# Important Streamflow Measurement Formulas PDF

Formulas
Examples
with Units

**List of 32**
**Important Streamflow Measurement Formulas**

## 1) Concentration of Variable of Interest given Instantaneous Discharge and Mass Flux Formula

Evaluate Formula

Formula

$$c = \frac{Q_m}{Q_{instant}}$$

Example with Units

$$4 = \frac{120\,m^3/s}{30\,m^3/s}$$

## 2) Instantaneous Discharge given Instantaneous Mass Flux Formula

Evaluate Formula

Formula

$$Q_{instant} = \frac{Q_m}{c}$$

Example with Units

$$30\,m^3/s = \frac{120\,m^3/s}{4}$$

## 3) Mass Flux Computation Formula

Evaluate Formula

Formula

$$Q_m = c \cdot Q_{instant}$$

Example with Units

$$120\,m^3/s = 4 \cdot 30\,m^3/s$$

## 4) An Introduction to River Hydraulics Formulas

### 4.1) Intermediate and High Flows Formulas

#### 4.1.1) Conveyance Function determined by Chezy's Law Formula

Evaluate Formula

Formula

$$K = C \cdot \left( \frac{A^{\frac{3}{2}}}{P^{\frac{1}{2}}} \right)$$

Example with Units

$$6.9714 = 1.5 \cdot \left( \frac{12.0\,m^2{}^{\frac{3}{2}}}{80\,m^{\frac{1}{2}}} \right)$$

#### 4.1.2) Conveyance Function Determined by Manning's Law Formula

Evaluate Formula

Formula

$$K = \left( \frac{1}{n} \right) \cdot \frac{(A)^{\frac{5}{3}}}{(P)^{\frac{2}{3}}}$$

Example with Units

$$8.2226 = \left( \frac{1}{0.412} \right) \cdot \frac{(12.0\,m^2)^{\frac{5}{3}}}{(80\,m)^{\frac{2}{3}}}$$

### 4.1.3) Cross-sectional Area using Chezy's Law Formula

Evaluate Formula

Formula

$$A = \left( \frac{K \cdot P^{\frac{1}{2}}}{C} \right)^{\frac{2}{3}}$$

Example with Units

$$13.1531\,\text{m}^2 = \left( \frac{8 \cdot 80\,\text{m}^{\frac{1}{2}}}{1.5} \right)^{\frac{2}{3}}$$

### 4.1.4) Cross-sectional Area using Manning's Law Formula

Evaluate Formula

Formula

$$A = \left( K \cdot n \cdot P^{\frac{2}{3}} \right)^{\frac{3}{5}}$$

Example with Units

$$11.804\,\text{m}^2 = \left( 8 \cdot 0.412 \cdot 80\,\text{m}^{\frac{2}{3}} \right)^{\frac{3}{5}}$$

### 4.1.5) Friction Slope Formula

Evaluate Formula

Formula

$$S_f = \frac{Q_{instant}^{2}}{K^2}$$

Example with Units

$$14.0625 = \frac{30\,\text{m}^3/\text{s}^{2}}{8^2}$$

### 4.1.6) Instantaneous Discharge given Friction Slope Formula

Evaluate Formula

Formula

$$Q_{instant} = \sqrt{S_f \cdot K^2}$$

Example with Units

$$29.9333\,\text{m}^3/\text{s} = \sqrt{14 \cdot 8^2}$$

### 4.1.7) Wetted Perimeter from Manning's Law Formula

Evaluate Formula

Formula

$$P = \left( \left( \frac{1}{n} \right) \cdot \left( \frac{A^{\frac{5}{3}}}{K} \right) \right)^{\frac{3}{2}}$$

Example with Units

$$83.3628\,\text{m} = \left( \left( \frac{1}{0.412} \right) \cdot \left( \frac{12.0\,\text{m}^2{}^{\frac{5}{3}}}{8} \right) \right)^{\frac{3}{2}}$$

### 4.1.8) Wetted Perimeter using Chezy's Law Formula

Evaluate Formula

Formula

$$P = \left( C \cdot \left( \frac{A^{\frac{3}{2}}}{K} \right) \right)^2$$

Example with Units

$$60.75\,\text{m} = \left( 1.5 \cdot \left( \frac{12.0\,\text{m}^2{}^{\frac{3}{2}}}{8} \right) \right)^2$$

## 4.2) Low Flow Formulas

### 4.2.1) Cease to Flow Depth given Depth at Gauging Station Formula

Evaluate Formula

Formula

$$h_{csf} = h_G - H_c \cdot \left( Q \right) - Q^{2^2}$$

Example with Units

$$0.1\,\text{m} = 6.01\,\text{m} - 0.05\,\text{m} \cdot \left( 3.0\,\text{m}^3/\text{s} \right) - 2.4^2$$

### 4.2.2) Depth at Gauging Station Formula

Evaluate Formula

Formula

$$h_G = h_{csf} + H_c \cdot \left( Q \right) + Q^{2^2}$$

Example with Units

$$6.01\,\text{m} = 0.1\,\text{m} + 0.05\,\text{m} \cdot \left( 3.0\,\text{m}^3/\text{s} \right) + 2.4^{2^2}$$

### 4.2.3) Discharge given Depth at Gauging Station Formula

Evaluate Formula

Formula

$$Q = \frac{h_G - h_{csf} - Q^{2^2}}{H_c}$$

Example with Units

$$3\,\text{m}^3/\text{s} = \frac{6.01\,\text{m} - 0.1\,\text{m} - 2.4^{2^2}}{0.05\,\text{m}}$$

### 4.2.4) Head at Control given Depth at Gauging Station Formula

Evaluate Formula

Formula

$$H_c = \frac{h_G - h_{csf} - Q^{2^2}}{Q}$$

Example with Units

$$0.05\,\text{m} = \frac{6.01\,\text{m} - 0.1\,\text{m} - 2.4^{2^2}}{3.0\,\text{m}^3/\text{s}}$$

## 5) Dilution Technique of Streamflow Measurements Formulas

### 5.1) Average Depth of Stream given Length of Reach Formula

Evaluate Formula

Formula

$$d_{avg} = \frac{0.13 \cdot B^{2^2} \cdot C \cdot \left( 0.7 \cdot C + 2 \cdot \sqrt{g} \right)}{L \cdot g}$$

Example with Units

$$15.1535\,\text{m} = \frac{0.13 \cdot 50\,\text{m}^{2^2} \cdot 1.5 \cdot \left( 0.7 \cdot 1.5 + 2 \cdot \sqrt{9.8\,\text{m/s}^2} \right)}{24\,\text{m} \cdot 9.8\,\text{m/s}^2}$$

### 5.2) Average Width of Stream using Mixing Length Formula

Evaluate Formula

Formula

$$B = \sqrt{\frac{L \cdot g \cdot d_{avg}}{0.13 \cdot C \cdot \left( 0.7 \cdot C + 2 \cdot \sqrt{g} \right)}}$$

Example with Units

$$49.7461\,\text{m} = \sqrt{\frac{24\,\text{m} \cdot 9.8\,\text{m/s}^2 \cdot 15\,\text{m}}{0.13 \cdot 1.5 \cdot \left( 0.7 \cdot 1.5 + 2 \cdot \sqrt{9.8\,\text{m/s}^2} \right)}}$$

### 5.3) Constant Rate Injection Method or Plateau Gauging Formula

Evaluate Formula

Formula

$$Q_f = Q_s \cdot \frac{C_2 - C_0}{C_1 - C_2}$$

Example with Units

$$20\,\text{m}^3/\text{s} = 60\,\text{m}^3/\text{s} \cdot \frac{6 - 4}{12 - 6}$$

### 5.4) Discharge in Stream by Constant Rate Injection Method Formula

Evaluate Formula

Formula

$$Q_s = Q_f \cdot \left(\frac{C_1 - C_2}{C_2 - C_0}\right)$$

Example with Units

$$60\,\text{m}^3/\text{s} = 20\,\text{m}^3/\text{s} \cdot \left(\frac{12 - 6}{6 - 4}\right)$$

### 5.5) Length of Reach Formula

Evaluate Formula

Formula

$$L = \frac{0.13 \cdot B^2 \cdot C \cdot \left(0.7 \cdot C + 2 \cdot \sqrt{g}\right)}{g \cdot d_{avg}}$$

Example with Units

$$24.2456\,\text{m} = \frac{0.13 \cdot 50\,\text{m}^2 \cdot 1.5 \cdot \left(0.7 \cdot 1.5 + 2 \cdot \sqrt{9.8\,\text{m/s}^2}\right)}{9.8\,\text{m/s}^2 \cdot 15\,\text{m}}$$

## 6) Electromagnetic Method Formulas

### 6.1) Current in Coil in Electromagnetic Method Formula

Evaluate Formula

Formula

$$I = E \cdot \frac{d}{\left(\frac{Q_s}{k}\right)^{\frac{1}{n_{system}}} - K_2}$$

Example with Units

$$50.113\,\text{A} = 10 \cdot \frac{3.23\,\text{m}}{\left(\frac{60\,\text{m}^3/\text{s}}{2}\right)^{\frac{1}{2.63}} - 3}$$

### 6.2) Depth of Flow in Electromagnetic Method Formula

Evaluate Formula

Formula

$$d = \frac{\left(\left(\frac{Q_s}{k}\right)^{\frac{1}{n_{system}}} - K_2\right) \cdot I}{E}$$

Example with Units

$$3.2298\,\text{m} = \frac{\left(\left(\frac{60\,\text{m}^3/\text{s}}{2}\right)^{\frac{1}{2.63}} - 3\right) \cdot 50.11\,\text{A}}{10}$$

### 6.3) Measurement for Discharge in Electromagnetic Method Formula

Evaluate Formula

Formula

$$Q_s = k \cdot \left( \left( E \cdot \frac{d}{I} \right) + K_2 \right)^{n_{system}}$$

Example with Units

$$60.0017\,\text{m}^3/\text{s} = 2 \cdot \left( \left( 10 \cdot \frac{3.23\,\text{m}}{50.11\,\text{A}} \right) + 3 \right)^{2.63}$$

## 7) Stage Discharge Relationship Formulas

### 7.1) Actual Discharge from Backwater Effect on Rating Curve Normalized Curve Formula

Evaluate Formula

Formula

$$Q_a = Q_0 \cdot \left( \frac{F}{F_o} \right)^{m}$$

Example with Units

$$9.001\,\text{m}^3/\text{s} = 7\,\text{m}^3/\text{s} \cdot \left( \frac{2.5\,\text{m}}{1.512\,\text{m}} \right)^{0.5}$$

### 7.2) Actual Fall at Stage given Actual Discharge Formula

Evaluate Formula

Formula

$$F = F_o \cdot \left( \frac{Q_a}{Q_0} \right)^{\frac{1}{m}}$$

Example with Units

$$2.4994\,\text{m} = 1.512\,\text{m} \cdot \left( \frac{9\,\text{m}^3/\text{s}}{7\,\text{m}^3/\text{s}} \right)^{\frac{1}{0.5}}$$

### 7.3) Diffusion Coefficient in Advection Diffusion Flood Routing Formula

Evaluate Formula

Formula

$$D = \frac{K}{2} \cdot W \cdot \sqrt{\bar{S}}$$

Example with Units

$$800\,\text{m}^2/\text{s} = \frac{8}{2} \cdot 100\,\text{m} \cdot \sqrt{4.0}$$

### 7.4) Gauge Height given Discharge for Non-Alluvial Rivers Formula

Evaluate Formula

Formula

$$G = \left( \frac{Q_s}{C_r} \right)^{\frac{1}{\beta}} + a$$

Example with Units

$$10.2055\,\text{m} = \left( \frac{60\,\text{m}^3/\text{s}}{1.99} \right)^{\frac{1}{1.6}} + 1.8$$

### 7.5) Measured Unsteady Flow Formula

Evaluate Formula

Formula

$$Q_M = Q_n \cdot \sqrt{1 + \left( \frac{1}{v_W \cdot S_o} \right) \cdot dh/dt}$$

Example with Units

$$14.4\,\text{m}^3/\text{s} = 12\,\text{m}^3/\text{s} \cdot \sqrt{1 + \left( \frac{1}{50.0\,\text{m/s} \cdot 0.10} \right) \cdot 2.2}$$

## 7.6) Normal Discharge at given Stage under Steady Uniform Flow Formula

Evaluate Formula

Formula

$$Q_n = \frac{Q_M}{\sqrt{1 + \left(\frac{1}{v_W \cdot S_o}\right) \cdot dh/dt}}$$

Example with Units

$$12\,m^3/s = \frac{14.4\,m^3/s}{\sqrt{1 + \left(\frac{1}{50.0\,m/s \cdot 0.10}\right) \cdot 2.2}}$$

## 7.7) Normalized Discharge of Backwater Effect on Rating Curve Normalized Curve Formula

Evaluate Formula

Formula

$$Q_0 = Q_a \cdot \left(\frac{F_o}{F}\right)^m$$

Example with Units

$$6.9992\,m^3/s = 9\,m^3/s \cdot \left(\frac{1.512\,m}{2.5\,m}\right)^{0.5}$$

## 7.8) Normalized Value of Fall given Discharge Formula

Evaluate Formula

Formula

$$F_o = F \cdot \left(\frac{Q_0}{Q_a}\right)^{\frac{1}{m}}$$

Example with Units

$$1.5123\,m = 2.5\,m \cdot \left(\frac{7\,m^3/s}{9\,m^3/s}\right)^{\frac{1}{0.5}}$$

## 7.9) Relationship between Stage and Discharge for Non-Alluvial Rivers Formula

Evaluate Formula

Formula

$$Q_s = C_r \cdot (G - a)^{\beta}$$

Example with Units

$$59.9377\,m^3/s = 1.99 \cdot (10.2\,m - 1.8)^{1.6}$$

## Variables used in list of Streamflow Measurement Formulas above

- **a** Constant of Gauge Reading
- **A** Cross-Sectional Area *(Square Meter)*
- **B** Average Width of Stream *(Meter)*
- **c** Concentration of Variable of Interest
- **C** Chézy's Coefficients
- $C_0$ Initial Concentration of Tracer
- $C_1$ High Concentration of Tracer at Section 1
- $C_2$ Concentration Profile of Tracer at Section 2
- $C_r$ Rating Curve Constant
- **d** Depth of Flow *(Meter)*
- **D** Diffusion Coefficient *(Square Meter Per Second)*
- $d_{avg}$ Average Depth of Stream *(Meter)*
- $dh/dt$ Rate of Change of Stage
- **E** Signal Output
- **F** Actual Fall *(Meter)*
- $F_o$ Normalized Value of Fall *(Meter)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- **G** Gauge Height *(Meter)*
- $H_c$ Head at Control *(Meter)*
- $h_{csf}$ Cease-to-Flow Depth *(Meter)*
- $h_G$ Depth at Gauging Station *(Meter)*
- **I** Current in Coil *(Ampere)*
- **k** System Constant k
- **K** Conveyance Function
- $K_2$ System Constant K2
- **L** Mixing Length *(Meter)*
- **m** Exponent on Rating Curve
- **n** Manning's Roughness Coefficient
- $n_{system}$ System Constant n
- **P** Wetted Perimeter *(Meter)*
- **Q** Discharge *(Cubic Meter per Second)*

## Constants, Functions, Measurements used in list of Streamflow Measurement Formulas above

- Functions: **sqrt**, sqrt(Number)
  *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- Measurement: **Length** in Meter (m)
  *Length Unit Conversion*
- Measurement: **Electric Current** in Ampere (A)
  *Electric Current Unit Conversion*
- Measurement: **Area** in Square Meter (m²)
  *Area Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s)
  *Speed Unit Conversion*
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  *Acceleration Unit Conversion*
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  *Volumetric Flow Rate Unit Conversion*
- Measurement: **Diffusivity** in Square Meter Per Second (m²/s)
  *Diffusivity Unit Conversion*

- $Q_0$ Normalized Discharge *(Cubic Meter per Second)*
- $Q_a$ Actual Discharge *(Cubic Meter per Second)*
- $Q_f$ Constant Discharge Rate at C1 *(Cubic Meter per Second)*
- $Q_{instant}$ Instantaneous Discharge *(Cubic Meter per Second)*
- $Q_m$ Instantaneous Mass Flux *(Cubic Meter per Second)*
- $Q_M$ Measured Unsteady Flow *(Cubic Meter per Second)*
- $Q_n$ Normal Discharge *(Cubic Meter per Second)*
- $Q_s$ Discharge in Stream *(Cubic Meter per Second)*
- $Q^2$ Terms of Order
- $\bar{S}$ Bed Slope
- $S_f$ Friction Slope
- $S_o$ Channel Slope
- $v_W$ Velocity of Flood Wave *(Meter per Second)*
- $W$ Width of Water Surface *(Meter)*
- $\beta$ Rating Curve Constant Beta

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