frac{d_n}{k_n}}$

Drop in water table (non-equilibrium analysis) $s_d = \frac{Q}{4\pi T}\ln\left(\frac{2.25\,T\,t}{r^2\,S}\right)$

IDF curve



CN