# HYDROLOGY SURFACE WATER EQUATION LIST

## (1) CONTINUITY EQUATION FOR RIVER DISCHARGE

$$Q = AV = wdV = wd\frac{L}{t} = \frac{VOL}{t}$$

Where $Q$ = DISCHARGE $(L^3/t)$
$A$ = Channel cross-sectional AREA $(L^2)$
$V$ = VELOCITY $(L/t)$
$w$ = CHANNEL WIDTH $(L)$
$d$ = CHANNEL DEPTH $(d)$
$VOL$ = VOLUME $(L^3)$
$t$ = time (time units)

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## (2) WATERSHED DRAINAGE DENSITY

$$D_d = \frac{\Sigma L}{A_d}$$

Where $\Sigma L$ = Sum of total stream lengths $(L)$
$A_d$ = drainage Area $(L^2)$
$D_d$ = DRAINAGE DENSITY $(L/L^2 = m/km^2)$

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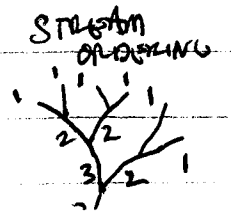
## (3) SHREVE MAGNITUDE FOR WATERSHEDS




$M$ = Σ FREQUENCY OF FIRST ORDER STREAMS

(4) RATIONAL RUNOFF METHOD (for watersheds)

$$Q_p = CIA \quad \text{where}$$

$Q_p$ = PEAK RUNOFF DISCHARGE ($L^3/t$)
$C$ = RATIONAL RUNOFF COEFFICIENT (dimensionless)
$I$ = RAINFALL INTENSITY ($L/t$)
$A_d$ = DRAINAGE AREA ($L^2$)

VALUES OF "C"

PAVEMENT $C = 0.70 - 0.95$
SANDY SOILS $C = 0.20 - 0.40$
CLAYEY SOILS/ COLLUVIUM $C = 0.40 - 0.50$

NOTE: WHERE SOILS ARE 100% SATURATED, $C \longrightarrow 1.0$,
SO IN THIS CASE $Q_p = IA$

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(5) FLOOD RECURRENCE INTERVAL

$$R.I. = \frac{n+1}{m}$$ where $n$ = TOTAL NO. OF EVENTS OR YEARS

$M$ = RANK OF EVENT, WITH #1 = LARGEST

$$P = \frac{1}{R.I.}$$ $P$ = PROBABILITY OF GIVEN MAGNITUDE OF FLOOD

(6) PEAK DISCHARGE

$Q_p$ = MAXIMUM DISCHARGE ON RECORD ($L^3/t$)

$Q_p$ DAILY = MAX. DAILY DISCHARGE

$Q_p$ ANNUAL = MAX YEARLY Q

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(7) EMPIRICAL HYDROLOGIC RELATIONS FOR SELECT REGIONAL WATERSHEDS

(A) $Q_{max} = 38 M^{0.89} D^{-0.50}$ FOR APPALACHIAN PLATEAU REGION

where $Q_{max}$ = maximum DISCHARGE ($L^3/t$)
$M$ = SIEVE MAGNITUDE (DIMENSIONLESS)
$D$ = DRAINAGE DENSITY ($L/L^2$)

(B) $Q_{2.33} = 34.5 A^{0.93}$ (VERMONT WATERSHED)

$Q_{2.33}$ = DISCHARGE WITH A 2.33 yr RECURRENCE INTERVAL

$A$ = DRAINAGE AREA

(C) GENERALIZED RELATIONSHIP

$Q_x = a A^b$ b range: 0.5 – 0.9

where $x$ = RECURRENCE INTERVAL, $Q$ = DISCHARGE, $A$ = DRAINAGE AREA, $a$ = Coefficient, $b$ = exponent.

(8) TIME FOR HYDRAULIC CONCENTRATION OF DRAINAGE BASIN

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DEFINED: TIME REQUIRED DURING A STORM, FOR OVERLAND AND CHANNEL FLOW TO TRAVEL FROM THE MOST DISTANT DRAINAGE DIVIDE TO THE OUTLET OF THE BASIN

$$t_c = \frac{L^{1.15}}{7700\, H^{0.38}}$$ (EMPIRICAL EQUATION)

$t_c$ = TIME OF CONCENTRATION (HOURS)

$L$ = LENGTH FROM DIVIDE TO BASIN OUTLET (ft)

$H$ = BASIN RELIEF BETWEEN DIVIDE AND OUTLET (ft)

HOW-TO: Steps in plotting a Gumbel flood-frequency curve:

1. Count or calculate the length of record (n, in years).

2. Determine the rank (r) for each flood of record. Rank in order from greatest flood (r = 1) to least flood (r = n).

3. Determine the recurrence interval for all floods with the equation (n + 1)/r.

4. Select a vertical axis for plotting discharge on the Gumbel curve. This takes experience and intuition, as the vertical axis must allow for the greatest flood of record AND 200 YEAR RECURRENCE FLOODS, which are usually greater than any flood of record. As a general rule, a vertical axis in which the greatest flood of record is 1/2 to 2/3 of the maximum value on the vertical axis will be adequate.

5. Plot the individual flood events on the curve.

6. Fit the curve with a straight line, or 2 or 3 straight line segments. Line segments should be defined by more than 2 data.